Thanks for picking up this book. I appreciate the lift.

Unique

This is the only book whose author is weird enough to try to reveal everything important about **computers** — and also **tricky living** — all in one book. You can learn part of this info yourself, without this book, by just asking weird friends & experimenting & sloshing through the Internet's drivel, but reading this book will save you lots of time and teach you tricks you can't find elsewhere. You can also call the author's cell phone, **603-666-6644**, for free help, day or night. He's usually available. He's me. Go ahead: bug me now!

Earlier editions were rated "**the best**," praised by **The New York Times** and thousands of other major newspapers, magazines, and gurus worldwide, in many countries; but this **34th edition** is even better! It adds the world's newest ~~crap~~ achievements: **Windows 11**, **Trump's downfall**, and other fantastic goodies/baddies: over 100,000 updates! It explains *clearly*, without wasting your time:

How to buy computers & smartphones smartly
How to use modern Windows, iPads, and Androids pleasantly
How to use the Internet, email, Microsoft Office, and more, beyond competence
How to write programs in *many* computer languages, to launch your career
Everything important about life, beginning with health, ending with sex, and getting intellectual & artistic along the way, with survival tips and candid chat about the no-no's (religions, politics, and international cultures)

No other book comes close.

Hop

Hop to whatever topic you like. **Page 3** shows them all. *Tricky Living* begins on page 192 and often gets bizarre. Sex jokes hide on pages 435-443, higher than kids can count.

Free phone help

Whenever you have a question about computers or anything else in your life, **call me, Russ, on my cell phone, 603-666-6644, for free help**. Yeah, call day or night, around the clock, 24 hours. I'm usually available, and I sleep just lightly.

I've answered hundreds of thousands of phone calls about computers (how to buy, use, fix, and program them), careers, and the rest of life (health, dating, other relationships, schools, math, English writing, foreign cultures, God, and beyond).

I answer most questions directly. If your question's too tricky for a quick answer, I'll teach you how to find the answer yourself and which people & resources to use. Try me. I'm free.

When you phone, **begin by saying your name, city, how you got my number ("from the 34th edition"), and your question's one-sentence summary**. Then we'll have a pleasant chat — unless I'm in the middle of another call or meeting, in which case I'll call you back free!

I occasionally travel to other countries, to learn better to think non-American. During those jaunts I might be harder to reach.

We must follow these rules:

For help about your computer, **phone when you're at the computer**. For help with your career or life, sob *before* calling, then tell me what to analyze.

To handle many calls each day while juggling other responsibilities, I must keep the average call to **7 minutes** but sometimes go longer. You can call often.

If the answer's **in this book**, I'll tell you the page but you must read it yourself.

I can't help you do **baddies** (such as taking illegal drugs, using pirated software, or bombing the USA).

If you're a kid, get your parents' permission to phone.

Ears

I wish everything in this book were 100% true, but computers & the world change faster than any human can write, so you'll occasionally bump into a paragraph that's outdated or otherwise ill-advised, for which I humbly apologize, o master! I'm your slave. Phone me anytime at 603-666-6644 to whip me into improving. I'm all ears, to improve my tongue.

Come visit

When you visit New Hampshire, **drop in & use my library**, free, anytime, day or night! In case I'm having an orgy with my 50 computers, **phone first** to pick a time when we're cooled down.

Visit **SecretFun.com**. It reveals any hot news about us, gives you useful links, and lets you read parts of this book online, free.

I read all email sent to **Russ@SecretFun.com**. I guarantee to reply, but just by phone, so then *phone me* at 603-666-6644.

Mail the coupon

Mail us the coupon on this book's last page. It gets you our **free Secret Brochure**, plus **discounts** on extra copies of this edition and other editions.

Love your librarian

These details will save your librarian from getting fired.

Title:	*Secret Guide to Computers & Tricky Living*, 34th edition
Author & publisher:	Russ Walter at 603-666-6644 (24 hours, usually in)
Rating:	this is the top-rated book about computers & life
Copywrong:	March 2022 by Russ Walter
ISBN:	Internat. Standard Book Number is 978-0-939151-54-7
Street address:	196 Tiffany Lane, Manchester NH 03104-4782
Internet addresses:	SecretFun.com, Russ@SecretFun.com

Elfish fun

I wrote most of this book myself, but over the years I've been helped by many elves, especially these:

My wife (**Donna Walter**) wrote the "Donna's comments" section.
Useful tidbits came from **Irene Vassos**, **Len Pallazola**, and **Lili Timmons**.
Priscilla Grogan and **Kira Barnum** slavishly helped me for many years.
Thousands of readers told me how to improve earlier editions.
Family & friends supported me when life got yukky.

Don't read this

My editor told me to put this stuff in. You don't have to read it.

Dedication I dedicate this book to the computer, without whom I'd be unemployed.

Acknowledgment I'd like to thank:

my many friends (whose names I've gladly forgotten)
my students (who naturally aren't my friends)
my word processor (which has a mind of its own)
all others who helped make this book impossible

I'd especially like to thank:

God (for influencing this book somehow)
Satan (for torturing me to write this book)
Bill Gates (for making software confusing, so I get paid to explain it)
Adolph Hitler (for making my dad flee Germany and meet my mom)
Donald Trump (for making the world bad enough to be worth writing about)
buyers of previous editions (for supporting this dying voice)

Prerequisite Before reading this book, you must pass this test: count to ten but (here's the catch!) without looking at your fingers. To remove the temptation, cut them off.

What this book will do for you It'll make you even richer than the author! Alas, he's broke.

Apology Any original ideas in this book are errors.

Forward because it's too late to turn back.

What's in this book?

Feast your eyes on the massive table of contents, splashed across the next page. It reveals that the Guide includes all 7 parts of computer life:

Buying:	how to buy great computers and smartphones, cheaply
Windows:	how to use Windows to handle life & the Internet
Handhelds:	how to use tablets and smartphones
Tricky living:	life beyond computers, from the practical to the naughty
Office:	how to use Microsoft Office (Word, Excel, and PowerPoint)
Programming:	how to program in Basic, Python, JavaScript, C#, and beyond
Parting:	our past, your future, and what to do next

Have fun:

Hardware details too hard to understand? Get electrified, starting on page 10.
Wanna **buy** modern computers? Their wrestling match starts on page 56.
Windows gotcha worried? Get your brain untangled, starting on page 70.
Oh-oh! Problems with security, maintenance, repairs? **Fixes** start on page 123.
Got an **Android** thingy but feel dumb about its details? Undumb on page 152.
Got an **Apple** thingy instead? Undumb, starting on page 181.
Scared about your **health** & how you'll die? Page 192 starts your glow.
Talk real **intellectual**-like by taking the hey-hey hayride bumps from page 229.
Up your **language**, in English & beyond, using tricks from page 239.
So many wild **places** in the USA and beyond! Visit them on page 285.
Become an **artiste** without being teased? Emoting starts on page 326.
Political elephants & donkeys both emit piles of shit. Savor them on page 372.
Oh no! **Trump**? Then Biden? Their rise and pratfalls start on page 379.
Make fun of **lawyers** before they make funk of you? Giggles start on page 395.
War ain't bad, it's fun — at least according to page 397.
Being good can be fun. So can **evil**. They start on 413.
Want **sex**? It starts on page 435.
Word, Excel, and PowerPoint giving you hell? Make heaven on page 444.
Learn not just one but *all* popular **programming** languages, starting on page 477.

Buying

The **buying** section gives you tricks to **use this book** then explains **how to shop** for a computer. It covers all popular computers: the towers, all-in-ones, notebook computers, tablets, and smartphones. It teaches you hardware & software jargon, reveals lots of dirt about the companies, and tells you how to get the best deals. It turns you into a German nun, who knows the difference between what's blessed and what's wurst.

It analyzes each of the computer's parts (the **chips**, **disks**, **I/O devices**, and **software**) and reveals the best way to buy **complete systems**.

Windows

The **Windows** section explains how to use the newest Windows (**Windows 10 & 11**).

It explains how to make Windows access the Internet (the **Web** and **e-mail**), using all the popular Web browsers (Edge, Internet Explorer, and Chrome) and email programs (Windows 10 Mail, Windows Live Mail, Yahoo Mail, and Gmail).

It explains how to protect your computer's **security**, make your computer run better (by doing **maintenance** and **repairs**), and give it advanced commands (using the **command prompt**, which lets you give sneaky DOS commands).

Handhelds

The **handhelds** section explains how to use popular tablets & smartphones.

It begins by explaining the best system (Android) in its 2 good forms (**pure Android** and **Samsung's Android**) and Apple's most reasonable alternative (the **iPad**).

Tricky living

There's more to life than just computers! The **tricky living** section explains everything *beyond* computers.

It begins on page 192. It digs into **health** (nutrition, exercise, maladies, and funny doctors), **daily survival** (housing, transportation, and money), **intellectuals** (educators, researchers, and scientists), **language** (how to write crazily well in English, plus how other languages differ), **places** (what's crazy in the USA, Canada, and China), **Donna's comments** (about the Chinese and crazy Americans), **arts** (painting, music, movies, and writing, all created by humans or computers), **math** (its methods, culture, and ridiculousness), **government** (politics, economy, law, war, and police secrets), **morals** (ethics, prejudice, and religions), and **sex** (its laughs & groans).

Its candid discussions of politics, religion, and sexual relations include comments from both sides of the aisle. If you're a parent who wants to shelter your kids from controversies, review this material before handing it to your kids; but it's milder than what's on TV and in high-school chitchat.

Office

The **Office** section explains how to use Microsoft Office's 3 best parts: **Word** (for word processing), **Excel** (for spreadsheets), and **PowerPoint** (for slide shows).

Programming

Our world is split into 3 classes of people:

avoiders	(who fear and loathe computers and avoid them)
users	(who use computers but don't really understand them)
programmers	(who understand computers and can teach them new tricks)

The Guide elevates your mind to the heights of class 3: it turns you into a sophisticated programmer.

To program the computer, you feed it instructions written in a computer language, which is a small part of English. The Guide's **programming** section explains all the popular computer languages & techniques.

It begins on page 477. It explains fundamental programming (using **Basic** and **Python**), applied programming (to **Web-page design** and **challenges**), and Visual programming (**Visual Basic** and **Visual C#**). It compares oodles of other **exotic languages** and gives you the history of them all. For the grand finale, you learn about programming in **assembler**.

Parting

The **parting** section is such sweet sorrow. It explains how the computer industry arose (**computer past**) and how to raise yourself (**your future**). It gives you helpful **resources** (an index and Secret Guide coupons).

Excuses from the editor, me!

Punctuation Previous editions wrote "**e-mail**"; but English gradually drops hyphens, so this edition shows the new style: "**email**." I still capitalize "**Internet**" & "**Web**," even though most news reporters have become too lazy to capitalize. The Tricky Living section obeys tradition: it puts the **period** (to end a sentence) *inside* any quotation marks; but computer sections, when quoting a word or phrase, put the period *after* the closing quotation mark, to indicate the period isn't part of what I'm quoting; same for **commas**.

Footnotes Are you an assoholic professor who gripes I have no footnotes? Note the **two feet** at the next page's bottom. They're my **footnotes** for "Government."

Buying

Windows

Handhelds

Tricky living

Microsoft Office

Programming

Parting

Praised by reviewers

If you like this book, you're not alone.

Praised by computer magazines

All the famous computer magazines have called Russ Walter the "computer guru" and praise him for giving free consulting even in the middle of the night. Here's how they evaluated *The Secret Guide to Computers*.

Compute "Russ is an industry leader."

Interface Age "The Guide is a best buy."

Microcomputing "Plan ahead; get the Secret now."

Enter "It's the best book about computer languages."

Eighty Micro "Theatrical, madcap Russ is a cult hero."

Mac User "It's an everything-under-one-roof computer technology guide."

Computer Bargain Info "The Guide is widely acclaimed by experts as brilliant."

Cider Press "The Guide should be given to all beginners with the purchase of their computers."

Softalk "The Guide fires well-deserved salvos at many sacred cows. It's long been a cult hit."

Computerworld "The Guide by unconventional computer guru Russ is informative, entertaining."

Computer Shopper "The Guide covers the entire spectrum. It's incredibly informative and amusing."

Creative Computing "The Guide is fascinating, easy to understand, an excellent book at a ridiculously low price. We especially endorse it."

Infoworld "Russ is recognized and respected in many parts of the country as a knowledgeable, effective instructor. His Guide is readable & outrageous and includes a wealth of info."

Byte "The Guide is amazing. If you've had difficulty understanding computers, or must teach other people about computers, or just want to read a good computer book, get the Guide."

PC World "Russ is a PC pioneer, a trailblazer, the user's champion. Nobody does a more thorough, practical, and entertaining job of teaching PC technology. It's a generous compendium of industry gossip, buying advice, and detailed, foolproof tutorials — a wonderful bargain."

Personal Computing "The Guide is bulging with information. You'll enjoy it. Russ's approach to text-writing sets a new style that other authors might do well to follow. It's readable, instructive, and downright entertaining. If more college texts were written in his style, more college students would graduate."

Christian Computing Magazine "The Guide is the most comprehensive reference in the industry. What planet is Russ from? It must be populated with nice people. You'll learn more from his Guide than from any 10 computer books you've ever read. To say this book is 'comprehensive' is a staggering understatement: nothing else in the industry even comes close. It's worth triple what Russ charges for it."

Popular Computing "Russ is king of the East Coast computer cognoscenti. His Guide is the biggest bargain in computer tutorials in our hemisphere. If CBS ever decides to replace Andy Rooney with a '60 Minutes' computer pundit, they'd need to look no further than Russ. His wry observations enliven his book. His Guide is the first collection of computer writings that one might dare call literature."

PC Magazine "The Guide explains the computer industry, hardware, languages, operating systems, and applications in a knowledgeable, amusing fashion. It includes Russ's unbiased view of the successes & failures of various companies, replete with inside gossip. By reading it, you'll know more than many who make their living with PCs. Whether novice or expert, you'll learn from it and have a good time doing so. No other computer book is a better value."

Computer Currents "Your computer literacy will come up short unless you know something about Russ. He's a folk hero. He knows virtually everything about personal computers and makes learning about them fun. If you've given up in disgust and dismay at reading other computer books, get the Guide. It should be next to every PC in the country. PC vendors would do themselves and their customers a big favor by packing a copy of the Guide with every computer that goes out the door. The Guide deserves the very highest recommendation."

Praised by financial magazines

Financial magazines love how the Guide helps accountants master computers.

Barron's "Russ is an expert who answers questions for free and has been inundated by calls."

Kiplinger's Personal Finance "Russ is a computer whiz whose mission is to educate people about computers. He lets strangers call him in the middle of the night for help with diagnosing a sick computer. His Guide covers all you ever wanted to know."

Abacus "Russ provides the best current treatment of programming languages. It's irreverent, like the underground books of the 1960's. It's simple to read, fast-paced, surprisingly complete, full of locker-room computer gossip, and loaded with examples."

Praised by wild magazines

Magazines that go beyond computers love how the Guide goes beyond nerds.

Esquire "The handy Guide contains lots of fact & opinion untainted by bias."

Omni "Guru Russ sympathizes deeply with people facing a system crash at midnight, so he broadcasts his home phone number and answers calls by the light of his computers, cursors winking. He's considered an excellent teacher. His Guide is utterly comprehensive."

The Whole Earth Catalog (in its "Coevolution Quarterly") "The personal-computer subculture was noted for its fierce honesty in its early years. The Guide is one of the few intro books to continue that tradition and the only intro survey of equipment that's kept up to date. Russ jokes, bitches, enthuses, condemns, and charms. The book tells the bald truth in comprehensible language."

Scientific American "The Guide is irresistible. Every step leads to a useful result. Russ's candor shines; he clarifies the faults & foibles others ignore or are vague about. The effect is that of a private chat with a friend who knows the inside story. It reads like a talented disc jockey's patter: it's flip, self-deprecatory, randy, and good-humored. His useful frank content & coherent style are unique. He includes first-rate advice. No room with a small computer and an adult beginner is well equipped without the Guide."

Praised by librarians

Librarians have called the Guide the best computer book ever written.

BookLovers Review "It's the best computer intro you can buy, a miracle, a must-have tutorial & reference."

Wilson Library Bulletin "The Guide is distinguished by its blend of clarity, organization, and humor. It cuts through the techno-haze. It packs more simple, fresh explication per page than anything else available."

School Library Journal "The Guide is a gold mine of information. It's crystal clear, while at the same time Russ delivers a laugh a paragraph along with a lot of excellent info. It's accessible even to kids, who'll love its loony humor. Buy it; you'll like it."

Net BookWatch "Many experts around the world agree this is the best single intro to computers. It's well organized, easy to understand, comprehensive, interesting, updated. Complex subjects are explained expertly. Every paragraph is easy to understand. With Russ as your guide, learning about hardware, software, and the Internet becomes pure fun. The Guide is essential reading for beginners and professionals."

Praised by computer societies

Computer societies, in their newsletters, newspapers, and magazines, have called the Guide the best computer book.

Tucson (Arizona) Computer Society "Wonderful stuff! Recommended. Very well done."

New England Computer Society "Russ is considered one of the few true computer gurus. His Guide is the world's best tutorial, the best present for anyone who wants to learn about computers without going crazy."

Boston Computer Society "The Guide is cleverly graduated, outrageous, funny. Russ turns computerese into plain speaking while making you giggle. He's years ahead of the pack instructing computer novices. His unique mix of zany humor & step-by-step instruction avoids the mistakes of manuals trying to follow his lead."

Sacramento (California) PC Users Group "The Guide is the best collection of computer help ever written. It includes just about everything you'd want to know about computers. You'll find answers for all the questions you thought of and some you didn't think of. No holds barred, Russ even tells you who in the industry made the mistakes & rotten computers and who succeeded in spite of themselves. The Guide is fascinating."

New York's "NYPC" "The Guide is the perfect book for any computer beginner because it covers a range of subjects otherwise requiring a whole reference library. It's even better for the experienced computer user, since it includes many advanced concepts, which one person could hardly remember. But one person apparently remembered them all: Russ. He's a fountain of computer knowledge and can even explain it in words of one syllable. His Guide reads like a novel: you can read simply for fun. It's recommended to anyone from rank beginner to seasoned power user."

Connecticut Computer Society "Russ's books have been used by insiders for years. He's a special teacher because of 3 factors: his comprehensive knowledge of many computer topics, his ability to break complicated processes into the smallest components, and his humor. The Guide includes his valuable, candid comments about various computers & software. He's one of the few people able to review languages, machines, and software, all in a humorous, clear manner, with the whole endeavor set off by his sense of industry perspective, history, and culture. If you're ever struck with a computer problem, give him a call."

Texas's "Golden Triangle PC Club" "Buy this book! You'll be glad! The marvelous Guide explains just about all computer topics in a way anyone can understand. In these days of having to use voice mail or email to reach tech support, it's amazing you can call Russ for help and he'll actually talk with you when you call. This book gives you extreme value for minimal cost. Russ is famous for his comprehensive knowledge of computers, his ability to simplify complicated processes, and his wry wit. Reading the Guide's a joy. He translates highly technical material into easily understandable language. He's the finest example of the preeminent computer professional. He's condensed so much material, in a way that never seems disorganized or cluttered. Anyone working with or interested in computers will find this book a must-have. The Guide stands above the crowd of computer books that just can't compete."

Praised by U.S. newspapers

The Guide's been praised by newspapers across the USA.

New Hampshire's "Hippo" "Very impressive."

Boston Phoenix "Russ has achieved international cult status. He knows his stuff, and his comprehensive Guide's a great deal."

Chicago Tribune "The Guide is the best computer book. It's a cornucopia of computer delights written by Russ, a great altruist & dreamer."

Boston Globe "Russ is a unique resource, important to beginning and advanced users. His Guide is practical, down-to-earth, easy to read."

Philadelphia Inquirer "Russ is the Ann Landers for computer klutzes, a high-tech hero. His wacky, massive Guide is filled with his folksy wit."

Dallas Times Herald "Easily the best beginners' book seen, it's not just for beginners. Its strength is how simple it makes everything, without sacrificing what matters."

Wall Street Journal "Russ is a computer expert, a guru who doesn't mind phone calls. He brings religious-like fervor to the digital world. His students are grateful. His Guide gets good reviews. He's influential."

Kentucky's "Louisville Courier" "Russ's Guide will teach you more computer fundamentals than the typical bookstore's thick books. The Guide gives his no-bull insights. The Guide's biggest appeal is its humor, wit, personality."

New York Times "The computer-obsessed will revel in Russ's Guide. He covers just about every subject in the microcomputer universe. It's unlikely you have a question his book doesn't answer."

New Jersey's "Asbury Park Press" "Most computer books, especially the good ones, are expensive — except the best one. The best computer book is the Guide. It's the only book that covers just about everything in computers."

Silicon Valley's "Times Tribune" "The Guide invites you to throw aside all rules of conventional texts and plunge into the computer world naked & unafraid. This book makes learning not just fun but hilarious, inspiring, addicting."

Connecticut's "Hartford Courant" "If you plan to buy a personal computer, the best gift for yourself is the Guide. It's crammed with info. It became an instant success as one of the few microcomputer books that was not only understandable & inexpensive but also witty — a combo still too rare today."

Detroit News "Russ is a legendary teacher. His fiercely honest Guide packs an incredible amount of info. It's the only book that includes all. He gives you all the dirt about the companies and their hardware, evaluates their business practices, and exposes problems they try to hide. Phone him; you'll always get a truthful answer."

Florida's "Hometown News" The Guide is thoroughly entertaining. It brings intimidating tech issues down to everyday language. And boy, does it cover the topics! Everything from old systems to new modern workhorses is hit upon. If you're looking for a book that touches on just about every aspect of computers and is easy to read, the Guide's for you."

Praised by overseas newspapers

The Guide's been praised by newspapers beyond the USA.

The Australian "The Guide's coverage of programming is intelligent, urbane, extremely funny, full of great ideas."

England's "Manchester Guardian" "Russ is a welcome relief. The internationally renowned computer guru tries to keep computerdom's honesty alive. His Guide's an extraordinary source of info."

Australia's "Sydney Morning Herald" "The Guide is the best computer intro published anywhere in the world. It gives a total overview of personal computers. It's stimulating, educational, provocative, a damn good read."

Fan mail

From our readers, we've received *thousands* of letters and phone calls, praising us. Here are examples.

Intoxicated

Our books make readers go nuts.

Sex "Great book. Better than sex." (Worcester, Massachusetts)

Devil "This book is great. It soars with the eagles and dances with the devil." (Chicago)

Get high "I'm high! Not on marijuana, crack, or cocaine, but on what I did at my computer with your Guide." (Beverly, Massachusetts)

Computer dreams "Wow — I loved your book. My husband says I talk about computers in my sleep." (Los Altos Hills, California)

Strange laughs "I enjoy the Guide *immensely*! My fellow workers think I'm strange because of all my laughing while reading it. Whenever I feel tired or bored, I pick up the Guide. It's very refreshing!" (Acton, Massachusetts)

Bedtime story "The book's next to the bed, where my wife and I see who grabs it first. The loser must find something else to do, which often seriously degrades reading comprehension." (Danville, New Hampshire)

Poo-poo "I finished the book at 2:30 AM and had to sit down and send you a big THANK-YOU-poo. A poet I am not, crazy I was not, until I started 18 months ago with this computer and then came *poo* who sealed my lot." (Hinesville, Georgia)

Beginners

Even beginners can master the Guide.

Face-off "I used to be an idiot. Now I can stare my computer in the face. Thanks." (San Antonio, Texas)

Godsend "You're a godsend. You saved me from being bamboozled by the local computer store." (Boston)

Saint "You should be canonized for bringing clarity and humor to a field often incomprehensible and dull." (Houston)

Computer disease "I was scared to go near a computer. I thought I might catch something. Now I can't wait." (Paterson, New Jersey)

Amaze the professor "I *love* the Guide! I've read it before taking a programming course, and I amaze my professor with my secret skills!" (Olney, Illinois)

Granny's clammy "I'm a 58-year-old grandma. My daughter gave me a PC. After weeks of frustration I got your Guide. Now I'm happy as a clam at high tide, eager to learn more & more. Wow!" (Seattle)

Bury the Book of Songs "This is the microcomputer book that should be buried in a time capsule for future archaeologists. By reading it, I've made my computer sing. My wife recognizes the melodies and wants to read the book." (Park Forest, Illinois)

Experts

Experts love the Guide.

Research center "Our research center uses and misuses gigabytes of computers. The Guide will improve our use/misuse ratio." (Naperville, Illinois)

PC Week reporter "I write for *PC Week* and think the Guide is the *best* book of its kind. I'm sending a copy to my little brother, who's a budding byte-head." (Boston)

Diehard consultant "It's really neat! I've been a computer consultant for many years, and when your book came yesterday I couldn't put it down." (Cleveland Heights, Ohio)

Math professor "I'm a math professor. The Guide's the best way in the universe to keep up to date with computers. People don't have to read anything else — it's *all* there." (New York City)

Careers

The Guide's propelled many careers.

Land a top job "Thanks to the Guide, I got an excellent job guiding the selection of computers in a department of over 250 users!" (New York City)

Land a first job "Last month, I bought your Guide. I've never seen so much info, packed so densely, in so entertaining a read. I was just offered a computer job, thanks to a presentation based on your Guide. I'm very, very, very happy I bought your book." (San Francisco)

Consultant's dream "Inspired by your book, your love for computers, and your burning desire to show the world that computers are fun and easily accessible, I entered the computer field. Now I'm a computer consultant. Your ideas come from the heart. Thanks for following your dream." (Skokie, Illinois)

Found Wall Street "8 years ago, I took your intro programming course. Now I run the computer department of a Wall Street brokerage firm. I'm responsible for 30 people and millions of dollars of computer equipment. The Guide's always been my foremost reference. Thank you for the key to wonderful new worlds." (Long Beach, New York)

Kid who grew up "Years ago, I saw you sell books while wearing a wizard's cap. I bought a book and was as impressed as a 16-year-old could be. Now I've earned B.A.'s in Computer Science and English, and I'm contemplating teaching computers to high school students. I can think of no better way to plan a course outline than around your Guide." (Pennington, New Jersey)

Better late than never

Readers wish they'd found the Guide sooner.

1 year "I learned more from the Guide than from a year in the computer industry." (Redwood City, California)

Prince Charming arrives "Where have you been all my life? I wish I'd heard of your Guide long ago. I'd have made far fewer mistakes if it had been here alongside my computer." (White Stone, Virginia)

5 years "I've fumbled for 5 years with computers and many books, all with short-lived flashes of enthusiasm, until I found your Guide. It's the first book that showed a light at the end of the tunnel, even for one as dull-brained as I." (Boise)

17 years "Though in a computer company for 17 years, I didn't learn anything about computers until I began reading the Guide. I love it! I always thought computer people were generically boring, but your book's changed my mind." (Hopkinton, Massachusetts)

Hacker "Great book. I'm 14 and always wanted to hack. Thanks to your Guide, I laughed myself to death and look forward to gutting my computer. Yours is the friendliest, funniest book on computers I've seen. If I'd started out with the Guide, I'd have saved 5 years of fooling around in the dark." (Northport, Alabama)

Pass-alongs

Readers pass the Guide to their friends.

Squabble with Dad "I love the Guide. Dad & I squabble over our only copy. Send a second so I can finish the Guide in peace." (New York City)

Round the office "Send 150 books. I passed my Guide around the office, and just about everyone who saw it wants copies." (Middleburg Heights, Ohio)

Advancing secretary "I'm ordering an extra copy for my secretary, to start her on the path to a higher paying and better regarded position." (Belleville, Illinois)

Round the house "Dad bought your Guide to help him understand my computer. It's become the most widely read book in our house. We love it!" (Boca Raton, Florida)

Coordinating the coordinators "Your book is amazing! I'm telling the other 50 PC coordinators in my company to be sure they're in on the secret. Bless you for your magnanimous philosophy!" (Morristown, New Jersey)

Make your guru giggle "I showed the Guide to my guru. Between laughs, chuckles, and guffaws, he agreed to use it to teach his high-school computer class. He even admitted he'd learned something, and that's the most unheard of thing I ever heard of." (Arivaca, Arizona)

Hide your secrets "I thought the Guide marvelous and proudly displayed it on my desk. A friend from South Africa saw it and said our friendship depended on letting her take it home with her. What could I do? You've gone international. I'm ordering another copy. Should I hide the book this time?" (Cinnaminson, New Jersey)

Cries and anger "I made the mistake of letting several friends borrow my copy of the Guide. Each time I tried getting it back, it was a battle. (I hate to see grown people cry.) I promised to order them copies of their own. I delayed several months, and now I've got an angry mob outside my door. While you process my order, I'll try pacifying them by reading aloud." (Winston-Salem, North Carolina)

Compared with other publishers

The Guide's better than any other book.

Rip-off "If you can break even at your book's low price, lots of guys are ripping us off." (Choctaw, Oklahoma)

Better than 10 "I learned more from your Guide than from a total of 10 books read previously." (Honolulu)

No big bucks "Your book is great! Its crazy style really keeps the pages turning. I appreciate someone who doesn't try to make big bucks off someone trying to learn. Thanks." (Vancouver, Washington)

Who's the author?

This section reveals who wrote this book — even if you'd rather not know.

Interview with Russ

In this interview, Russ explains what's behind this book.

Why did you write the Secret Guide? I saw my students trying too hard to take notes, so I made my own notes to hand them. Over the years, my notes got longer. For each new edition, I try harder to make it the kind of book I wish I had when *I* was a student.

What does the Guide cover? Everything about computers and life. Every topic is touched on; the most important topics are covered in depth.

Who reads the Guide? All sorts. Kids read it because it's easy; professionals read it because it contains secret tidbits you can't find elsewhere.

Why do you charge so little? I'm not trying to profit. I'm just trying to make people happy — by charging as little as possible, while still covering expenses. Instead of "charging as much as the market will bear," I try to "charge so little the people will cheer."

Do you really answer the phone 24 hours? When do you sleep? I sleep by my cell phone. When folks call in the middle of the night, I wake up, answer their questions, then go back to snooze. If you get my voice mail, I'm in a meeting but will try to call you back within an hour.

Why do you give phone help free? Are you a masochist, a saint, or a nut? I give free help for 3 reasons: to be nice, keep in touch with readers (who suggest improvements), and please callers enough so they'll tell their friends about me (so I don't have to advertise).

At computer shows, you appeared as a witch? I like to wear a witch's black hat and red kimono over a monk's habit and roller skates, with my white gloves caressing an Afro spear. It's fun.

What's your background? I got degrees in math & education from Dartmouth & Harvard, taught at many colleges (Wellesley, Wesleyan, Northeastern, and beyond), and was a founding editor of *Personal Computing* magazine. But most of my expertise comes from spending many hours every day reading books, magazines, newspapers, and Internet articles, discussing computer lifestyle questions on the phone, and analyzing life.

About the so-called author

Since the author is so lifeless, we can keep his bio short.

Birth of a notion The author, Russy-poo, was conceived in 1946. So was the modern ("stored-program") computer.

9 months later, Russy-poo was hatched. The modern computer took a few years longer, so Russ got a head start. But the computer quickly caught up. Ever since, they've been racing against each other, to see who's smartest.

The race is close, because Russ and the computer have a lot in common. Folks say the computer "acts human" and say Russ's personality is "as a dead as a computer."

Junior Jews Russ resembles a computer in many ways. For example, both are Jewish.

The modern computer was fathered by John von Neumann, a Jew of German descent. After living in Hungary, he fled the Nazis and became a famous U.S. mathematician.

Russ's father was Henry Walter, a German Jew who fled the Nazis and became a famous U.S. dental salesman. To dentists, he sold teeth, dental chairs, and balloons to amuse kids.

The race for brains To try outsmarting the computer, Russ got his bachelor's degree in math from Dartmouth in yummy '69 and sadly stayed a bachelor for many years.

He got an M.A.T. in math education from Harvard. Since he went to Harvard, you know he's a genius. Like most genii, he achieved the high honor of being a junior-high teacher. After his classes showered him with the Paper Airplane Award, he moved on to teach at a private school for exclusive girls. ("Exclusive" means everyone can come except you.)

After teaching every grade from 2 through 12 (he taught the 2nd-grade girls how to run the computer, the 12th graders less intellectual things), he fled reality by joining Wesleyan University's math Ph.D. program in Connecticut's Middletown (the middle of Nowhere), where after 18 months of highbrow hoopla he was seduced by a computer to whom he's now happily married.

Married life After the wedding, Russ moved with his electrifying wife to Boston's Northeastern University, where he did a hilarious job of teaching in the naughty Department of "Graphic Science." After quitting Northeastern and also editorship of *Personal Computing*, he spends his time now happily losing money by publishing this book.

To provide company for his electronic wife, he bought her 40 computers, hid them in a van, and drove them around the country, where they performed orgies and did a strip tease, to show students a thing or two about computer anatomy. Banned in Boston, Russ and his groupies moved north, to Somerville, until it became slumville in 1998, when they moved further north, to New Hampshire, the "granite state," since Russ has rocks in his head.

That year, Russ became a bigamist: though still married to a computer, he also married a human. She's a Chinese philosopher even stranger than Russ. The couple is called "Russy-poo old and Egg-foo young."

Russ's body Here are Russ's stats, from head to toe:

head in the clouds, **hair** departing, **brow** beaten, **eyes** glazed, **lashes** 40, **nose** to the grindstone, **mouth** off, **smile** bionic, **tongue** bitten, **teeth** remembered, **cheeks** in a royal flush, **chin** up, **shoulders** burdened, **wrists** watched, **hands** some, **thumbs** up, **heart** all, **back** got everyone on it, **buns** toasted, **knees** knocked, **heeled** well, **arches** gothic, **toes** stepped on

He wears a stuffed shirt and sacramental socks — very holy!

Russ's résumé We told Russ to write this book because when he handed us this résumé, we knew he was the type of author that publishers long for: nuts enough to work for free!

Age: too. **Sex:** yes! **Race:** rat. **Religion:** Reformed Nerd.
Address: wear pants instead. **City:** Zen. **State:** distressed. **Zip:** up fly.
Birthplace: in my mom. **Citizenship**: US, not THEM.
Father: time. **Mother:** earth. **Spouse:** Brussels. **Kids:** you often.
Social security: 007-vs-666. **Phone home:** E.T. **Cell phone:** no, *buy* phone.
Occupation: vegetable. **Career goal:** play dead. **Objective:** yes, not biased.
Work experience: giggle. **Military experience:** salute my dad.
Language experience: Frenching. **Education:** Ph.Uk.
Hobbies: sleep & cry. **Sport:** dodge tomatoes. **Desire:** hide under sink.
Disabilities: have dis ability & dat ability. **Preferred seat:** first ass.
Favorite food: thought. **Dietary restriction:** can't eat people, unless fried.
Humor: less.

About our headquarters

Come visit our Home Office, in Russ's home. It includes our Production Department, near or in Russ's bed. Russ gave birth to this book himself; nobody else would dare!

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You're reading the 34th edition. To squeeze so many new topics into it, we had to leave out older topics, which you can still get in our **classic books**. To let you get those classics easily, we've dropped editions 31, 32, and 33 to just **$7** each, all earlier classics to **$2** per book. At those prices, with free U.S. shipping, we lose money on every classic, but we're happy to do that, since our mission is to be helpful, not rich. Grab a whole bunch o' books for yourself, friends, colleagues, schools, and charities.

Here are the biggest differences among the last eight editions of the *Secret Guide*:

Topic	Editions
advanced DOS	27
Windows 3 & 95	27 28 29
Windows 98	27 28 29 30
Windows 98SE & Me	28 29 30
Windows XP	28 29 30 31 32
Windows Vista	30 31 32
Windows 7	31 32 33
Windows 8 & 8.1	32 33
Windows 10	33 34
Windows 11	34
Internet Explorer	27 28 29 30 31 32 33
Microsoft Edge	33 34
Netscape Navigator	27 28
Mozilla Firefox	30 31 32
Chrome & Safari	31 32 33 34
Outlook Express	27 28 29 30 31 32
Yahoo Mail	30 31 32 33
Windows Mail	30 31 32 33 34
Gmail	31 32 33 34
Apple Mac	27 28 29 30
iPad basics	31 32 33 34
iPad details	32 33 34
iPhone	32 33
Android	32 33 34
tricky living included	31 32 33 34
2016 president election	33 34
2020 president election	34
emotional integers	34
dBase, FoxPro, Q&A	27 28
WordPerfect & Quattro	27 28 29
MS Publisher & Access	27 28 29 30 31 32 33
modern MS Word	30 31 32 33 34
QBasic's advanced tricks	27 28 29
QBasic's essentials	27 28 29 30 31
QB64	31 32 33
BBC Basic for Windows	34
Fortran, Cobol, Logo	27
Pascal	27 28
C	27 28 29 30
Visual C++	27 28 29 30 31 32
Java	27 28 29 30 31 32 33
Visual Basic	28 29 30 31 32 33 34
Visual C#	31 32 33 34
Python	33 34
Front Page	27 28 29
advanced HTML	28 29 30 31 32 33 34
JavaScript & JScript	29 30 31 32 33 34
numerical analysis	27
computer dictionary	27 28
Linux KDE & Palm OS	28 29 30
blogs	30 31 32
new advice on buy&fix	34

Classic editions of *Tricky Living* include thousands of other differences. For example, the first & second editions of *Tricky Living* include a discussion of prostitution; the current book discusses the Bible instead.

To get classic editions, use the coupon on the back page. We especially recommend:

the 33rd edition (unabridged!)
the 27th edition (historic!)
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How to shop

Here's how to shop for a computer — and deal with the jargon that's involved.

Kinds of computers

Hey kid, wanna getta computer? You got lotsa choices, and they keep changing.

How computers changed

The definition of "**computer**" has changed.

Before 1940, computers were human. Dictionaries said a "computer" was "a person who computes." If you could add, subtract, multiply, and divide quickly, in your head, you were called "a good computer." Astronomers hired computers who computed the positions of heavenly bodies.

In the 1940's, engineers invented giant electronic machines that could compute fast, so a "computer" meant "a giant electronic machine that can compute fast." The typical computer was huge (consuming a whole room), weighed several tons, and cost millions of dollars. During World War 2, American engineers built computers to do **ballistics** (figure out how to aim a rocket to bomb Germans), while German engineers built computers to figure out how to bomb Americans back.

In the 1950's, computers got slightly cheaper. Big companies bought them to do accounting and other clerical tasks, such as alphabetizing and looking up customer records. A "computer" meant "a machine that can do intellectual tasks, such as math and clerical stuff."

In the 1960's, engineers figured out how to make electronics be smaller and cheaper. That led to smaller computers, called **minicomputers**. **In the 1970's**, engineers invented even smaller computers, called **microcomputers**. By the end of the 1970's, you could buy all 3 sizes of computers:

A **maxicomputer** filled a room
and typically cost between $300,000 and $20,000,000.

A **minicomputer** fit in a room's corner
and typically cost between $10,000 and $300,000.

A **microcomputer** fit on a desk
and typically cost between $100 and $10,000.

The typical big company owned a maxicomputer; but each department also had its own minicomputer (to handle the department's special needs), and each clerk had a **personal microcomputer** (to do specialized work but also play games). A microcomputer used mainly by just one person is called a **personal computer (PC)**.

Nowadays, the typical company is run by a collection of microcomputers, all communicating with each other, because that collection costs less than buying a maxicomputer or minicomputers. "Maxicomputers" and "minicomputers" have become obsolete, and those terms aren't used anymore. The typical computer is a microcomputer costing between $100 and $2,000.

Now computers do *many* kinds of intellectual tasks, so the definition of "computer" has become "a machine that can do intellectual tasks." Popular intellectual tasks include math, clerical organizing (alphabetizing & looking up records), playing games, editing your writing, communicating with folks living far away, and controlling other machines.

If your employer bought a computer many years ago and refuses to replace it with something more modern (because switching takes too much effort), the polite way to describe your anger is to say that you're stuck using a **legacy system**, because your employer's computer is a legacy handed down from folks who preceded you: a **legacy system** is an outdated computer system.

Embedded computers

If a computer hides inside a machine and controls it, the computer is called **hidden** and **embedded**. It's called an **embedded system**.

For example, a computer's embedded in your digital watch, microwave oven, pocket calculator, home thermostat, car dashboard, videogame machine, and advanced sex toys. There's even an embedded computer in your bed, if you bought a massager.

Such a computer dedicates its entire life to performing just one task (such as "telling the time" or "controlling the oven"), so it's also called a **dedicated computer** and a **dedicated controller**. Most such computers can be made for under $10 each — after the manufacturer has spent many thousands of dollars to research how to make them. If you meet a person whose career is "**developing embedded systems**", that person invents computers that hide inside other devices.

The typical cell phone includes an embedded computer. If that computer is advanced, the phone is called **smart**, so it's a **smartphone**. Now most cell phones are smartphones, but you can still buy 3 kinds of cell phones:

Kind of cell phone	What kind of computer it contains
basic phone	a computer that's relatively stupid
feature phone	a computer smart enough to give you a few fun features
smartphone	a computer that's brilliant about many things

If a computer isn't hidden, it's **visible**.

This book explains how to buy & use visible computers. It also explains how to buy & use smartphones, so you can become a smarty, not just a plain phony.

The 3 wares

To build a complete computer system, you need **hardware**, **software**, and **liveware**.

Hardware

Computer equipment is called **hardware** because it's built from wires, screws, and other parts you can buy in hardware & electronics stores. Cynics say it's called "hardware" because it's hard to fix and because, when you try to buy hardware, you can get screwed and go nuts.

The computer's parts are called its **components**. You want several kinds of computer components.

Output A component showing you the answer is called an **output device**. The most popular output devices are:

a **screen** (which is also called a **display**), like a TV screen
a **printer** (which can print on paper)
a pair of stereo **speakers**

Input A component letting you give the computer a command is called an **input device**. The most popular input device is a **keyboard**, which resembles a typewriter's keyboard.

Another input device is a **mouse** (a little box you slide across your desk, to move a pointer that's on your screen). Instead of a mouse, you can use a **touchpad** (a pad your finger rubs across) or **touch-sensitive screen (touchscreen)**, which looks like an ordinary screen but can sense where your finger taps the screen.

Your computer system can also include a **microphone** (so you can talk & sing to the computer), a **camera** (so the computer can see what you and your environment look like), and an **optical scanner** (a special camera that looks at a sheet of paper and copies its info into the computer). If the optical scanner hides inside a printer, the printer is called an **all-in-one printer** and can imitate a Xerox copying machine. Some all-in-one printers can also imitate a fax machine.

Input devices and output devices are both called **I/O devices**. Computerists sing "I/O, I/O, it's off to work I go!"

Processor The component that thinks is the **processor**. The computer's main processor is called the **central processing unit (CPU)**. The most popular kind of processor is a **microprocessor chip** (little square onto which is stamped a fancy electric circuit).

Memory Components that remember are called **memory**.

The most popular memory is made of **memory chips** (little squares that can retain a magnetic or electric charge). Another kind of memory is a **disk** (a rotating circular platter that holds a code made of scratches or magnetic charges). Disks are slower than memory chips but have more **capacity** (can hold more info).

Why those 3? For a computer to do useful thinking, you need all 3 of those types of hardware:

The **processor** does the thinking itself; it processes info.
The **memory** remembers the computer's thoughts.
The **I/O devices** communicate those thoughts.

A computer without memory is as useless as a person who says, "I had a great idea but can't remember it." A computer without an input/output system is as useless as a person who says, "I had a great idea and remember it but won't tell you, and I also won't listen to anything you say."

When you're buying a computer, check all 3 types and make sure they're good. This book explains how to judge them.

Communication A component letting the computer communicate with other computers is called a **communication device**.

The most popular communication device is a **modulator/demodulator** (**modem**, pronounced "Moe dem"), which is a box that connects your computer to a phone system (or to a cable-TV system). Another communication device is a **router** (pronounced so it rhymes with "chowder"), which lets several computers share routes to a modem (or to a similar device).

System unit The computer's main box is the **system unit**, in which hide the processor, memory, and many other electronics. The system unit's outer surface is the **case**.

Cables A **cable** (insulated bunch of wires) can connect one component to another.

The most popular kind of cable is the **Universal Serial Bus cable (USB cable)**. For example, a USB cable typically runs from the printer to the system unit.

Software

The info the computer deals with is called **software**, because you can't feel it: it flows through the computer's circuits as coded pulses of electricity.

Some software sits in your computer's memory (in memory chips or disks). When your computer is turned on, software flows into & out of your computer's memory, through the computer's wires.

For example:

Software (info) gets into the computer
when you insert chips or disks or type on the keyboard.

You can copy software (info) from the computer's memory
to your screen & printer.

Software (info) gets transferred into and out of your computer
by communicating with other computers.

Hardware consists of physical objects. You can hold them in your hand; you can *feel* hardware. You can't feel **software**, which is just information, an abstract concept, though you can feel the disks or memory chips it comes on.

The info you put into the computer is called **input**. What the computer puts out (onto your screen & printer) is called **output**.

If you feed the computer wrong software — wrong facts or wrong instructions — the computer will print wrong answers. Wrong stuff is called **garbage**. If you feed the computer some garbage, the computer spits out garbage answers. When a computer gives wrong answers (wrong output), it's usually because somebody fed it wrong input. So if a computer prints wrong answers, the computer might not be broken; it might just have been fed wrong data or programs. If you tell a technician to fix it, the technician might reply, "Hey, the computer's fine! Don't blame the computer! It's *your* fault for feeding it garbage! If you put garbage in, you get garbage out!" That principle is called "**garbage in, garbage out**" (which is abbreviated **GIGO**, pronounced "guy go", as a woman says on a bad date). The technician will say, "It's just a case of GIGO".

Your computer wants 2 kinds of software:

data	(lists of names, addresses, numbers, words, and facts)
programs	(lists of instructions that tell the computer what to do)

Your computer wants 3 kinds of programs:

The **basic input-output system (BIOS)** tells the computer how to begin handling input & output when you turn the power on. For example, it tells the computer how to deal with the keyboard and screen. The BIOS hides in the computer's memory chips.

The **operating system (OS)** tells the computer what to do afterwards. It gives the computer its personality. The most popular operating system for normal computers is Microsoft's **Windows**. Though "**PC**" usually means "personal computer," a more restrictive definition of "**PC**" is: a computer that resembles IBM's Personal Computer and uses Windows. The main competitor to Windows is Apple's **macOS**, made for Apple's **Mac computers**. The most popular operating systems for smartphones are Apple's **iOS** and Google's **Android**.

Application programs (apps) tell the computer how to do specialized tasks, such as play a specific game or do a specific kind of advanced math.

When you buy a computer, the advertised price usually includes the important hardware, the BIOS, the OS, and **applets** (little apps that accomplish a little), but you must pay extra to add apps that are bigger & better.

Apps that are crappy (because they consist mainly of just ads) are called **crapps**. Too many computers are full of crapps.

When you buy a computer, you'll cry, because it typically comes full of **crapplets** (little apps that are crapps).

Liveware

How good is a computer system? That depends on the quality of 3 wares:

Hardware	(computer equipment)
Software	(info in the computer)
Liveware	(an alive human sitting at the computer)

The **liveware** is called the **user** or **operator**. That's you!

If you're stupid, your colleagues will call you a **meathead** (because your head is made of bad meat instead of wires). You'll also be called **meatware**, **wetware** (because your brain is wetter than a computer's), and **jellyware** (because your brain cells are jiggly, like jelly).

For example, if you make a mistake and try to blame the computer, your boss can say:

> The problem isn't in the computer. The problem's in the wetware.

Your boss can also write:

> **PICNIC:** Problem In Chair, Not In Computer.
> The problem's an **"I D ten T"** (because you're an ID-10-T, an IDIOT!).

Here's when that jargon began:

> The term "**liveware**" was popularized by Garry Trudeau in a 1982 Doonesbury cartoon, though invented by others in 1966.
>
> The term "**meathead**" was popularized by the TV character Archie Bunker in 1971, though used back in 1863.

Summary

For a complete **computer system**, you need all 3 wares: the hardware (equipment), software (info), and liveware (people).

Beware of the 3 wares! You can spend lots to buy hardware (and repair it), buy software (and improve it), and hire helpers (and train them). Make sure you've budgeted for all 3 wares!

Congrats! Now you know the 3 ways that buying a computer can suck up your money. Yes, buying a computer can suck.

Form factors

Like people, computers come in many shapes & sizes. A computer's size & shape is called its **form factor**. Here are the 4 most popular form factors, listed from smallest to biggest:

Form factor	Typical screen size	Alternative screen sizes
smartphone	6.1 inches	anywhere from 4 to 6.9 inches
tablet	10.2 inches	anywhere from 7 to 12.9 inches
laptop	15.6 inches	anywhere from 10 to 17.3 inches
desktop	23.8 inches	anywhere from 14 to 31.5 inches

"Screen size" is measured diagonally (from the top-left corner to the bottom-right corner of the glass).

Let's look at the details….

Smartphone

A **smartphone** can make phone calls and is small enough to fit in your pocket. Its screen is touch-sensitive: it knows where you touched it.

In the United States, most people use smartphones by **Apple** (which is American) or **Samsung** (which is Korean and means "3 stars" in Korean).

> Apple's smartphones are called **iPhones** and use the **iOS** operating system (invented by Apple).
>
> Samsung's smartphones are called **Galaxy** and use the **Android** operating system (invented by Google). Other popular Android smartphones are made by **Motorola** and **LG**.

If a smartphone's screen is bigger than average, so it's almost as big as a tablet, the smartphone is called a **phablet** (because it's a **phone tablet** and, if you like big phones, you think it's **phabulous!**). The most popular phablets are Samsung's **Galaxy Note 10** and Samsung's **Galaxy S20**.

Tablet

A **tablet computer** is bigger than a smartphone, so its screen is easier to read and type on. It can't fit in your pocket, but it can fit in your pair of hands (though it works better on your desk). If it can fit in just *one* hand, it's called a **handheld computer**.

Since a tablet computer can't make phone calls, it's cheaper than a smartphone, and it's safer to give to young kids to play on. Tablet computers are popular among kids, car passengers, and delivery drivers (such as UPS and FedEx).

The most famous tablet computer is Apple's **iPad**, which uses the **iPadOS** operating system.

Some tablet computers use **Android** instead of iPadOS. Popular Android tablet computers are Samsung's **Galaxy Tab** and Walmart's **Onn**.

Microsoft's **Surface** tablet uses the Windows operating system.

If a tablet's main purpose is to read **electronic books (ebooks)**, it's called an **ebook reader** (or **e-reader**). The most popular e-readers are Barnes & Noble's **Nook** (which uses Android) and Amazon's **Fire** (which uses a variant of Android).

Laptop

A **laptop computer** is bigger than a tablet, so its screen is even easier to read. The laptop computer includes a keyboard (like a typewriter), which is much easier to type on than trying to type on the screen. That's the main advantage of a laptop computer over smartphone or tablet: easier typing!

When you look at a typical laptop computer, you see mainly the screen plus the keyboard The keyboard is attached to the screen by a hinge. Having a hinge is called a **clamshell design**, since opening and closing the laptop is like opening and closing a clam's shell. Open the laptop to use it; close the laptop to transport it.

Most of the electronics (such as the processor and the memory) hide inside the keyboard, not in the screen.

A typical laptop computer (15.6-inch screen) is also called a **notebook computer**, since it's about the size of a student's notebook.

A laptop's keyboard includes a touchpad. The laptop's screen might be a touchscreen or might be too stupid to know where you touched.

The laptop's price does not include a mouse, but you'll want to attach one.

The typical good laptop computer includes the Windows operating system and is made by **Lenovo** (which is based in Hong Kong, Beijing, Singapore, and North Carolina). Other popular Windows laptop computers are made by **Hewlett-Packard (HP)** and **Dell**.

Cheap laptops, popular in schools (because they're cheap), are called **Chromebooks**. They use Google's **Chrome OS** instead of Windows.

Apple's laptops are called **MacBooks** and use **macOS**.

If you're not sure which is better for you — laptop or tablet — you can try this compromise:

> If a laptop computer has a touchscreen you can rotate or detach, so the touchscreen acts like a tablet, it's called a **convertible** (or **2-in-1**).

Smartphones, tablets, and laptops are all called **portable computers** and **mobile devices** that let you do **mobile computing**, because they're easy to carry around (using just one arm) and contain batteries (so you can use them even when you're not near an electrical socket).

Desktop

If a computer is too big to carry in one arm but still small enough to fit on a desk, it's called a **desktop computer**.

It resembles a laptop computer but has these differences:

The screen is much bigger and is attached to a built-in stand.
The keyboard is not hinged to the screen. The keyboard is detached.
There's no big battery. The computer runs just when plugged into the wall.
The price includes a mouse, so the keyboard doesn't bother to include a touchpad.

Where are most of the electronics, such as the processor and the memory? In a laptop computer, they're hidden in the keyboard, but in a desktop computer they're hidden elsewhere.

If the electronics are hidden in the screen (behind the screen's glass), the system is called an **all-in-one computer**. The most popular manufacturers of all-in-one computers are **Hewlett-Packard (HP)** and **Dell**.

If the electronics are hidden in a separate box instead, that box is called the **system unit**. That box is easier to open than a smartphone, tablet, laptop, or all-in-one computer, so you can easily modify its electronics to achieve fancier abilities, such as handling more data and playing faster games. Its price might not include a screen.

If the system unit is **tall** (typically 15 inches) but not wide, it's called a **tower**, and it can be put on or under the desk. The most popular manufacturers of towers for business are **Hewlett-Packard**, **Lenovo**, and **Dell**. The most popular manufacturers of towers for fast games are **CyberPower** and **iBuyPower**.

If the system unity is wide but not tall, it's traditionally put on the desk and called a **traditional desktop computer**. If it's no more than 3½ inches tall, so it's basically flat like a Domino's pizza-delivery box, it's called a **pizza-box computer**. The pizza-box computer is called **1-unit tall (1U)** if it's just 1¾ inches tall; it's called **2-units tall (2U)** if it's 3½ inches tall. In a huge company, the main computer room contains *many* 1U and 2U pizza-box computers, all sitting in a cabinet full of shelves (racks) to hold them; they're called **rack-mounted computers**.

Which form factor to buy

Which form factor should you buy? That depends on your priorities. Here are the grades, from A (which is the best) to F:

	Smartphone	Tablet	Laptop	Desktop
Makes phone calls?	A	F	F	F
Easy to carry?	A	B	C	F
Can run unplugged?	A	A	B	F
Has big screen?	F	C	B	A
Has big memory?	F	D	B	A
Has good keyboard?	F	D	B	A
AVERAGE	C	C-	C+	C

Notice that for each form factor, the "AVERAGE" grade is approximately C. That's why each form factor is still being used.

Which form factor is best for you? That depends on your priorities.

Since I was stupid enough to write this book, I had to buy all 4 form factors, to try them out. Each form factor has its own joys — and its own form of hell.

Networks

Instead of buying a big computer, the typical big company buys many little computers and lets them communicate with each other, to form a **network**.

If the computers communicate with each other through cables of wires, the network is called **hard-wired**. If the computers communicate with each other by using radio waves instead, the network is called **wireless**.

If the network's computers are all in the same building, the network is called a **local-area network (LAN)**. If the computers are farther apart, the network is called a **wide-area network (WAN)**.

Each computer in the network is called a **node**.

A special person (the **network supervisor**) manages the network by controlling the **network's main computer** (the **server**). Ordinary folks (**users**) sit at the network's lesser computers (**workstations**), which all communicate with the server.

The most famous wide-area network is the **Internet**. It began in the 1950's as a small network (a few universities communicating with each other) but later expanded dramatically, so now it includes *millions* of computers all over the world; most of the world's visible computers are part of the Internet. When you buy a typical computer, it communicates with the Internet **wirelessly** (using radio waves) or through an ordinary phone line (called **dial-up**) or through a speeded-up phone line called a **digital-subscriber line (DSL)** or through a cable-TV line (called **cable**). An ordinary phone line (dial-up) is ridiculously slow; the other methods (wireless, DSL, and cable) are reasonably fast and called **broadband**. So if a computerist says "I want broadband," the computerist wants fast Internet access, not a band of female musicians!

You can mix technologies. For example, the typical laptop computer communicates with the Internet by sending a radio wave (wirelessly) to a little box, called a **wireless router** (usually pronounced so the "rou" rhymes with "cow"), which then passes the signal to the rest of the Internet by using cable or DSL, with the help of a converter box called a **modulator/demodulator** (**modem**, pronounced "Moe dem"). You can buy a wireless router (and modem) for your home or office.

When the wireless router is turned on (and attached to a modem), it creates a **wireless access point (WAP)**, which is also called a **hot spot**. While you're traveling with your laptop computer, you can use the hot spots that are in many coffeehouses, restaurants, public libraries, and other public locations. You can use them even while you're driving by in your car; that's called **wardriving**.

Manufacturers

Who makes computers?

IBM & Lenovo

The most famous computer manufacturer has been **IBM**, which stands for **International Business Machines Corporation**.

Too often, it also stood for "Incredibly Boring Machines", "Inertia Breeds Mediocrity", "International Big Mother", "Imperialism By Marketing", "Idolized By Management", "Incompetents Becoming Managers", "Intolerant of Beards & Mustaches", "It Baffles Me", "It's a Big Mess", and "It's Better Manually". But those negative comments apply just to IBM's past: in the 1990's IBM switched; it became open-minded and friendly.

IBM is based in the town of Armonk, New York.

During the 1950's, 1960's, and 1970's, IBM was famous for selling huge computers (called **maxicomputers** or **mainframes** or **powerful servers**).

Later, IBM started selling small computers also. IBM's first successful small computer was a desktop computer called the **IBM Personal Computer (IBM PC)**. Then other companies made imitations, called **IBM-compatible computers** or **IBM PC clones**. Now most desktop and laptop computers are IBM-compatible.

Recently, IBM's stopped making cheap computers for consumers: instead, IBM sells just expensive computers (powerful servers) to big businesses. For example, IBM used to make a laptop computer called the **ThinkPad**, but IBM sold its ThinkPad division to **Lenovo** (which is mainly in Hong Kong but recently created a headquarters office in North Carolina, to look American). IBM is in 120 countries. The country having the most IBM employees is India, not the United States.

HP

A California company called **Hewlett-Packard (HP)** has made more computers than any other company. It's made many kinds of computers: powerful servers, tower computers, laptop computers, tablet computers, and hidden computers. Most of them were sold under the name "HP"; others were sold under the names "**Compaq**" and "**Palm**" which are companies that Hewlett-Packard acquired. Many of HP's computers are sold in chain stores such **Best Buy**, **Staples**, and **Walmart**. In 2015, HP split into 2 companies:

HP Incorporated sells cheap computers & printers.
Hewlett-Packard Enterprise Company manages huge systems for huge businesses.

Dell

A Texas company called **Dell** sold computers through mail-order but now also sells computers through chain stores (such as **Staples** and **Best Buy**). It mainly makes desktop computers and laptop computers, though it dabbles in other kinds of computers also. Dell used to have a reputation for high quality, but now Dell's computers are unexceptional or problematic.

Gateway & Acer

An Iowa company called **Gateway** was famous for selling desktop computers through mail-order. Gateway acquired a company called "**eMachines**", which was famous for selling desktop computers cheaply through chain stores, especially Best Buy and Circuit City. Gateway sells computers through mail order & stores. Gateway moved from Iowa to South Dakota but now is headquartered in California. The entire Gateway company was bought by a Taiwan company called **Acer**.

Asian laptops

Many companies in Asia make laptop computers. The most famous are **Acer** (from Taiwan), **Asus** (from Taiwan and means "Pegasus but let's begin with A"), and **Lenovo** (mainly from Hong Kong, though headquartered in North Carolina). Japanese companies (**Sony** & **Toshiba**) used to make laptop computers but quit in 2016.

White-box computers

Many tiny computer stores build their own "generic" tower computers by throwing together parts from many suppliers. Such an unbranded computer is called a **white-box computer**, since the system unit is a typically a plain white metal box that has no manufacturer's name written on it.

Apple

A California company called **Apple** makes the iPhone (a smartphone), the iPad (a tablet computer), and **Macintosh (Mac)** computers (laptops & all-in-ones). They're all beautiful to look at, creatively designed, fun & easy to use, reliable, and come with good free help at Apple stores and by phone. Apple's Mac computers are particularly popular among graphic artists and magazine publishers.

Alas, Apple's computers cost more than the competition, and Apple's computers aren't completely compatible with other computers: if you buy an Apple computer, you must learn to do things differently and buy different accessories for it.

What's popular?

Here's the surprising truth.

For "normal" computers (meaning laptop & desktop), Lenovo is strongest:

Of all the "normal" computers (laptop & desktop, not tablet, not phone, not embedded) sold today in the world,
24% are by Lenovo
22% are by HP
16% are by Dell
8% are by Apple (and called "Macs")
8% are by Acer
22% are by a wide variety of other manufacturers

Since percentages bob up and down by 2% each month, I've rounded all those percentages to the nearest 2%.

For tablet computers, Apple is strongest:

Of all the tablet computers sold today in the world,
32% are by Apple (and called "iPads")
20% are by Samsung
10% are by Lenovo
8% are by Amazon
6% are by Huawei
24% are by a wide variety of other manufacturers

For smartphones, Samsung is strongest:

Of all the smartphones sold today in the world,
22% are by Samsung
16% are by Apple (and called "iPhones")
14% are by Xiaomi
10% are by Oppo
10% are by Vivo
28% are by a wide variety of other manufacturers

Prices drop

On average, computer prices dropped 3% per month. That price decline was in effect from the 1940's through 2019, though it was interrupted in 2020 by the Covid-19 pandemic, a shortage of chips & truckers, international trade tariffs, and an increased demand by home-schooled kids. I hope the price drop resumes.

Here's how that drop of 3% per month would affect you.…

Suppose for a particular computer item the average price charged by dealers is $100. Next month, that item's average price will probably drop 3%, to $97. After *two* months, its average price will have dropped about 3% again, so its price will be 97% of $97, which is $94.09.

Here's how the math works out:

> On the average, computer prices drop
> about 3% per month,
> 30% per year,
> 50% every two years,
> 90% every six years,
> 99% every twelve years.

Therefore:

> If a computer item's average price is $100 today,
> it will probably be $97 next month,
> $70 a year from now,
> $50 two years from now,
> $10 six years from now,
> $1 twelve years from now.

The typical computer system costs about $1000 (by the time you get done paying for all the extras & accessories). Here's what the math looks like for a $1000 system:

> If a computer system costs you $1000 today,
> it will probably cost you
> $970 if you buy a month from now,
> $700 if you buy a year from now,
> $500 if you buy 2 years from now,
> $100 if you buy 6 years from now,
> $10 if you buy 12 years from now.

Does that mean computer stores will be selling lots of computers for $10 twelve years from now? No! Instead, computer stores will *still* be selling computers for about $1000, but those $1000 systems will be much fancier than the systems sold today. By comparison, today's systems will look primitive — much too primitive to run the programs-of-the-future — so they'll be sold off as old, quaint, primitive junk in garage sales.

Find that hard to believe? To become a believer in rapidly dropping prices, just try this experiment: walk into a garage sale today, and you'll see computer systems selling for $10 that sold for $1000 twelve years ago!

So the longer you wait to buy a computer, the less you'll pay. But the longer you wait, the longer you'll be deprived of having a computer, and the further behind you'll be in computerizing your life and becoming a computer expert. Don't wait. Begin your new computerized life now!

Subculture

Computers are like drugs: you begin by spending just a little on them but soon get so excited by the experience — and so hooked — that you wind up spending more and more to feed your habit.

> Your first computer experience seems innocent: you spend just a little money for a cute little computer. You turn the computer on and suddenly the computer's screen shows dazzling superhuman colors, swirling hypnotically. You say "Wow, look at all those colors!" and feel a supernatural high.
>
> But after 2 months of freaking out with your new computer, the high wears off and you wonder, "What can I buy that's new, exciting, and gives me an even bigger high?" So you buy more stuff to attach to your computer. Now you're in really deep, financially and spiritually. You're hooked. You've become addicted to computers. Each month you return to your favorite computer store to search for an even bigger high — and spend more money.
>
> Look at me. I'm a typical computer junkie. I've already bought 50 computers, and I'm still going. Somebody help me! My computers have taken over my home. Whenever I try to go to sleep, I see those computers staring at me, their lights winking, tempting me to spend a few more hours in naughty fun, even if the sun's already beginning to rise.

Computerists use the same lingo as druggies: to buy a computer, you go to a **dealer**; and when you finally start using your computer, you're called a **user**.

> As your addiction deepens and you search for greater highs, you squander even more money on computer equipment, called **hardware**. You stay up late (playing computer games or removing errors), so next morning you go to work bleary-eyed. Your boss soon suspects your computer habit, realizes you're not giving full attention to your job, and fires you.
>
> Jobless while your computer bills mount ever higher, you run out of money to spend on computers, but your computer addiction still runs through your brain. To support your habit, you write or buy programs and try to resell them to friends. That makes you a pusher: you turn your friends into addicts too, and you all join the increasing subculture of computer junkies.

Drugs differ from computers in just one way: if you're into drugs, people call you a "washout"; but if you're into computers, people say you'll have a "wonderful career" — and they're right!

As a computer pusher, you can make lots of dough, but just if instead of calling yourself a "pusher" you call yourself a **computer consultant**. Yes, a computer consultant is a person who gives computer advice to other victims — and pushes them into buying more computers!

A computer consultant who gives free help seems kind, but the truth is revealed in these lines of Tom Lehrer's song,"The Old Dope Peddler":

> He gives the kids free samples
> Because he knows full well
> That today's young innocent faces
> Will be tomorrow's clientele.

Your marriage

The computer will fascinate you. It'll seduce you to spend more time with it. You'll fall in love with it. You'll start buying it presents: exotic foods (expensive programs to munch on) and expensive jewels (a printer and fancier speakers).

Then the computer will demand you give it more. While you enjoy an exciting orgy with your computer and think it's the most joyous thing that ever happened to you, suddenly the computer will demand you buy it more memory. It'll refuse to continue the orgy until you agree to its demand. And you'll agree — eagerly!

The computer's a demanding lover. You'll feel married to it.

> Marrying a computer is much groovier than marrying a person: computers are good at "getting it on" (they feel all electric and tingly) and they never argue (they're always ready to "do it", except when they "have a headache").

I wanted to call this book "The *Sexual* Guide to Computers" and put a photo of my computer wife and me on the cover; but since some communities dislike mixed marriages, I had to play cool and say just "Secret" Guide to Computers. But here's the real secret: this book's about sex.

If you marry a computer but already married a human, your human spouse will call you a "bigamist" and feel jealous of the computer. Your marriage to that human can deteriorate into divorce.

Several women got divorced because they took my computer course. Their husbands had 2 complaints:

> "You spend most of your time with the computer instead of with me.
> When you *do* spend time with me, all you want to talk about is the computer."

To prevent such marital problems, coax your spouse to play a game on the computer. Your spouse will get hooked on the game, become as addicted to the computer as you, enjoy blabbing about the computer with you, and encourage you spend money on your habit. Sociologists call that **technological progress**.

Why buy a computer?

The average American has 3 goals: to make money, have fun, and "become a better person". Making money is called **business**; having fun is **pleasure**; and becoming a better person is **personal development**. The computer will help you do all 3: improve your business, increase your pleasure, and help you become a better person.

The reasons why people buy computers are emotional:

> **Teenager:** "Computers are a blast: sci-fi come true!"
>
> **Parent:** "My kids must become computer-competent to survive! If I buy my kids a computer, they'll explore it (instead of sex & drugs), wonder how it's programmed, become programmers, get straight A's in school, become computer consultants, and make lots of dough, so they can support me in my old age and I can brag about them to my neighbors."
>
> **Grandparent:** "The world's becoming computerized, and I don't want my grandkids to say I'm out of it. I wouldn't blow money on this stuff myself, but my kids are giving me a computer so grandkids can send me mail and photos electronically, using the Internet. Those grandkids are so cute! Computers are so much fun!"
>
> **Kindergartner:** "Grandma, I wanna computer for my birthday! And if you don't buy it, they say I'll never go to Harvard."
>
> **Worried worker:** "My company's computerizing. If I don't master computers, they'll master *me* and steal my job! If I learn about computers, I can keep my job, get promoted, then quit and become a rich computer consultant!"
>
> **Adventurer:** "The computer's a challenge. If I can master it, that proves I'm not as stupid as people say!"
>
> **Wanting what's due:** "I've been treated like shit all my life; I *deserve* a computer! I'm gonna get my hands on that machine and make it my slave."
>
> **Subversive:** "If Big Brother has Big Blue watching me, I'll turn my computer into Big Mama and scramble their waves!"
>
> **Social-studies teacher:** "The Internet's amazing! So much info is published there about current events, history, and the future! I'll make my students do research using the Internet and publish their papers there, so they'll become internationally famous and make *me* famous for being their teacher!"

Hassles

When you buy a computer, you'll have lots of hassles.

Repairs Since a complete computer system includes so many parts (CPU, ROM, RAM, disks, keyboard, screen, mouse, printer, stereo speakers, modem, microphone, scanner, network card, software, etc.), *at least one* of them won't work properly, and you must fix it.

Instructions You won't completely understand the instructions for your hardware & software, so you'll ask your friends & me for help. You try getting help from manufacturers and dealers; but if your question's long-winded, their answers will be curt.

If the dealer who sold you the computer is honest, he'll say:

> "I don't know how to run all the hardware & software I sold you. To learn how, read the instructions and buy books in bookstores. No, I haven't read them myself, because they're too long-winded, complicated, and vague. If you don't like those instructions, take our courses: they're expensive and won't teach you as much as you need, but they'll give you the illusion you're making *some* progress."

Most dealers aren't that candid.

Programs If you try writing your own programs, you'll discover Murphy's law: no matter how long you think a program will take to write, it will take you longer. If you're wiser and try to buy a finished program from somebody else, you'll find the program works worse than advertised, its manual is missing or unintelligible, and you must modify the program to meet your personal needs.

Data entry If you figure out how to use the program, your next torture is to type the data you want the program to process. The typing is sheer drudgery, but you must do it.

Worthwhile? Those headaches are just the *beginning* of what can become an extended nightmare. Buying a computer starts by being exciting but quickly becomes nerve-racking.

Eventually, you'll pass that nerve-racking transition stage and be thrilled. That painful transition is worth the effort if you plan to use the computer a lot. If you plan to use a computer just occasionally, you'd be better off not buying a computer at all: continue doing your work manually.

Promises Salespeople wanting you to buy fancy hardware or software say "it will be great", but computer stuff never turns out as good as promised.

For example, here's the tale of **the woman who was married 3 times but remained a virgin**:

> Her first husband, on his wedding night, discovered he was impotent.
>
> Her second husband, on *his* wedding night, decided he was gay.
>
> Her third husband was a computer salesman who spent the whole night saying how great it was going to be. Computer salesmen make great promises but don't deliver.

Here's the story of **the programmer who died and went to Heaven's gate**, guarded by St. Peter, who let the programmer choose between Heaven and Hell:

> The programmer peeked at Heaven and saw angels singing boring songs. He peeked at Hell and saw a beach full of beautiful bodies sunbathing and frolicking, so he chose Hell. Suddenly the beach vanished, and he was dragged to a chamber of eternal torture. When he asked "What happened to the beach?", the devil replied "Oh, that was just the demo."
>
> Hot technologies look temptingly beautiful; but when you try to experience them, you'll have a devil of a time!

Parts

A computer has several parts. Smartphones and tablets are simple, but bigger computers are more confusing. Let's look at the biggest types.

Tower computer's parts

A tower computer's main part is the box called the **system unit**, which is a tower that's 15 inches tall (and 15 inches from front to back) but just 7 inches wide.

7 cables Out of the system unit's rear come 7 cables.

One of those cables is the **power cord**. It goes to a source of electricity (the electrical outlet socket in the room's wall — or a power strip connected to that outlet). That cable feeds power to the computer.

One cable goes to the **keyboard**, which looks like a typewriter's keyboard. To send a message to the computer, type the message on the keyboard. A standard computer keyboard contains 104 keys, which let you type all the letters of the alphabet, all the digits, all the punctuation symbols, and other symbols too. Some of the keys are for editing: they help you edit what you typed.

One cable goes to the **monitor**, which looks like a TV set: it contains a screen that shows the words you typed, the computer's answers, and pictures.

One cable goes to the **mouse**, which is a small box about the size of a pack of cigarettes. If you slide the mouse across your desk, an arrow moves across your monitor's screen; so to move the screen's arrow, slide the mouse! To manipulate an object on the monitor's screen, slide the mouse until the screen's arrow moves to that object; then press the mouse's left button.

One cable goes to the **printer**, which is a box that prints on paper.

One cable goes to **stereo speakers**, so the computer can produce sound effects, play music, sing, and talk to you!

The final cable goes toward other computers (or a modem), to form a **network** (such as the Internet). That cable is called a **network cable**. If you're accessing the Internet by dial-up, the network cable is an ordinary phone line (which goes to your wall's phone jack); if you're accessing the Internet by broadband instead, the network cable is a fattened phone line, called an **Ethernet cable**, which goes to a modem.

Altogether, the typical tower computer includes:

the system unit
a keyboard, monitor, mouse, printer, speakers, and cables from them to system unit
power cords from wall (or power strip) to the system unit, monitor, and printer
a network cable to let the computer communicate with other computers

Advertised price When you buy a tower computer, the advertised price includes most of those items: it typically includes the system unit, computer keyboard, mouse, and pair of stereo speakers. But **the printer is usually excluded from the advertised price: it costs extra.**

Does the advertised price include the monitor? To find out, read the ad carefully!

If you're lucky, the ad says "**monitor included**". If the ad says "**monitor optional**" instead, the monitor is *not* included in the advertised price and costs extra.

Extras If your computer is extra-fancy, 3 extra cables come out of the system unit:

A cable goes to a **microphone (mike)**, which lets you feed sounds into the computer. If you talk and sing into the mike, the computer can make digital recordings of your speech and performance, analyze them, and react accordingly!
A cable goes to a **scanner**, which is a box that you can shove a sheet of paper into; the scanner reads what's on the paper and tells the computer what the paper said. If you rip an article out of a newspaper and feed it into the scanner, the scanner will transmit the newspaper's article to the computer, so the computer can analyze what's in the newspaper's article and become a smarter computer! If you feed a photo into the scanner, the scanner will transmit the photo to the computer, and the photo will appear on the computer's screen.
A cable goes to a **digital camera**, which takes photos and feeds them to the computer.

Summary In a typical tower computer, the main box is called the **system unit**, from which cables run out to other computer devices, called **external peripherals**, such as the keyboard, monitor, mouse, printer, speakers, and — if your system is fancy — a microphone, scanner, and digital camera.

Ports On the system unit's back wall, you'll see many sockets to plug cables into. Each of those sockets is called a **port**. Here's what the 11 most important ports look like (on a traditional tower computer):

Whose cable goes to port	Port's name	Port's appearance
keyboard	keyboard port	circle, with 5 round pinholes in it
monitor	video port	D shape, with 15 round pinholes in it
modern printer, camera, or mouse	USB port	rectangular hole with 4 wires in it
traditional printer	parallel printer LPT1 port	D shape, with 25 round pinholes in it
traditional mouse	PS/2 mouse port	circle, with 6 round pinholes in it
very old mouse	9-pin serial COM1 port	D shape, with 9 pins in it
phone on your desk	phone jack	square hole (4 wires in it) labeled "PHONE"
phone jack on room's wall	modem port	square hole (4 wires in it) labeled "LINE"
another computer or fast Internet	RJ-45 Ethernet port	slightly widened square hole (8 wires in it)
speakers	speaker jack	big round pinhole, next to loudspeaker picture
microphone	microphone jack	big round pinhole, labeled "MIC"

Traditionally, all those ports are on the system unit's back wall; but if your system unit is modern, some of those ports are on the system unit's front wall instead, so you can reach them more easily.

Unfortunately, the speaker jack has the same shape as the microphone jack. Make sure you don't mix them up! If you accidentally plug a speaker into the microphone jack, you'll hear a loud buzz!

The phone jack has the same shape as the modem port, but many computers still work even if you mix up those ports.

All the other ports are safer: they have different shapes to prevent mix-ups.

A **connector** (a **port** or a **cable's end**) that has pins sticking out of it is called **male** (because the pins look like little penises). A connector that has holes instead is called **female** (because it's eager to have a male connector plugged into it).

Setup Setting up the computer is easy! Just plug the cables into the components and ports, and you're done!

Inside the system unit

The system unit is a magical box you'll probably never need to open. But someday, you'll get curious about what's inside.

How to peek Here's how to peek inside the system unit (of a tower computer or traditional desktop computer).

Make sure the computer's turned off.

Remove the screws from the 4 corners of the system unit's back wall. Notice how big those screws are. Remove any other screws that size from the back wall's edges.

Then remove the system unit's cover:

If the unit's a **tower**, pull the cover back slightly, then lift it.
If the unit's a **traditional desktop** that's not a tower, slide the cover forward — or if it refuses, try sliding the cover back — then lift it slightly.
If the cover doesn't quite come off, jiggle it slightly, and also double-check whether you've removed all the screws holding it in place.

Finally, peek into the system unit and admire the goodies within! To be safe, avoid touching them.

Circuit boards Inside the system unit, you see several green plastic boards, called **circuit boards** (because they have electric circuits on tjhem). On each circuit board, you see many black rectangular objects, called **chips**: each chip contains a miniature electronic circuit inside!

Mobo The biggest circuit board is called the **motherboard** (or, more briefly, **mobo**). It's about the size of sheet of paper (8½" × 11"). In the typical desktop computer (which is a tower), the mobo is vertical, attached to the tower's right edge.

CPU On the mobo, the biggest chip is the one that does most of the thinking. That chip is called the **central processing unit (CPU)**. It's also called the **microprocessor**. A standard computer uses a brand of microprocessor called a **Pentium**, manufactured by an intelligent California company called **Intel**. Modern Pentiums are called **Core**.

In big, ancient computers, the thinking is done by a gigantic collection of chips working together, instead of a single microprocessor chip. That collection is called the **processor**. The term **microprocessor** was invented by folks amazed that a processor could be made small enough to fit on a single chip.

Expansion cards Besides the motherboard, the system unit contains smaller circuit boards (called **expansion cards**) that snap into slots in the motherboard.

The most important expansion card is the **video card**. It manages the monitor. It includes the video port, which attaches to the cable that comes from the monitor.

Another expansion card is the **sound card**. It manages the stereo speakers and microphone and attaches to the cables that comes from them.

Another expansion card is the **modem** (pronounced "mode em"). It manages phone signals and attaches to cables that come from the phone and the phone jack.

If your computer is part of a local-area network, your computer includes a **network interface card (NIC)**, which attaches to the network cable that comes from the network's other computers.

The keyboard does *not* have its own expansion card. Instead, the keyboard's cable plugs directly into the motherboard.

Memory The 4 most popular kinds of memory are **ROM chips**, **RAM chips**, **flash memory**, and **hard disks**.

ROM chips remember info *permanently*. Even if you turn off the computer's power, ROM chips continue to remember what they've been told. The info in the ROM chips cannot be destroyed or edited. The most important ROM chips are on the motherboard.

RAM chips remember info *temporarily*. They're electronic scratchpads that the CPU uses to store temporary reminders. For example, they remember what problem the computer's working on at the moment. They get erased when you switch to a different computer problem or turn the computer off.

Flash memory combines the best features of ROM and RAM:

> Like ROM, it can remember info permanently, even while the power is turned off. Like RAM, it lets you edit that info.

Flash memory has **great capacity** (it holds more info than ROM or RAM) but works slower. Flash memory is called a **flash drive** or **solid-state drive (SSD)** when it's in a normal computer (but not when it's in a cell phone).

Hard disks can hold even more info than flash memory and cost less but work slower. They're in old computers (invented before flash memory) and in computers for big businesses (who want to store more info than flash memory can hold).

Older types of memory, which have become less popular, are **floppy disks**, **compact disks (CD)**, and **digital versatile disks (DVD)**.

Power supply The **power cord** comes from your room's wall and goes into the back of the system unit. Look inside the system unit, at the back wall, where the power cord goes in. There you see, inside the system unit, a big metal box, called the **power supply**.

> If you look in a *tower*, the power supply is usually at the back wall's top.
>
> If you stand in front of a *desktop computer* and look down into it, so you see an aerial view, the power supply is usually in the back right corner.

The power supply is an **AC/DC transformer**: it converts the alternating current (coming from your office's wall) to the direct current that your computer requires.

Laptop computer's parts

The typical laptop computer uses a **clamshell design**: it opens, like a clamshell, to reveal 2 parts:

> The bottom part (¾" high) contains the main system-unit circuitry with a built-in keyboard, built-in pair of stereo speakers, built-in **touchpad** (square pad you rub with your finger instead of using a mouse), and built-in rechargeable battery.
>
> The top part (½" thick) pries up to become a screen (made of the same materials used in screens of pocket calculators and digital watches).

The laptop computer can get power from its built-in battery; but if you plug the computer into a wall's electrical outlet, the computer will use the wall's power instead while the battery recharges.

Once the computer gets electrical power, you can operate the computer without attaching anything to it. But the computer includes ports to let you attach optional extras. To its **USB ports**, you can attach a mouse (to use instead of the awkward built-in touchpad) and printer. You can use the computer's other ports to attach **headphones** (to use instead of the built-in speakers) and **network cables**.

Dealing with dealers

To buy a computer device (smartphone, tablet, laptop, or desktop), where should you go? You have many choices. Enjoy the hunt!

Stores

If you live near a **Best Buy** store, go there first, because:

> Best Buy sells a wide variety of computer devices (smartphones, tablets, laptops, and desktops) from many manufacturers. You can freely touch & try all those devices in the store. Prices are discounted. At many Best Buy stores, the staff is knowledgeable & helpful. To get the most help, visit during the middle of the day in the middle of the week; avoid evenings & weekends.

After visiting Best Buy, visit other stores.

> **Walmart** is especially good for finding cheaper computers & devices.
> **Sam's Club** requires a paid membership but often gives bigger discounts.
> **Costco** is more pleasant than Sam's Club but prices are usually higher.
> **Staples** gives fewer choices but sometimes gives a good deal.
> **Target** sometimes gives big discounts on devices by Apple.
> **Stores that repair** computers often give discounts on old used computers.
> **Stores owned by Verizon** often give discounts on smartphones.
> **Microsoft** used to have helpful stores but closed them all.

Micro Center is a popular chain of 25 superstores (in Massachusetts, New York, New Jersey, Pennsylvania, Maryland, Virginia, Georgia, Ohio, Michigan, Illinois, Minnesota, Missouri, Kansas, Colorado, Texas, and California).

> Like Best Buy, it's a pleasant place to browse, since the staff is friendly and the selection is huge. The typical Micro Center store contains 45,000 square feet displaying 36,000 products. A gigantic room is devoted to books, a gigantic room is devoted to Macs, a gigantic room is devoted to I/O devices (such as printers and scanners), etc. To find the store nearest you, phone 800-743-7537.

Mail order

Sometimes you can find lower prices on the Internet, from those dealers and also directly from the manufacturers (such as **HP** and **Lenovo**). State & federal laws keep changing about whether mail-order sales are subject to sales tax.

Before buying mail-order, ask whether the product's in stock, how long the dealer will take to fill your order, how it will ship, and what the shipping charge is: many dealers overcharge! Since products are improved often, check whether the dealer is selling you the *newest* version.

Price changes

Each week, prices change, especially on **Sundays**, as advertised in Sunday newspapers. Bigger discounts are available near **holidays & celebrations** (Presidents Day, July 4, Thanksgiving, Christmas, back-to-school, and graduation). When a manufacturer (such as Apple) announces a **new version** of a product, the previous version drops in price.

What's missing?

Before you pay, find out what the price does *not* include. Examples:

The price probably does not include a **printer**. The printer's price probably doesn't include a **cable** to go from the printer to the computer.

If you're buying an **Apple smartphone** now, the advertised price probably doesn't include a **charger**, which you must pay extra for, to give the phone electricity.

If you're buying a tower, the price might not include a **screen** (monitor).

The advertised price might include an inferior processor, memory, or screen unless you pay an **upcharge**.

If the price seems to include good software, that software might be just a **trial version** that stops working after a month or two.

If you dislike what you bought, you might have just 15 days to **return** it, and you might also have to pay a 15% **restocking fee**.

If you need **help** using your device (because it doesn't work or you can't find the instructions or you don't understand them), the free help might be limited to just the first month and to just a few minutes of tech-support time, or maybe you're unable to contact any tech-support people at all.

Protect yourself

Some dealers offer **price-protection**: after you buy, if you find the same product at a lower price within 30 days, your dealer will refund the difference.

Before you buy, ask questions about the product's abilities, to make sure it will do what you expect. Tell the dealer what hardware and software you own, and ask the dealer whether the product's compatible with your system.

The typical product comes in a cardboard box. On the box's back (or on some other side), you'll usually see a list of the **system requirements**. That's a list of what hardware and software you must already own to make that product work with *your* computer.

Use your credit card

Pay by credit card rather than a check.

If you pay by credit card and have an unresolved complaint about what you bought, Federal laws say that the credit-card company can't bill you! Moreover, if a mail-order company takes your money, spends it, and then goes bankrupt before shipping your goods, the credit-card company gets stuck, not you!

Some credit cards double the manufacturer's warranty, so a "one-year warranty" becomes a *two*-year warranty! Does *your* credit card give you that warranty extension? Ask!

Read the fine print

When reading an ad, make sure you read the fine print at the bottom of the ad. It contains many disclaimers, which admit that the deal isn't quite as good as the rest of the ad implies.

Asterisk In the middle of an ad, next to an exciting price or feature or warranty, you'll often see an asterisk (*). The asterisk means: "for details, read the fine print at the bottom of the ad". That fine print contains disclaimers that will disappoint you. In long multipage ads, the fine print is often buried at the bottom of just *one* of the ad's pages, far away from the page where the asterisk appeared, in the hope that you won't notice the fine print.

So if you see what looks like a great deal, but the deal has an asterisk next to it, the asterisk means "the deal is not really as great as we imply".

Fine-print phrases In many computer ads, the fine print contains these phrases….

"Monitor optional" means this price does *not* include a monitor. The monitor costs extra, even though the ad shows a photo of a computer with a monitor.

"Upgrade price" means you get this price just if you already own an older version of this stuff.

"With system purchase" means you get this price just if you're stupid enough to also buy an overpriced full computer system at the same time.

"Reflects cash discount" means you get this price just if you're stupid enough to pay cash instead of using a credit card. (By paying cash, you can't complain to a credit-card company if you get ripped you off.) If you use a credit card, the seller will charge you about 3% above the advertised price.

"Includes rebate" means you must pay more, then request a rebate from the manufacturer. (You'll probably never get that rebate, since you'll forget to ask for the rebate form or forget to mail the rebate form, or the rebate form will have already expired, or you'll lose the receipt or code number you must mail with the rebate form to get the rebate, or you can't mail the receipt because you already used it to apply for a rebate on a second item you bought simultaneously, or the manufacturer loses your paperwork or is a jerk who waits many months to send the rebate or goes bankrupt.)

"Manufacturer's warranty" means that if the stuff breaks, don't ask the seller for help. Phone the original manufacturer instead (who'll probably ignore you).

"Refurbished" or **"factory serviced"** means another customer bought this stuff, didn't like it, and returned it to the factory, which examined it and thinks it's good enough to resell (after jiggling it a bit), so now *you're* getting stuck with this lemon.

"Open box" means the computer was on display, so other customers fiddled with it and dirtied it, and its box & instructions might be missing.

"For in-stock items" means that although the seller promised to ship immediately, the seller won't if you order stuff that's not yet in the warehouse.

"25% restocking fee" means that if you return the stuff, you won't get your money back. Instead, the seller will keep 25% of the price (as a restocking fee) and return just 75% to you. Moreover, you'll have to pay the cost of shipping the stuff back.

Request discounts

To encourage a store to give you a discount, mention low prices from competitors and agree to buy many items at once. Say that if you don't get a discount, you'll shop elsewhere. Many stores do **price-matching**: they'll match the price of any other local store, though not the prices of mail-order dealers. Some stores let salespeople give 10% discounts, which are subtracted from the salesperson's commission.

Some suppliers (such as Apple and Microsoft) give educational discounts to schools, teachers, and some college students. To find out whether *you* can get educational discounts, ask those suppliers, your town's computer stores, and your school's administrators.

Chips

The computer is full of chips. Let's examine them.

Chip technology

If you unscrew the system unit (the box containing the CPU and memory) and peek at the circuitry inside, you'll see a green plastic board, on which is printed an electrical wiring diagram.

Since the diagram's printed in copper (instead of ink), the diagram conducts electricity. It isn't just a diagram of an electrical circuit; it *is* an electrical circuit!

The green plastic board — including the circuit printed on it — is called a **printed-circuit board (PC board)**. Each wire that's stamped onto the PC board is called a **trace**.

The typical computer contains several PC boards.

Motherboard & babies

In your computer, the largest and most important PC board is called the **motherboard** (or, more briefly, **mobo**).

In a smartphone or tablet or laptop or traditional laptop, the motherboard lies flat, on the system unit's bottom.

In an all-in-one computer, the motherboard is vertical, behind the screen.

In a tower computer, the motherboard is vertical, attached to the tower's right edge.

The other PC boards are smaller. Those little baby boards (about the size of a postcard) are called **PC cards**.

The typical motherboard has several **slots** on it. Into each slot, you can put a PC card.

Caterpillars

On each PC board, you'll see black rectangles. If you look closely at a black rectangle, you'll see it has tiny legs, so it looks like a black caterpillar.

The "caterpillars" come in many sizes. In a typical computer, the shortest caterpillars are ¾ of an inch long and have 7 pairs of legs; the longest are 2 inches long and have more legs.

Though each black caterpillar has legs, it doesn't move. It's permanently mounted on the PC board.

Each leg is made of tin and called a **pin**.

Hidden inside the caterpillar is a metal square, called a **chip**, which is very tiny. The typical chip is just an eighth of an inch long, an eighth of an inch wide, and a hundredth of an inch thick! On that tiny metal chip are etched *thousands* of microscopic electronic circuits! Since all those circuits are on the chip, the chip's called an **integrated circuit (IC)**.

4 purposes

Each chip serves a purpose.

If the chip's purpose is to "think", it's called a **processor chip**.
If the chip's purpose is to "remember" info, it's called a **memory chip**.
If the chip helps devices communicate with each other, it's an **interface chip**.
If the chip acts as a slave & helper to other chips, it's a **support chip**.

So a chip is either a processor chip, a memory chip, an interface chip, or a support chip — or it's a combination chip that accomplishes *several* purposes.

How chips are designed

To design a chip, the manufacturer hires an artist, who draws on paper a big sketch of what circuits to put onto the chip. It helps if the artist also has a degree in engineering — and knows how to use another computer to help draw all the lines.

After the big sketch is drawn, it's photographed.

Have you ever photographed your friend and asked a photography store for an "enlargement"? To produce a chip, the chip's manufacturer does the opposite: it photographs the sketch but produces a "reduction" to just an eighth of an inch on each side! Whereas a photo of your friend is made on treated paper, the tiny photo of the chip's circuitry consists of metal and semiconductors on treated silicon, so the photo's an actual working circuit! That photographic process is called **photolithography** (or **photolith**).

Many copies of that photo are made on a large silicon wafer. Then a cutter slices the wafer into hundreds of chips. Each chip is put into its own caterpillar.

The caterpillar's purpose is just to hide and protect the chip inside it; the caterpillar's just a strange-looking package containing the chip. Since the caterpillar's a package that has 2 rows of legs, it's called a **dual in-line package (DIP)**. That DIP's only purpose is to house the chip.

Computer hobbyists always talk about chips & DIPs, serve chips & dips at parties, and are called "dipchips".

Buying chips

If you ask a computer dealer to sell you a chip, the dealer also gives you the chip's DIP (the entire caterpillar).

Since you've asked for a chip but also received a DIP, you might think the caterpillar (the DIP) is the chip. But the caterpillar's *not* the chip; the chip hides inside the caterpillar.

The typical caterpillar-and-chip costs $3, but you might pay a different amount, depending on how fancy the chip's circuitry is.

You can get chips mail-order from **JDR Computer Devices** in California, phone 800-538-5000 or 650-625-1400.

How chips chat

The chip inside the caterpillar acts as the caterpillar's brain. The caterpillar also contains a "nervous system", made of thin wires that run from the brain (the chip) to the legs (the pins). The wires in the caterpillar's nervous system are very thin: each wire's diameter is about half of a thousandth of an inch.

If one caterpillar wants to send electrical signals to another caterpillar, the signals go from the first caterpillar's brain (chip) through the caterpillar's nervous system to its legs (pins). Each pin is attached to a trace (wire) on the PC board. The signals travel through those traces, which carry the signals across the PC board until the signals reach the second caterpillar's pins. Then the signals travel through the second caterpillar's nervous system to that caterpillar's brain (chip).

Binary code

To communicate with each other, the caterpillars use a secret code. Each code is a series of 1's and 0's. For example, the code for the letter A is 01000001; the code for B is 01000010; the code for the number 5 is 101; the code for 6 is 110.

That's called the **binary code**, because each digit in the code has just *two* possibilities: it's either a 1 or a 0. In the code, each 1 or 0 is called a **binary digit**. A **bi**nary digi**t** is called a **bit**. So in the computer, each **bit** is a 1 or a 0.

When a caterpillar wants to send a message to another caterpillar, it sends the message in binary code.

To send a 1, the caterpillar sends a high voltage through the wires. To send a 0, the caterpillar sends little or no voltage through the wires.

To send the number 5, whose code number is 101, the caterpillar sends a high voltage (1), then a low voltage (0), then a high voltage (1). To send those three bits (1, 0, then 1), the caterpillar can send them in sequence through the same leg (pin); or for faster transmission, the caterpillar can send them through three pins simultaneously: the first pin sends 1, while the next pin sends 0 and the third pin sends 1.

The speed at which bits are sent is measured in **bits per second (bps)**.

RAM

The computer system contains **memory chips**, which remember what problem the CPU (the computer's brain) is working on.

You want 3 kinds of memory chips: **RAM**, **ROM**, and **flash memory**.

The **RAM** chips remember info just temporarily.
The **ROM** chips remember info permanently.
Flash-memory chips are a compromise: they remember info semi-permanently.

Let's begin by looking at RAM chips.

If a chip remembers info just temporarily, it's called a **random-access memory chip (RAM chip)**. When you buy RAM chips, they contain no info yet; you tell the CPU what info to put into them. Later, you can make the CPU erase that info and insert new info instead. The RAM chips hold info just temporarily: when you turn the computer's power off, the RAM chips are automatically erased.

Whenever the CPU tries to solve a problem, the CPU stores the problem in the RAM chips, temporarily. There it also stores all instructions on how to solve the problem; the instructions are called the **program**.

If the computer doesn't have enough RAM chips to hold an entire problem or program, you (or a programmer) must split the problem or program into several shorter ones instead and tell the CPU to work on each short problem temporarily.

How RAM is measured

A **character** is any symbol you can type on the keyboard, such as a letter or digit or punctuation mark or blank space. Examples:

The word HAT consists of 3 characters. The phrase MR. POE consists of 7 characters: M, R, the period, the space, P, O, and E. The phrase LOVE 2 KISS U consists of 13 characters.

Instead of saying "character", hungry programmers say **byte**. So the phrase LOVE 2 KISS U consists of 13 bytes. If you store that phrase in the RAM, that phrase occupies 13 bytes of the RAM.

RAM chips are manufactured by a process that involves doubling. The most popular unit of RAM is "2 bytes times 2 times 2 times 2 times 2 times 2 times 2 times 2 times 2 times 2", which is **1024 bytes**, which is called a **kilobyte**. It's about a quarter as many characters as you get on a typewritten page (assuming the page is single-spaced with one-inch margins and elite type). The abbreviation for *kilobyte* is **K**. For example, if a salesperson says an old computer has a "512K RAM", the salesperson means the main circuitry includes enough RAM chips to hold 512 kilobytes of information, which is slightly over 512,000 bytes.

A **megabyte** is 1024 kilobytes. Since a kilobyte is 1024 bytes, **a megabyte is "1024 times 1024" bytes, which is 1,048,576 bytes altogether**, which is slightly more than a million bytes. It's about how much you can fit in a 250-page book (assuming the book has single-spaced typewritten pages). The abbreviation for *megabyte* is **meg** or **M**.

A **gigabyte** (pronounced "gig a bite") is 1024 megabytes. It's slightly more than a billion bytes. The abbreviation for *gigabyte* is **gig** or **G**.

A **terabyte** is 1024 gigabytes. It's slightly more than a trillion bytes. The abbreviation for *terabyte* is **T**.

To honor the words "kilobyte", "megabyte", "gigabyte", and "terabyte", programmers name their dogs Killer Byte, Make A Byte, Giggle Byte, and Terror Byte.

Rows of RAM chips

In a primitive old microcomputer (such as the Commodore 64), the RAM is a row of eight chips on the motherboard. That row of chips holds a total of 64 kilobytes (64K). That row of chips is called a **64K chip set**. Each chip in that set is called a "64K chip", but you need a whole row of those 64K chips to produce a 64K RAM.

If your computer is slightly fancier (such as the Apple 2c), it has *two* rows of 64K chips. The two rows together total 128K.

If your computer is even fancier, it has *many* rows of 64K chips. For example, your computer might have 4 rows of 64K chips. Since each row is a 64K RAM, the 4 rows together total 256K.

During the 1980's, computer engineers invented 256K and 1M chips.

If your computer has very little RAM, you can try to enlarge the RAM by adding extra rows of RAM chips to the motherboard. But if the motherboard's already full, you must buy an extra PC card to put the extra chips on. That extra PC card is called a **RAM memory card**.

Parity chip

The original IBM PC contained an extra chip in each row, so each row contained 9 chips instead of 8. The row's ninth chip is called the **parity chip**. It double-checks the work done by the other 8 chips, to make sure they're all working correctly!

So for an original IBM PC (or imitations of it), you must buy 9 chips to fill a row.

RAM sticks

If your computer is modern and you want to insert an extra row of RAM chips, you do *not* have to insert 8 or 9 separate chips into the motherboard. Instead, you can buy a **RAM stick** (tiny memory card) that contains all 8 or 9 chips and just pop the whole strip into the computer's motherboard, in one blow.

If the stick is classic,
it contains a single row of chips, pops into one of the motherboard's slots,
and is called a **Single In-line Memory Module (SIMM)**.

If the strip is modern,
it contains *two* rows of chips (one row on each side of the strip)
and is called a **Dual In-line Memory Module (DIMM)**.

Some computers use SIMMs containing a set of just 2, 3, or 4 chips. That set of special chips imitates 8 or 9 normal chips.

Each SIMM fits into a motherboard slot by using 30, 64, or 72 big pins.
The typical DIMM uses 100, 144, 168, 172, 184, 214, 240, or 288 big pins.

A **nanosecond** is a billionth of a second. The typical SIMM contains chips that are fast: they retrieve info in 60 nanoseconds. Some SIMMs and DIMMs contain chips that are even faster: 10 nanoseconds.

Dynamic versus static

A RAM chip is either **dynamic** or **static**.

If it's **dynamic**, it stores data for just 64 milliseconds. After the 64 milliseconds, the electrical charges that represent the data dissipate and become too weak to detect.

When you buy a PC board containing dynamic RAM chips, the PC board also includes a **refresh circuit**. The refresh circuit automatically reads the data from the dynamic RAM chips, then rewrites the data onto the chips before 64 milliseconds go by. Every 64 milliseconds, the refresh circuit reads the data from the chips and rewrites the data, so that the data stays refreshed.

If a chip is **static** instead of dynamic, the electrical charge never dissipates, so you don't need a refresh circuit. (But you must still keep the power turned on.)

In the past, computer designers used just static RAM because they feared dynamic RAM's refresh circuit wouldn't work. But now refresh circuits are reliable, and the most popular kind of RAM is dynamic.

Dynamic RAM is called **DRAM** (pronounced "dee ram"). Static RAM is called **SRAM** (pronounced "ess ram").

Faster circuitry

The circuitry on SIMM and DIMM cards has improved, to let a stream of data get from the memory card to the CPU chip faster. Such improvements have fancy names:

In 1987 came the first improvement, called **Fast Page Mode (FPM)**.
In 1995 came **Extended Data Output (EDO)**, which went even faster.
In 1996 came **Synchronous DRAM (SDRAM)**, which went even faster.
In 1999 came **Rambus DRAM (RDRAM)**, which went even faster.

In 2000 came **Double Data Rate SDRAM (DDR SDRAM)**, which had 184 pins and went about as fast as RDRAM but cost less.

In 2003 came **DDR2 SDRAM** (240 pins, transfers twice as fast as DDR).
In 2007 came **DDR3 SDRAM** (240 pins, transfers twice as fast as DDR2).
In 2014 came **DDR4 SDRAM** (288 pins, transfers twice as fast as DDR3).
In 2020 came **DDR5 SDRAM** (288 pins, transfers twice as fast as DDR4).

If you want to buy an extra SIMM or DIMM to put in your computer, make sure you buy the same kind already in your computer.

How much RAM?

The original IBM PC came with just 16K of RAM, but you could add extra RAM to it. **To run modern Windows software, you need at least 4 gigabytes of RAM**.

Prices

If you tell HP to custom-build a computer for you, HP typically charges **$10 per extra gigabyte of RAM**. For example:

To switch from 8G of DDR4 SRAM to 12G, add $40.
To switch from 8G of DDR4 SRAM to 16G, add $80.

But to switch from 16G of DDR4 SRAM to 32G, add just $110 (not $160).

ROM, PROM, flash

If a chip remembers info permanently, it's called a **read-only memory chip (ROM chip)**, because you can read the info but can't change it. The ROM chip contains permanent, eternal truths and facts put there by the manufacturer, and it remembers that info forever, even if you turn off the power.

Here's the difference between RAM and ROM:

RAM chips remember, temporarily, info supplied by you.
ROM chips remember, forever, info supplied by the manufacturer.

A traditional computer includes many RAM chips (arranged in rows) but just a *few* ROM chips.

What kind of info is in ROM?

In a traditional computer, one of the ROM chips contains instructions that tell the CPU what to do first when you turn the power on. Those instructions are called the **ROM bootstrap**, because they help the computer system start itself going and "pull itself up by its own bootstraps".

In a traditional computer, that ROM chip also contains instructions that help the CPU transfer information from the keyboard to the screen and printer. Those instructions are called the **ROM operating system** or the **ROM basic input-output system (ROM BIOS)**.

In a traditional IBM-compatible PC, the motherboard contains a **ROM BIOS chip**. That chip contains the ROM BIOS and also the ROM bootstrap. If your computer's made by IBM, that chip is typically designed by IBM; if your computer's made by a company imitating IBM, that chip is an imitation designed by a company such as **Phoenix**. Such a chip designed by Phoenix is called a **Phoenix ROM BIOS chip**. Other companies that designed ROM BIOS chips for clones are **Quadtel** (which was recently bought by Phoenix), **Award** (which was recently bought by Phoenix), and **American Megatrends Incorporated (AMI)** (which remains independent).

How ROM chips are made

The info in a ROM chip is said to be **burned into** the chip. To burn in the info, the manufacturer can use two methods.

One method is to burn the info into the ROM chip while the chip's being made. A ROM chip produced by that method is called a **custom ROM chip**.

An alternate method is to make a ROM chip that contains no info but can be fed info later. Such a ROM chip is called a **programmable ROM chip (PROM)**. To feed it info later, you attach it to a device called a **PROM burner**, which copies info from a RAM to the PROM.

Info burned into the PROM can't be erased, unless the PROM's a special kind: **an erasable PROM (EPROM)**. You can buy 3 types of erasable PROMs:

An **ultraviolet-erasable PROM (UV-EPROM)** gets erased by shining an intense ultraviolet light at it for 30 minutes (or leaving the chip in sunlight for a week). That technique erases the entire chip.

An **electrically erasable PROM (EEPROM)** gets erased by sending it an electrical shock for 4 milliseconds. (A millisecond is a thousandth of a second). That technique erases a few bytes at once but not the whole chip.

Flash memory gets erased by sending it an electrical shock for 1 millisecond. That technique erases a whole 64-kilobyte block at once, "in a flash". It's the most popular type of erasable PROM. It's used in digital cameras (to store pictures), cell phones, and reprogrammable BIOS chips. If the flash memory pretends to be an extra hard disk & drive, it's called a **solid-state drive (SSD)** and runs faster than a traditional hard disk & drive. If you tell HP to custom-build a computer for you, HP charges about **25 cents per extra gigabyte of SSD**. For example:
To switch from 128G SSD to 256G, add $40.
To switch from 256G SSD to 512G, add $60.
To switch from 512G SSD to 1024G (which is 1T), add $90.
To switch from 1T to 2T, add $200,
A solid-state drive that plugs into the system unit's USB port is called a **USB flash drive** (and is about the size of your thumb); it costs $6 for 16 gigabytes, $8 for 32 gigabytes, $10 for 64 gigabytes, $15 for 128 gigabytes, at Best Buy.

After you erase an erasable PROM, you can feed it new info.

Electronic devices (smartphones, tablets, laptops, and desktops) now tend to include flash memory instead of old-fashioned ROM, because flash memory is more flexible: it can be upgraded more easily whenever software improvements are needed.

CPU

The part of the computer that thinks ("the brain") is called the **processor** (or **central processing unit** or **CPU**).

In a maxicomputer or minicomputer, the processor consists of several chips, which are **processor chips**.

In a microcomputer, the processor is so small it consists of just a single chip, called a **microprocessor**. It sits on the motherboard. Yes, in a typical microcomputer, the part that does all the thinking is just a tiny square of metal, less than ¼" on each side!

Intel's designs

The typical microprocessor uses a design invented by **Intel**. Intel has gradually improved that design by putting more circuitry on the chip:

Chip's name	Year invented	Transistors on chip
Intel 8088	1979	29,000 transistors
Intel 286 (also called 80286)	1982	134,000 transistors
Intel 386 (also called 80386)	1985	275,000 transistors
Intel 486 (also called 80486)	1989	1,200,000 transistors
Intel Pentium	1993	3,100,000 transistors

The Intel Pentium could have been called the "Intel 586", but Intel called it the "Pentium" instead so Intel could trademark the name and prevent companies from copying it. It's the first computer chip that sounds like a breakfast cereal: "Hey, kids, to put zip into your life, try Penti-yumms. They build strong computer bodies, 5 ways!"

The Intel **8088** was used in the **original IBM PC** and the **IBM PC XT**.
The Intel **286** was used in a computer called the **IBM AT**.

The 8088, 286, 386, and 486 chips are all outdated, no longer actively marketed. **All Windows computers contain Pentiums** — or improved Pentiums, or imitations made by Intel's competitors.

Gigahertz

In an army, when soldiers march, they're kept in step by a drill sergeant who yells out, rhythmically, "Hup, two, three, four! Hup, two, three, four! Hup, two, three, four!"

Like a soldier, the microprocessor takes the next step in obeying your program just when told by the computer's "drill sergeant", which is called the **computer clock**. The clock rhythmically sends out a pulse of electricity; each time the clock sends out a pulse, the microprocessor does one more step in obeying your program.

The clock sends out *billions* of pulses every second, so the microprocessor accomplishes *billions* of steps in your program every second!

Each pulse is called a **clock cycle**. The clock's speed is measured in **cycles per seconds**. A "cycle per second" is called a **hertz (Hz)**, to honor German physicist Heinrich Hertz.

A "million cycles per second" is called a **megahertz (MHz)**.

1000 megahertz is called a **gigahertz (GHz)**. It's a billion hertz. Intel has invented fast Pentiums that go at 1, 2, 3, 4, and even 5.3 gigahertz.

Slower than a Pentium

The Pentium's an amazing chip: while it thinks about one part of your program, it simultaneously starts getting the next part of your program ready for processing. That chip's ability to do several things simultaneously is called **parallel processing**.

The Pentium is smarter than old chips (the 8088, 286, 386, and 486): the Pentium can perform more tasks simultaneously; it performs more parallel processing.

Variant chips

Old chips had variants:

The Intel **8088** came in 2 versions. One version (called simply the "8088") went slightly slower than the other version (called the **8086**).

The Intel **386** came in 2 versions. One version (the **386SX**) went slightly slower than the other version (the **386DX**).

The Intel **486** came in 2 versions. One version (the **486SX**) went slower than the other version (the **486DX**). Moreover, the 486DX came in 3 varieties: the original 486DX, the **486DX2**, and the **486DX4**.

The **Pentium** comes in many versions. Here are the most popular, listed from slowest to fastest:

Version	Invented	Comment
Pentium classic	1993	Pentium Pro is a faster variant
Pentium MMX	1995	understands 57 more instructions than classic
Pentium 2	1997	resembles Pentium MMX but 30% faster
Pentium 3	1999	understands 70 more instructions
Pentium 4	2000	Pentium 4M uses less electricity, for laptops
Pentium D	2005	D means dual: caterpillar contains 2 chips
Pentium Core Duo	2006	1 chip contains 2 cores, so acts like 2 chips
Pentium Core 2 Duo	2006	1 chip contains 2 cores, so acts like 2 chips
Pentium Core i3	2010	now 1 chip contains 2 or 4 cores
Pentium Core i5	2010	crude version in 2009, but now 4 or 6 cores
Pentium Core i7	2010	crude version in 2008, but now 4 or 8 cores
Pentium Core i9	2017	now 1 chip contains 8 cores

To help low-income folks, Intel eventually decided to make a cheaper Pentium, called **Celeron**. It goes slower.

The first Celeron, invented in 1998, was a cheaper, slower version of the **Pentium 2**. The newest Celeron is a cheaper, slower version of the **Pentium Core 2 Duo**.

For *very* low-income folks, Intel makes a version that's even cheaper & slower, called the **Atom**.

What's available

Intel stopped marketing the oldest chips (8086, 8088, 286, 386, 486 and oldest Pentiums). **Modern computers use these new Pentiums: the Core i3, Core i5, Core i7, and Core i9.**

Here are prices of various Pentium chips:

Intel Pentium chip	Cores	Cache memory	Gigahertz	Price
Core i5-11400	6	12 megabytes	4.4GHz	$170
Core i5-11600K	6	12 megabytes	4.9GHz	$250
Core i7-11700	8	16 megabytes	4.9GHz	$319
Core i7-11700K	8	16 megabytes	5.0GHz	$350
Core i9-11900	8	16 megabytes	5.2GHz	$450
Core i9-11900K	8	16 megabytes	5.3GHz	$500

That chart shows the lowest price charged by resellers for a single chip in June 2021, according to Intel. By the time you read this, prices might be lower, since prices change frequently (about every 2 months). That chart also shows how much **cache memory** (fast-access internal memory) is included inside the Pentium chip.

If you tell HP to custom-build a computer for you, here's what HP charges:

To switch from i3 to i5, add $100.
To switch from i5 to i7, add $150.
To switch from i7 to i9, add $260.

Imitations

Intel's competitors imitate Intel's chips. For example, these imitations go faster than Intel's originals:

Intel's chip	Imitations
8088 (4.77 or 7.18 MHz)	NEC's V20 chip goes faster: 10 MHz.
8086 (8 or 10 MHz)	NEC's V30 chip goes fast: 10 MHz.
286 (6-12 MHz)	Harris's 286 goes faster: 16 & 20 MHz versions.
386 (16-33 MHz)	AMD's 386 goes faster: 40 MHz.
486 DX (25-100 MHz)	AMD's 486 goes faster: 66-120 MHz versions.

Advanced Micro Devices (AMD) makes **Ryzen** chips, which compete against Intel's Pentium Core chips:

AMD Ryzen chip	Cores	Cache memory	Gigahertz	Price
Ryzen 5 5600X	6	35 megabytes	4.6 GHz	$299
Ryzen 7 5800X	8	36 megabytes	4.7 GHz	$449
Ryzen 9 5900X	12	70 megabytes	4.8 GHz	$549
Ryzen 9 5950X	16	73 megabytes	4.9 GHz	$799

That chart shows the price charged for a single chip in January 2021, according to Wikipedia.

Half-assed systems

While a chip waits for your commands, the chip accomplishes nothing useful during the wait: it just mumbles to itself.

To make full use of a fast Pentium, make sure you know what commands to give the computer. To let the chip reach its full potential, buy lots of RAM, big disk drives (or an SSD), and a quick printer. Otherwise, the Pentium will act as idiotic as if in the army: it will just "hurry up and then wait" for other parts of the system to catch up and tell it what to do next.

A mind's a terrible thing to waste! To avoid wasting the computer's mind (the CPU), make sure the other computer parts are good enough to match the CPU and keep it from waiting.

If you get suckered into buying a computer that has a fast Pentium chip but insufficient RAM, insufficient drives, and a slow printer, you've bought a computer that's just half-fast: it's half-assed.

Total cost

When you buy a computer, its advertised price includes a microprocessor, motherboard, and other goodies. Pay for the microprocessor separately just if you're inventing your own computer, buying parts for a broken computer, or upgrading your computer by switching to a faster microprocessor & motherboard.

Though the microprocessor is cheap, the computer containing it can cost many hundreds or thousands of dollars. That's because the microprocessor is just a tiny part of the computer. In addition to the microprocessor, you'll want memory chips, interface chips, support chips, PC boards (to put the chips on), I/O devices (a keyboard, screen, printer, speaker, and mouse), disks, and software.

Math coprocessor

Each Pentium chip includes **math coprocessor circuitry**, which handles advanced math fast. That circuitry can multiply & divide long numbers & decimals and compute square roots, logarithms, and trigonometry.

Primitive chips — the 8088, 8086, 286, 386SX, 386DX, and 486SX — do *not* include such circuitry.

To make a primitive chip do advanced math, you must feed the chip a program that teaches the chip how to break the advanced problem down into a series of simpler problems. That program runs slowly — nearly 100 times slower than if a math coprocessor were present!

Here's the only difference between a 486DX chip and a 486SX chip:

The 486DX chip (and 486DX2 and 486DX4) includes math-coprocessor circuitry; the 486SX does not. Intel invented the 486DX, then later invented the 486SX by using this manufacturing technique: Intel took each 486DX whose math coprocessor was faulty and called it a 486SX. So a 486SX is just a defective 486DX.

If your CPU lacks math-coprocessor circuitry (because your CPU is an 8088, 8086, 286, 386, or 486SX), here's how to do math quickly: buy a **math coprocessor chip**. Put it next to the CPU chip on the motherboard. It contains the math-coprocessor circuitry that the CPU lacks.

Intel CPU	Which Intel math coprocessor to buy
8088 or 8086	8087
286	287
386SX	387SX
386DX	387DX
486SX	487SX

Better yet, give up and buy a new computer, containing a Pentium!

Disks

Memory comes in 4 popular forms: RAM chips, ROM chips, flash-memory chips, and disks.

You already learned about RAM chips, ROM chips, and flash-memory chips. Let's examine disks. Disks are becoming less popular (because chips are becoming cheaper than before), but many computers still use disks!

A computer disk is round, like a phonograph record.

Computers can handle 4 kinds of disks:

A **floppy disk** is made of flimsy material. It's permanently encased in a sturdy, square dust jacket.

A **hard disk** is made of firmer material. It typically hides in your computer permanently, unseen.

A **CD** is the same kind of compact disk that plays music.

A **DVD** is the same kind of digital video disk that plays movies.

Each kind has its own advantages and disadvantages.

Floppy disks are the easiest to mail to your friends: just stick the floppy disk in an envelope, perhaps with some padding. Unfortunately, floppy disks work the most slowly, and they hold the least data: the typical floppy disk holds about 1 megabyte, while the typical CD-ROM can hold *many hundreds* of megabytes, and the typical hard disk can hold a billion megabytes!

Hard disks work the fastest — over 20 times faster than the other kinds! But hard disks are also the most expensive. Moreover, they typically can't be removed from your computer and so can't be mailed to your friends.

CDs and **DVD**s are the best value: they cost less than 1¢ per megabyte to manufacture. But they have a frustrating limitation: the info on those disks is hard to edit. A DVD can hold more megabytes than a CD and therefore costs more to manufacture.

Computer experts argue about spelling. Some experts write "**disk**", others write "**disc**".

Most manufacturers write "disk" when referring to floppy disks or hard disks but write "disc" when referring to CDs & DVDs. To be more consistent, I'll always write "disk", even when referring to CDs & DVDs.

Floppy disks

I'll start with floppy disks, because they're the easiest to understand (though they've become less popular).

A **floppy disk** (or **diskette**) is round but comes permanently sealed in a square **dust jacket**. Don't try to remove the floppy disk from its dust jacket. The floppy disk is as thin and flimsy as a sheet of paper but is protected by the sturdy, square jacket that encases it.

3 standard sizes

Floppy disks come in 3 standard sizes.

The most popular size is called a **3½-inch** floppy disk, because it comes in a square jacket that's about 3½ inches on each side. (Each side of the jacket is slightly *more* than 3½ inches, and the disk's diameter is slightly *less*.)

An older size, used just on older computers, is called **5¼-inch**; it comes in square jacket that's exactly 5¼ inches on each side. An even older size, **8-inch**, is used just on ancient computers that are no longer built.

Those 3 sizes have nicknames:

An 8-inch floppy disk is called a **large floppy**.
A 5¼-inch floppy disk is called a **minifloppy**.
A 3½-inch floppy disk is called a **microfloppy**.

Here's their history:

8-inch floppies were invented in the **early 1970's** by **IBM**.

5¼-inch floppies were invented in the **late 1970's** by **Shugart Associates**, which later became part of Xerox.

3½-inch floppies were invented in the **1980's** by **Sony**. They've become the most popular size because they're the smallest (small enough to fit in your shirt's pocket) and sturdiest (sturdy enough to survive when you fall on your face). They're easy to mail, since they're small enough to fit in a standard white business envelope and sturdy enough to survive the U.S. Postal System.

Jacket colors

The jacket of a 5¼-inch or 8-inch floppy disk is usually black. The jacket of a 3½-inch floppy disk is usually black, blue, white, or beige (very light grayish brown). If you pay a surcharge, you can get jackets that have wilder colors.

Magnetized iron

The round disk (which hides inside the square jacket) is coated with rust, so it looks brown. Since the rust is made of iron, which can be magnetized, the disk stores magnetic signals. The pattern of magnetic signals is a code representing your data.

Drives

To use a floppy disk, you must buy a **floppy-disk drive**, which is a computerized record player.

If the drive is **external**, it's a box sitting near the system unit. If the drive is **internal**, it's built into the system unit.

The drive has a slit in its front side. To use the drive, push the disk (including its jacket) into the slit.

When you push your disk into the slit, don't push the disk in backwards or upside-down! Here's **how to push the disk in correctly:**

The disk's jacket has a label on it and a big oval cutout. (If the disk is 3½-inch, the cutout is covered by a metal slider.)

Insert the disk so **the oval cutout goes into the drive before the label does**. If the drive's slit is horizontal, make sure the label's on the jacket's *top* side; if the drive is vertical, make sure the label's on the jacket's *left* side.

If the disk is 5½-inch or 8-inch, close the drive's latch, to cover the slit and hold the disk in place. (If the disk is 3½-inch, there's no latch.) Since the slit and latch act as a **door**, closing the latch is called **closing the door**.

Then the disk drive automatically positions the disk onto the turntable that's hidden inside the drive. The turntable's called the **spindle**. It can spin the disk fast.

Like a record player, the disk drive contains an arm with a "needle" on it. The needle's called the **read-write head**, because it can read what's on the disk and also write new info onto the disk.

To transfer info to the disk, the computer lowers the read-write head onto the disk. An electrical charge passes through the head. The charge creates an electromagnetic field, which magnetizes the iron on the disk's surface. Each iron particle has its own north pole & south pole; the patterns formed by the north & south poles are a code that stands for the info you're storing.

Tracks As the disk spins, the head remains stationary, so that the head draws a circle on the spinning disk's surface. The circle's called a **track**.

To draw the circle, the head doesn't use ink; instead, it uses a pattern of magnetic pulses. Since your eye can't see magnetism, your eye can't see the circle; but it's there!

When you start using a blank disk, the arm puts the head near the disk's outer rim, so that the head's track (circle) is almost as wide as the disk. That track's called **track 0**.

Then the arm lifts the head, moves the head slightly closer to the virgin disk's center, and puts the head back down onto the disk again. The head draws another circular track on the disk, but this new circular track is slightly smaller than the previous one. It's called **track 1**.

Then the head draws track 2, then track 3, then track 4, and so on, until the head gets near the center of the disk, and draws the last circular track (which

is smaller than the other tracks).

To organize the info on a track, the computer divides the track into **sectors**. Each "sector" is an arc of the circle.

Single-sided versus double-sided drives A modern disk drive has 2 read-write heads. One head uses the disk's top surface, while the other head uses the disk's bottom, so that the drive can use both sides of the disk simultaneously. That's called a **double-sided disk drive**. (Double-sided is also called **DS** and **2-sided** and **2S**.) The drive puts info onto the disk by first using track 0 of the main side, then track 0 of the flip side, then track 1 of the main side, then track 1 of the flip side, etc.

If a drive's so old and primitive that it has just *one* read-write head, it uses just one side of the disk and is called a **single-sided disk drive**. (Single-sided is also called **SS** and **1-sided** and **1S**.)

Capacity How many kilobytes can you fit on a floppy disk? The answer depends on which kind of drive you have.

The most popular kind of floppy-disk drive is called a **3½-inch high-density floppy drive**. Here's how it works:

It holds a 3½-inch floppy disk. It writes on both sides of the disk simultaneously, since it's a double-sided disk drive. It writes 80 tracks on each side. It divides each track into 18 sectors. Each sector holds "512 bytes", which is half a kilobyte, ½K.

Since the disk has ½K per sector, 18 sectors per track, 80 tracks per side, and 2 sides, the disk's total capacity is "½K times 18 times 80 times 2", which is 1440K. So altogether, the disk holds 1440K. That's called **1.44M** (where an **M** is defined as being 1000K), so a 3½-inch high-density floppy drive is also called a **1.44M drive**, and the disk you put in it is called a **1.44M floppy disk**. Since the disk holds 1.44M (which is 1440K), and since a K is 1024 bytes, the disk holds "1440 times 1024" bytes, which is 1,474,560 bytes.

Although the disk holds 1440K, some of those K are used for "bureaucratic overhead" (such as holding a directory that reminds the computer which data is where on your disk). A Mac uses just 1 sector (½K) for bureaucratic overhead. An IBM-compatible computer uses 33 sectors (16½K) for bureaucratic overhead, leaving just 1423½K for your data.

When you buy a blank disk to put in a 1.44M drive, make sure the disk is 3½-inch; and to get full use of what the drive can accomplish, make sure the disk is **high-density (HD)**. An HD 3½-inch disk has the letters **HD** stamped in white on its jacket (but with the D nudged against the H) and has an extra square hole cut through its jacket.

Old computers use inferior floppy drives, whose capacities are *below* 1.44M.

A capacity below 150K	is called **single-density (SD)**.
A capacity above 150M but below 1M	is called **double-density (DD)**.
A capacity above 1M	is called **high-density (HD)**.

Anything below high-density is called **low-density**.

Although the jacket of a high-density 3½-inch disk has "HD" stamped on it and an extra hole punched through it, the jackets of other kinds of disks can lack any distinguishing marks. Too bad!

Popular IBM-compatible drives For IBM-compatible computers, four kinds of floppy drives have been popular:

IBM drive's name	Capacity	Details
5¼-inch double-density	360K	40 tracks per side, 9 sectors per track
5¼-inch high-density	1200K(=1.2M)	80 tracks per side, 15 sectors per track
3½-inch double-density	720K	80 tracks per side, 9 sectors per track
3½-inch high-density	1440K(=1.44M)	80 tracks per side, 18 sectors per track

Each of those IBM-compatible drives is double-sided and has ½K per sector. They're manufactured by companies such as **NEC**, **Teac**, **Chinon**, **Epson**, and **Alps**. The fanciest drives (3½-inch high-density) used to be expensive, but now you can buy them for just $29 from mail-order discount dealers.

Mac drives For Mac computers, three kinds of floppy drives have been popular:

Mac drive's name	Capacity	Details
1-sided double-density	400K	1 side, 8-12 sectors per track
2-sided double-density	800K	2 sides, 8-12 sectors per track
high-density	1440K(=1.44M)	2 sides, 18 sectors per track

Each Mac drive is 3½-inch and has 80 tracks per side, ½K per sector.

On a disk, the inner tracks have smaller diameters than the outer tracks. Mac double-density drives puts fewer sectors onto the inner tracks and put extra sectors onto the outer tracks, as follows: the outer 16 tracks are divided into 12 sectors, the next 16 tracks into 11 sectors, the next 16 into 10, the next 16 into 9, and the inner 16 into 8.

Speed In the disk drive, the disk spins quickly.

Low-density 5¼-inch disks revolve 5 times per second.
8-inch disks and high-density 5¼-inch disks revolve faster: 6 times per second.
3½-inch disks revolve even faster: between 6½ and 10 times per second.

Buying disks

When you buy a floppy disk, make sure its size matches the size of the drive: a 3½-inch disk will *not* work in a 5¼-inch drive. If your drive is single-density or double-density, it can't handle high-density disks.

Formatting the disk Before you can use a blank floppy disk, its surface must be **formatted** (divided into tracks and sectors). Buy a disk that's been formatted already, or buy an unformatted disk and make your computer format it (by giving a formatting command).

After the disk's been formatted, put whatever info you wish onto the disk. (Warning: if you accidentally tell the drive to format that disk again, the drive will erase all your old data!)

Remember:

If a disk is blank, make sure it's formatted before you use it.
If a disk already contains info, don't format it; it's been formatted already.

What's a disk worth? Though you can buy a blank floppy disk for under 50¢, a disk containing info costs much more. The price depends on how valuable the info is.

Protect your disks

Unfortunately, magnetic signals on a disk are easy to destroy, so **keep your disk at least 6 inches away from magnets**, such as:

paper clips that have been in a magnetized paper-clip holder
speakers in your stereo, TV, and phone (because speakers contain magnets)
electric motors (because motors generate an electromagnetic field)

Keep your disk away from heat, because heat destroys the disk's magnetism and "melts" your data:

Don't leave your disk in the hot sun, or on a sunny windowsill, or in the back of your car on a hot day. If your disk drive or computer feels hot, quickly lower its temperature, by getting an air conditioner or a fan.

A 3½-inch floppy disk comes in a strong jacket.

If you're using a 5¼-inch or 8-inch floppy disk instead, beware! Its jacket is too weak to protect it from pressure. Don't squeeze it. Don't put it under a heavy object (such as a paperweight or book). To write a note on the disk's jacket, don't use a ballpoint pen (which crushes the disk); use a soft felt-tip pen instead.

Keep the disk away from dust. For example, don't smoke cigarettes near the disk, because the smoke becomes dust that lands on the disk.

Keep the disk dry. If you must transport a disk during a rainstorm, put the disk in a plastic bag. Don't drink coffee or soda near the disk: your drink might spill.

To handle the disk, **touch just the disk's jacket, not the brown disk itself**. Holes in the jacket let you see the brown disk inside; don't put your fingers in the holes.

Write-protect notch When you buy a blank **5¼-inch or 8-inch** floppy disk, the disk comes in a square black jacket. One of the square's 4 sides has a notch cut into it.

You can cover the notch, by sticking a plastic **tab** over it. The tab has a gummed back, so you can stick it on the disk easily and cover the notch. You get the tab free when you buy the disk.

For a **3½-inch** disk, the notch is different:

It's a square hole near the jacket's corner but not on the jacket's edge. To cover it, you use a black slider instead of a tab. On old Apple Mac disks, the slider was red instead of black.

Whenever you ask the computer to change the info on the disk, the drive checks whether you've covered the notch.

For a 5¼-inch disk, the normal situation is for the notch to be uncovered. For a 3½-inch or 8-inch disk, the normal situation is for the notch to be covered.

If the situation's normal, the computer will obey your command: it will change the info on the disk as you wish. But **if the situation's abnormal (because the notch is covered when it should be uncovered, or is uncovered when it should be covered), the computer will refuse to change the disk's info**.

If your disk contains valuable info and you're afraid some idiot will accidentally erase or alter that info, make the situation abnormal (by changing whether the notch is covered), so the computer will refuse to change the disk's info. It will refuse to erase the disk, refuse to add new info to the disk, and refuse to edit what's on the disk. The disk is protected from being changed, protected from being written on; the disk is **write-protected** (**locked**). Since the tab affects whether the disk is write-protected, the tab is called a **write-protect tab**, and the notch is called a **write-protect notch**.

When you buy a disk that already contains info, the disk usually comes write-protected, to protect you from accidentally erasing the info.

If you buy a 5¼-inch floppy disk that already contains info, it might come with a write-protect tab already covering the notch, to write-protect the disk. But instead of creating a notch then covering it with a tab, some manufacturers save money by getting special disks that have no notch. The computer treats a notchless disk the same way as a disk whose notch is covered.

Backup Even if you handle your disk carefully, eventually something will go wrong, and some info on your disk will get wrecked accidentally. To prepare for that inevitable calamity, tell the computer to copy all info from the disk onto a blank disk, so the blank disk becomes an exact copy of the original. Store the copy far away, in a different room, or — better yet — a different building. The copy is called a **backup**. Use the backup disk when the original disk gets wrecked. Making a backup disk is like buying an insurance policy: it protects you against disasters.

When you buy a floppy that already contains software, try copying the floppy before you begin using it.

If you're lucky, the computer will make the backup copy without any hassles. If you're unlucky, the software company put instructions on the floppy that make the computer *refuse* to copy the disk, because the company fears you'll illegally make copies to your friends. A floppy the computer refuses to copy (and so is protected against illegal copying) is called **copy-protected**. A floppy you can copy is called **copyable** (or **unprotected**).

Super-capacity floppies

Though a standard floppy disk holds up to 1.44M, **super-capacity** floppy disks hold more and come in three styles:

Type	Size	Capacity	Price
Zip disk	4"	100M	$89 drive by Iomega, $11 disk
Zip 250 disk	4"	250M	$187 drive by Iomega, $17 disk
LS-120 disk	3½"	120M	$100 drive by Imation, $10 disk

Super-capacity floppy disks used to be popular, but newer computers use CD or DVD disks instead, which cost less and hold more.

Hard disks

Hard disks are better than floppy disks in 3 ways:

Hard disks are sturdier than floppies.
Hard disks are hard and firm; they don't flop or jiggle.
They're more reliable than floppies.

Hard drives hold more info than floppy drives.
The typical floppy drive holds 1.44 megabytes.
The typical hard drive holds 1 terabyte (which is 1,000,000 megabytes).

Hard drives work faster than floppies.
The typical floppy disk rotates between 5 and 10 times per second.
The typical hard disk rotates between 90 and 167 times per second.

Unfortunately, the typical hard disk can't be removed from its drive: the hard disk is **non-removable**, stuck inside its drive permanently. (Hard disks that are **removable** are rare.)

Since the typical hard disk is stuck forever inside its drive, in one fixed place, it's called a **fixed disk**.

Though the typical floppy-disk drive holds just one disk at a time, the typical hard-disk drive holds a whole **stack** of disks and handles all the stack's disks simultaneously, by using many arms and read-write heads.

For example, a 1-terabyte hard drive holds a non-removable stack of disks, and the entire stack totals 1 terabyte. Each disk in the stack is called a **platter**.

If your hard drive is the rare kind that holds a *removable* stack of disks, the stack comes in a **cartridge** or **pack** that you can remove from the hard drive.

Back in 1977, the typical hard disk had a 14-inch diameter and was removable. The hard-disk drive was a big cabinet (the size of a top-loading washing machine), cost about $30,000, held 0.1 gigabytes, and required a minicomputer or mainframe.

Life's gotten smaller!

Now the typical desktop computer's hard disk has a diameter of just 3½ inches, a height of just 1 inch, costs $46, holds 1000 gigabytes (which is a terabyte), and fits in a desktop computer. Notebook computers use hard disks whose diameter is just 2½ inches.

IBM drive letters

A traditional IBM-compatible computer has both a floppy drive and a hard drive. The floppy drive is called **drive A**; the hard drive is called **drive C**.

If the computer has *two* floppy drives, the main floppy drive is called **drive A**; the other floppy drive is called **drive B**.

If the computer has *two* hard drives, the main hard drive is called **drive C**; the other hard drive is called **drive D**.

Copy between disks

When you buy a program, it might come on a floppy disk (or CD or DVD). Put that disk into its drive then copy the program from that disk to the hard disk. (To find out how to copy, follow the program's instructions.) Then use just the copy on the hard disk (which holds more info and works faster than a floppy disk or CD or DVD).

Like floppy disks, hard disks are coated with magnetized iron. Floppy disks & hard disks are both called **magnetic disks**. Like floppy disks, hard disks are in constant danger of losing their magnetic signals — and your data!

Protect yourself! Every week, take any new info that's on your hard disk and copy it onto a pile of floppy disks (or CDs or DVDs or a USB flash drive), so you've created a **backup copy** of what was new on your hard disk.

To avoid giant disasters, avoid creating giant files. If you're writing a book and want to store it on your hard disk, split the

book into chapters, and make each chapter a separate file, so if you accidentally say "delete" you'll lose just one chapter instead of your entire masterpiece.

How the head works

In a floppy drive, the read-write head (the "needle") touches the spinning floppy disk. But in a *hard* drive, the read-write head does *not* touch the spinning hard disk; instead, it hovers over the disk, very close to the disk (just a tiny fraction of an inch above the disk), so close that the read-write head can detect the disk's magnetism and alter it.

Since the head doesn't actually touch the disk, there isn't any friction, so the head and the disk don't suffer from any wear-and-tear. That's why a hard-disk system lasts longer than a floppy-disk system and is more reliable.

Winchester drives In all modern hard drives, the head acts as a miniature airplane: it **flies** above the disk.

It flies at a very low altitude: a tiny fraction of an inch. The only thing keeping the head off the rotating disk is a tiny cushion of air — a breeze caused by the disk's motion.

When you unplug the drive, the disk stops rotating, so the breeze stops, and the head comes to rest on a **landing strip**, which is like a miniature airport.

Such a drive is called a **flying-head drive**. It's also called a **Winchester drive**, because "Winchester" was IBM's secret code-name for that technology when IBM was inventing it.

The head flies at an altitude that's extremely low — about a ten-thousandth of an inch! That's even smaller than the width of a particle of dust or cigarette smoke! So if any dust or smoke lands onto the disk, the head will smash against it, and you'll have a major disaster.

To prevent such a disaster, the entire Winchester drive is sealed airtight, to prevent any dust or smoke from entering the drive and getting onto the disk. Since the drive is sealed, you can't remove the disks (unless you buy an extremely expensive Winchester drive that has a flexible seal).

Speed

Here's how the computer retrieves data from the drive.

First, the drive's head moves to the correct track.

The time that the head spends moving is called the **seek time**. Since that time depends on how far the head is from the correct track, it depends on where the correct track is *and where the head is moving from*.

According to calculus, on the average the head must move across a third of the tracks to reach the correct track. That's why the time to traverse a third of the tracks is called the **average seek time**.

A **millisecond (ms)** is a thousandth of a second. In a typical hard drive, the average seek time is about 9 milliseconds. (In older hard drives that are no longer made, the average seek time was 28 milliseconds.)

After the head reaches the correct track, it must wait for the disk to rotate, until the correct sector reaches the head.

That rotation time is called the **latency**. On the average, the head must wait for half a revolution; so the **average latency time** is a half-revolution. The typical cheap hard drive rotates 5400 times per minute, which is 90 times per second, so a half-revolution takes half of a 90th of a second, so it's a 180th of a second, so it's about .006 seconds, which is 6 milliseconds.

If you add the average seek time to the average latency time, you get the total **average access time**. So for a typical cheap hard drive, the average access time = 9 milliseconds seek + 6 milliseconds latency = 15 milliseconds.

For a higher quality hard drive, the rotation speed is 7200 rpm (instead of 5400), giving 120 rotations per second (instead of 90), an average latency of 4 milliseconds (instead of 6), and an average access time of 13 milliseconds (instead of 15).

During the last few years, hard drive manufacturers have become dishonest: they say the "average access time" is 9 milliseconds, when they should actually say the "average seek time" is 9 milliseconds.

After the head finally reaches the correct sector, you must wait for the head to read the data. If the data consumes *several* sectors, you must wait for the head to read all those sectors.

Manufacturers

For many years, most hard drives for microcomputers were built by 4 American companies: **Seagate Technology (ST)**, **Quantum**, **Western Digital**, and **Conner**:

Seagate was the first of those companies to make hard drives for microcomputers. It set the standard that the other companies had to follow. New Seagate drives work fine, though Seagate's old models were noisy & unreliable.

Quantum became famous by building the hard drives used in Apple's Mac computers. Quantum also built drives for IBM PC clones. Quantum drives are excellent.

Western Digital invented hard drives that cost less. They're popular in cheap clones and discount computer stores.

Conner was the first company to invent hard drives tiny enough to fit in a laptop computer. Seagate had ignored the laptop market too long, and Conner's popularity zoomed up fast. Conner became the fastest-growing company in the history of American industry!

Other manufacturers of hard drives were America's **Maxtor** & **Micropolis**, Japan's **Toshiba** & **Fujitsu** & **Hitachi** & **NEC**, and Korea's **Samsung**.

Companies merged:

Toshiba bought Fujitsu's hard-drive business. Western Digital bought Hitachi's hard-drive business. Maxtor bought Quantum's hard-drive business; then Seagate bought the hard-drive businesses of Maxtor, Conner, and Samsung. Micropolis & NEC gave up and left the hard-drive business.

Now just 3 hard-drive manufacturers remain:

Western Digital (44% of all hard drives)
Seagate (40%)
Toshiba (16%)

To use a hard drive, you need a **hard-drive controller**, which was a card you had to buy separately but nowadays is included on the hard drive's card and in the hard drive's price.

How many sectors?

How many sectors do you get on a track?

Early schemes Back in the 1980's, the typical hard-drive controller for IBM-compatible computers put 17 sectors on each track.

That scheme was the **Seagate Technology 506 with Modified Frequency Modulation (ST506 MFM)**.

An improved scheme squeezed 26 sectors onto each track and was the **ST506 with Run Length Limited (ST506 RLL)**. A further improvement squeezed 34 sectors onto each track and was the **Enhanced Small Device Interface (ESDI)**.

Squeezing extra sectors onto each track increases the drive's **capacity** (total number of megabytes) and the **transfer rate** (the number of sectors that the head reads per rotation or per second).

All those schemes — MFM, RLL, and ESDI — have become obsolete.

IDE Now the most popular scheme is called **Integrated Drive Electronics (IDE)**. Like ESDI, it squeezes 34 sectors onto each track; but it uses special tricks to transfer data faster.

The original version of IDE was limited to small drives: up to 528M.

Western Digital invented an improved version, **Enhanced IDE (EIDE)**, which could handle bigger drives and went faster: it transferred 16.6 **megabytes per second (MB/s)**. Seagate invented competing methods (**Fast ATA-2** and **Fast ATA-3**), which also transfer 16.6 MB/s.

All those technologies got replaced by **Ultra**, which transfers twice as fast: 33.3 MB/s. The Ultra version of EIDE is **Ultra IDE**; the Ultra version of Fast ATA is **Ultra ATA**. Then came an even faster Ultra ATA, called **Ultra ATA-100** (100 MB/s). Maxtor invented an even faster Ultra ATA, **Ultra ATA-133** (133 MB/s).

All those ATA technologies are called **Parallel ATA (PATA)**. They've been replaced by an even faster type, **Serial ATA (SATA)**. The first SATA controller (**SATA/150**) transferred 150 MB/s. Newer SATA controllers (called **SATA 2** or **SATA/300**) transfer 300 MB/s. The newest SATA controllers (called **SATA 3** or **SATA/600**) transfer 600 MB/s (6 giga**bits** per second).

SCSI A totally different fast scheme is the **Small Computer System Interface** (**SCSI**, which is pronounced "scuzzy").

A fast version of SCSI, **Ultra 160 SCSI**, transfers 160 MB/s.

During the 1980's and early 1990's, SCSI was used on most Mac hard drives and the biggest IBM-compatible hard drives, because IDE drives were too slow and held just a few megabytes. But during the late 1990's, IDE drives became faster, bigger, and cheaper, so SCSI drives became unpopular.

IBM-compatible drives Modern, popular IBM-compatible hard drives cost **about $30 per terabyte**. When discussing hard drives, a **gigabyte** (**gig** or **G**) is defined to mean "1000 megabytes"; a **terabyte (T)** means "1000 gigabytes".

Here are the prices charged by Best Buy for desktop-computer SATA/600 drives when this book went to press in June 2020:

Capacity	Speed	Cache	Manufacturer	Price
1 T	7200 rpm	64M	Seagate	$46
2 T	7200 rpm	256M	Seagate	$56
3 T	5400 rpm	64M	Western Digital	$70
4 T	7200 rpm	128M	Toshiba	$105
6 T	5400 rpm	64M	Western Digital	$200
8 T	7200 rpm	256M	Western Digital	$250
10 T	7200 rpm	256M	Western Digital	$320

The drive's **cache** (or **buffer**) is RAM chips holding copies of the sectors you used recently — so if you want to look at those sectors again, you can read from the RAM chips (which are fast) instead of waiting for the disk to spin (which is slow).

External drives A hard drive's price depends on whether the drive is **internal** (fits inside the computer) or **external** (comes in a separate box that you put next to the computer). Internal drives are faster; but if your computer is small or filled up or can't be easily opened, you must buy an external drive instead. The typical external drive plugs into a USB port.

When this book went to press in June 2020, here's what Best Buy charged for external USB drives made by Western Digital:

1T for $45, 2T for $60, 4T for $90, 5T for $105, 12T for $320, 14T for $380

History Hard-drive prices dropped dramatically! Here's what size hard drive you could get for about $200 each year:

Year	$200 size	Year	$200 size	Year	$200 size
1992	50M=.05G	1998	8G	2004	200G
1993	130M=.13G	1999	13G	2005	300G
1994	340M=.34G	2000	30G	2006	400G
1995	850M=.85G	2001	80G	2007	500G
1996	1G	2002	120G	2008	640G
1997	3½G	2003	180G	2009	1000G=1T
				2010	2000G=2T

Now you can get a 5T drive for $105.

Buy a big drive Buy a drive that holds several terabytes. It will give you more peace of mind than a smaller drive, and it will also act faster.

For example, suppose you want to store a terabyte of info, and you're debating whether to buy a 1-terabyte drive or a 2-terabyte drive. Suppose each drive is advertised as having a 9-millisecond seek time. The 2-terabyte drive will nevertheless act faster. Here's why.…

Suppose you buy the 2-terabyte drive and use just the first terabyte of it. Since you're using just the first half of the drive, the head needs to move just half as far as usual; so over the 1-terabyte part you're using, the effective average seek time is just half as much as usual: it's 4½ milliseconds!

RAID

If you need lots of terabytes, attach several hard drives together, and make the drives all act simultaneously. The group of drives is called a **drive array** and acts as one huge drive. That technique is called **RAID** (which originally stood for **Redundant Array of Inexpensive Disks** but now stands for **Redundant Array of Independent Disks**).

Here are RAID's most popular versions:

RAID level 0, called **data striping**, is the fastest. It divides each long file into several **stripes**. A stripe's first part is put onto drive 1, second part onto drive 2, third part onto drive 3, etc., simultaneously, so that the stripe spans across all the drives. Each drive therefore has to handle just *part* of each stripe and just *part* of each file and finishes faster.

RAID level 1, called **data mirroring**, is the safest. It uses just 2 drives. It puts each file onto drive 1 and simultaneously puts a backup copy of the file onto drive 2, so drive 2 always contains an exact copy of what's on drive 1. That way, if drive 1 ever fails, the computer can get the info from drive 2.

RAID level 3, called **shared data parity**, is more sophisticated: it's a clever compromise between RAID level 0 and RAID level 1. Like RAID level 0, it divides each long file into stripes, puts a stripe's first part onto drive 1, second part onto drive 2, third part onto drive 3, etc.; but onto the final drive it puts **parity info** instead, which is info that the computer uses to double-check the accuracy of the other drives.

RAID level 5, called **distributed data parity**, is the most sophisticated. It resembles RAID level 3; but instead of putting all the parity info onto the *last* disk, it puts the first stripe's parity info onto the *first* disk, the second stripe's parity info onto the *second* disk, etc., so that the parity info is distributed among *all* the disks, to prevent the last disk from getting overworked and bogging down the whole system.

CD

Instead of buying a program on a floppy disk, you can buy a program on the same kind of **compact disk (CD)** that holds music.

A CD that holds music is called a **music CD** (or **audio CD**).

A CD that holds computer data instead is called a **computer CD** (or **data CD**). Since the computer data on it cannot be erased, a computer-data CD is also called a **CD read-only memory (CD-ROM)**.

To make your computer read the CD-ROM disk, put the disk into a **CD-ROM drive**, which is a souped-up version of the kind of CD player that plays music.

Like an ordinary CD player, a CD-ROM drive uses just **optics**. No magnetism is involved. The drive just shines a laser beam at the shiny disk and notices, from the reflection, which indentations (**pits**) are on the disk. The pattern of pits is a code that represents the data. So a CD-ROM drive's an example of an **optical disk drive**.

To put the disk into the drive, press a button on the drive. That makes the drive stick its tongue out at you! The tongue is called a **tray**. Put the disk onto the tray, so that the disk's label is face-up. (If the drive is old-fashioned, you must put the disk into a **caddy** first; but the most modern drives are **caddyless**.) Then push the tray back into the drive. Finally, use the keyboard or mouse to give a command that makes the computer taste what you've put on its tongue.

Drive letters

Here's how a traditional computer assigns the drives:

Drive A is a 3½-inch floppy drive (1.44M).
Drive B is a 5¼-inch floppy drive (1.2M).
Drive C is a hard drive (about 1T) or a solid-state drive.
Drive D is a CD-ROM drive (or a DVD drive).

If your computer has *two* hard drives, the first hard drive is C, the second is D, and the CD-ROM drive is the next letter (E).

Size

The standard CD-ROM disk has a diameter of 12 centimeters (which is about 5 inches) and holds 650 megabytes.

The CD-ROM disk is single-sided: all the data is on the disk's *bottom* side — the side that doesn't have a label.

The disk contains 2 billion pits, all arranged into a single spiral (like the groove on a phonograph record). If you were to unravel the spiral, to make it a straight line, it would be 3 miles long!

On a CD, each "song" is called a **track**; it can hold music or computer data. Each "song" (track) can be as long or as short as you wish. The CD can hold 99 tracks, totaling an hour of music (for an audio CD) or 650 megabytes (for a CD-ROM disk). 650 megabytes is about 450 times as much as a high-density 1.44M floppy, so a single CD-ROM disk can hold as much info as a stack of 450 high-density 1.44M floppies!

Since a CD-ROM disk holds so much, a single CD-ROM can hold a whole library (including encyclopedias, dictionaries, other reference materials, famous novels, programs, artwork, music, and videos). It's a great way to distribute massive quantities of info! Moreover, a CD-ROM disk costs less than 15¢ to manufacture (once you've bought the appropriate CD-ROM-making equipment, which costs several hundred dollars).

CD-ROM disks store info differently than floppy & hard disks:

> On a CD, each track is part of a spiral. On a floppy or hard disk, each track is a circle.
>
> On a CD, different tracks have different lengths and hold a different number of bytes. On a typical floppy or hard disk, all tracks have the same number of bytes as each other.

Speed

When buying a CD-ROM drive, the most important factor to consider is the drive's speed.

Transfer rate The speed at which the drive spins is called the **transfer rate**. The higher, the better!

On the first CD-ROM drives that were invented, the transfer rate was the same speed as a music CD's: **150 kilobytes per second**. That speed is called **1X**.

> Then came drives that could spin twice as fast (300 kilobytes per second). That's called **double speed** or **2X**. Then came **3X** drives, then **4X**, then **4½X**, then **6X**, then **8X**, then **10X**, then **12X**. Then came even faster drives, called **24X/12X** (or **24X maximum** or **24X max**), that read outer tracks at a maximum speed of 24X, though the inner tracks are read at just 12X. Now you can buy drives that go much faster: **56X max**!

Seek time The average time it takes for the head to move to the correct track is called the **average seek time**.

The lower the average seek time, the better! In modern CD-ROM drives, the average seek time is 100 milliseconds or less.

Caring for your CD-ROM disks

A CD-ROM disk's main enemy is dirt.

> Like a music CD, a CD-ROM disk comes in a clear square box, called the **jewel box**. To use the disk, remove it from the jewel box and put it in the drive. When you finish using it, put it back into the jewel box, which keeps the dust off it.
>
> When putting the disk into or out of a drive, don't put your fingers on the disk's surface: instead, **hold the disk by its edge**, so your greasy fingerprints don't get on the disk's surface.
>
> Once a month, gently **wipe dust** off the disk's bottom surface (where the data is). While wiping, be gentle and don't get your greasy fingerprints on the disk. Start in the middle and wipe toward the outer edge.

If you want to write on the disk, **use a felt-tipped pen** (not a ballpoint or pencil). Don't stick any labels on the disk.

The typical CD-ROM disk will last about 12 years. Then the aluminum on its surface will start to oxidize (corrode), and the CD will become unreadable.

CD-R

You can create your own CD's, in the privacy of your home, if you buy a **CD-Recordable drive (CD-R drive)**. It can write onto blank **CD-R disks**, which used to be expensive but now are cheap.

You can buy 100 blank CD-R disks for $15 at Walmart, so the disks cost you just 15¢ each.

Although a CD-R drive can write onto a disk, it can*not* erase or edit what you wrote.

CD-RW

For more flexibility, you can buy a **CD-ReWritable drive (CD-RW drive)**, which can write onto a blank **CD-RW disk** and then edit what you wrote. CD-RW drives used to be expensive, but now they've become nearly as cheap as CD-R drives, so nobody bothers selling CD-R drives anymore.

You can buy 100 blank CD-RW disks for $50 at Walmart.com, so the disks cost you 50¢ each.

Creating your own CD (by using a CD-R or CD-RW drive) is called **CD burning** (because the data is **burned into** the CD), so CD-R and CD-RW drives are called **CD burners**.

DVD

In 1997, the electronics industry began selling an improved kind of CD, called a **Digital Versatile Disk (DVD)**. It looks like a standard-size CD but holds more info.

Unlike a standard CD, which holds just an hour of music or 650M of data, a standard DVD can hold a 2-hour movie (including the video and sound) or 4.7G of data. Since it can hold a movie, some movie lovers call it a "Digital Video Disk", but it's more versatile than just that!

Improved DVD

A DVD can be recorded on just the bottom side (like a CD) or on both sides. (To use the second side, you must remove the disk from the drive and flip the disk upside down, like you'd flip a phonograph record.) A dual-sided DVD can hold 9.4G of data.

An improved technology, called **dual-layer DVD**, puts nearly *two* layers of data on each side, so you get 8.5G per side, 17G total.

A DVD that contains computer data (instead of a movie or music) is called a **DVD-ROM disk**. To use it, put it in a **DVD-ROM drive**, which costs just *slightly* more than a CD-ROM drive. Every DVD-ROM drive can read DVD-ROM disks and standard CD-ROM disks; just *modern* DVD-ROM drives can also read CD-R and CD-RW disks.

Create your own DVD

To create and edit your *own* DVDs in your own home, buy a **DVD+RW drive**. It can read & write DVD+RW disks, DVD+R disks, CD-RW disks, and CD-R disks.

Get a DVD+RW drive, not a DVD-RW drive (which uses different disks, called DVD-RW disks), or get a **DVD±RW drive** (which can handle both DVD+RW and DVD-RW disks).

Here's what stores charged in June 2020:

an internal DVD±RW drive	$25 at Best Buy
an external DVD±RW drive (using USB)	$30 at Best Buy
100 blank DVD+R disks	$20 at Sam's Club (so 20¢ each)

I/O devices

To get info into and out of the computer, you need **input/output devices (I/O devices)**. Here they are.…

Screens

The computer's **screen** is also called the **display**. It resembles a TV screen but lacks an antenna and a dial to change channels. It gives you just one channel: computer!

Kinds of screens

You have many choices.

Built in? Is the screen attached?

If the screen is permanently attached to the front of the computer's main part, the screen is called **built-in**. The screen is built-in if you have a smartphone or tablet computer or laptop or all-in-one.

In a tower computer or traditional desktop computer, the screen is **stand-alone** (a separate box, with a cable running from it to the computer's main part, which is the system unit) and is called a **computer monitor**. The advertised price of such a computer system usually does *not* include the computer monitor, which costs extra, though sometimes you'll see a **bundle price** that includes both the system unit and the computer monitor in the bundle. The computer monitor's price includes the cable that goes to the system unit.

Touch-sensitive? If the screen can sense where you touched the screen, it's called a **touch-sensitive screen (touchscreen)**.

Every **smartphone** has a touchscreen.

The typical **tablet computer** has a touchscreen (though old Kindle and Nook e-readers do not).

If a **laptop computer** or **all-in-one computer** uses a new operating system (such as **Windows 8 or 8.1 or 10 or 11**), it expects you to have a touchscreen; it's awkward to use without a touchscreen; using it without a touchscreen feels like torture. If you tell HP to custom-build a laptop for you with a 15.6" screen, HP charges $50 extra to make the screen be touch-sensitive. Older operating systems (such as Windows 7, Windows Vista, Windows XP, and Mac OS X) don't know how to handle touchscreens (unless you add extra software). For example, Apple's laptop computers and all-in-one computers do *not* use touchscreens.

The typical **tower computer** does *not* have a touchscreen (because touchscreen monitors are pricey and hard to connect).

CRT or LCD? Technology has improved.

If the computer's screen is old-fashioned, it resembles an old TV: it's bulky (*many* inches thick), heavy, and consumes lots of electricity, because it contains a **picture tube**. The technical name for "picture tube" is **cathode-ray tube (CRT)**.

If the computer's screen is modern, it resembles a modern TV: it's thin (less than an inch thick), lightweight, and consumes just a modest amount of electricity, because it contains a **liquid-crystal display (LCD)**. The cost of manufacturing an LCD has dropped, so now **an LCD costs much less** than a CRT; hardly anybody buys a CRT anymore. They typical LCD screen is supplemented by **light-emitting diodes (LED)** and called an **LED screen**.

Flat? Is the screen **flat**?

An LCD screen is typically **flat** (not bent or curved).

A CRT screen is based on a picture tube whose screen is typically curved, but if you pay extra you can get a CRT whose screen is flat. The flat screen has 2 advantages:
It displays horizontal and vertical lines more accurately (without curving).
It reflects light from fewer angles (so you see fewer annoying reflections).

Color? The typical screen is **color** (which means it can show all the colors of the rainbow). Cheaper screens are **monochrome** (which meant they're limited to just black-and-light).

Monochrome LCD screens are used in cheap gadgets that don't require color and must run on minimal electricity. For example, monochrome LCD screens are used in digital wristwatches and solar pocket calculators. They display black and white.

Monochrome screens were also used long ago, in the cheapest CRT monitors. 4 types of CRT monochrome monitors were common:

A	**paper-white monitor**	displayed black and white.
An	**amber monitor**	displayed black and yellow.
A	**green-screen monitor**	displayed black and light green.
A	**gray-scale monitor**	displayed many shades of gray.

How colors are produced

On the screen, the picture shown is made of thousands of tiny dots. Each tiny dot is called a **picture's element** (**pixel** or **pel**).

In a color screen, each pixel's color is made by aiming 3 colored lights (red, green, and blue) all at the same pixel.

If just the red light shines at the pixel, the pixel looks red.
If just the green light shines at the pixel, the pixel looks green.
If just the blue light shines at the pixel, the pixel looks blue.

If all 3 lights shine at the pixel, the pixel looks very bright: white!
If all the lights are turned off, the pixel looks black.

To make the pixel look **cyan** (greenish blue), just the green & blue lights shine.
To make the pixel look **magenta** (purplish red), just the red & blue lights shine.
To make the pixel look **yellow**, just the red and green lights shine (which produce a color that's brighter and lighter than red or green alone).

That's how to produce 8 colors: red, green, blue, white, black, cyan, magenta, and yellow.

Although a primitive screen produces just those 8 colors, a modern screen can produce extra colors by varying the light's intensity. For example, instead of the red light being either "on" or "off", it can be "completely on", "partly on" (so it looks dim), or "off".

Here are the names for the different levels of color monitors:

A **primitive RGB monitor** produces just **8 colors**. Its cable to the computer includes a red-light wire, a green-light wire, and a blue-light wire. Each wire's current has 2 choices (on or off), so the total number of color choices is "2 times 2 times 2", which is 8.

A **Color Graphics Adapter monitor (CGA monitor)** can produce **16 colors**. Its cable to the computer includes a red-light wire, a green-light wire, a blue-light wire, and an intensity wire. Each wire's current has 2 choices (on or off), so the total number of choices is "2 times 2 times 2 times 2", which is 16.

An **Enhanced Graphics Adapter monitor (EGA monitor)** can produce **64 colors**. Its cable to the computer includes 2 red-light wires (generating a total of 4 levels of red-light intensity), 2 green-light wires, and 2 blue-light wires, so the total number of choices is "4 times 4 times 4", which is 64.

A **Video Graphics Array monitor (VGA monitor)** can produce **over 16 million colors**. Its cable to the computer includes 1 red-light wire, 1 green-light wire, and 1 blue-light wire, and each wire can handle 256 levels of intensity, so the total number of choices is "256 times 256 times 256", which is 16,777,216.

A **High-Definition Multimedia Interface monitor (HDMI monitor)** uses a cable containing more wires, to produce even higher quality. HDMI was invented in 2002. The first HDMI was called **HDMI 1**; afterwards came improvements, called **HDMI 1.1, 1.2, 1.3, 1.4, and 2**. For example, the current version, **HDMI 2**, can also handle sounds (like a TV) and many pixels on the screen ("4096×2160 pixels", totaling 8,847,360 pixels), and each pixel can show "2^{48} colors", totaling 281,474,976,710,656 colors.

The standard is now HDMI (any version from 1 through 2). Primitive RGB, CGA, and EGA monitors are obsolete and no longer built. VGA is still available but obsolescent.

Here's how a cable connects a monitor to the system unit:

The typical HDMI cable contains 19 wires. Some of them transmit codes about colors and sounds; the others help administer the signals.

For a VGA monitor, the cable to the system unit includes 1 red-light wire, 1 green-light wire, 1 blue-light wire, and several other wires to help administer the signals. Altogether, the VGA cable contains 15 wires.

CGA and EGA cables each contain just 9 wires. If you see a monitor whose cable contains just 9 wires, the monitor is either CGA or EGA, so it's obsolete.

How are the 3 lights (red, green, and blue) produced?

In an LCD screen, a **backlight** (at the screen's back wall) constantly shines at you through 3 colored filters (a red filter, a green filter, and a blue filter).

In a CRT screen (which is a picture tube), a **gun** shoots electrons at colored phosphors, to wake them up and make them glow temporarily. The gun shoots at the first pixel (which is at the screen's top-left corner), then the second pixel (which is to the right of the first pixel), etc., until the entire first row's been shot; then the gun shoots lower rows. Before the phosphors fade much, the gun returns to the screen's first pixel and shoots them all again, to keep them awake ("refresh" them). How long do you have to wait until the gun shoots the first pixel again? That's called the **refresh rate**. You want a refresh rate that's fast: at least 85 times per second (which is called "**85 cycles per second**", "**85 "Hertz**", "**85 Hz**"). If the refresh rate is slower, your eye notices the phosphors are flickering, so you get a headache and want to puke. Flicker is noticeable especially if you look at the screen out of the corner of your eye, since your eye's peripheral vision is most sensitive to flicker. More precisely:
85 hertz is excellent, seems flicker-free.
75 hertz is rather good. It's acceptable to most folks, annoying to some.
60 hertz is rather bad. It's annoying to everybody but still usable.
Below 60 hertz is terrible, unusable.

Sizes

Computer screens come in many sizes.

CRT monitors The typical CRT monitor produces VGA color and is **17-inch (17")**. That means the distance from the picture tube's top-left corner to the picture tube's bottom right corner is 17 inches, measured diagonally.

Although the picture tube's diagonal size is 17-inch, you see just 16 inches, because 1 inch is hidden behind the plastic that makes up the monitor's case.

Most CRT monitors are made by companies whose US headquarters are in California. Consumers complained to California's attorney general that such a monitor shouldn't be called "17-inch", since just 16 inches are viewable. California now requires all ads for "17-inch" CRT monitors to include a comment, in parentheses, saying that the **viewable image size (vis)** is just 16 inches, so the ad looks like this:

17" monitor (16" vis)

Instead of buying a 17-inch CRT monitor, you can buy a bigger one (19-inch or 21-inch) or a smaller one (15-inch or 14-inch). In each case, the viewable image size is about an inch less than the size of the tube.

Each position on the screen is a **pixel**. The pixels are arranged in rows and columns, to form a grid. In a primitive VGA monitor, the screen is wide enough to hold 640 columns of pixels, and the screen is tall enough to hold 480 rows of pixels, so altogether the number of pixels in the grid is "640 times 480", which is written "**640×480**", which is pronounced "640 by 480". That's called the screen's **resolution**.

If you buy a big VGA or HDMI monitor (such as 21-inch), the screen is big enough to hold *lots* of pixels. You can use such a screen in two ways: you can make the screen either show lots of tiny pixels or show a smaller number of fat pixels.

Here's how many pixels the typical CRT screen can display:

If screen is 14" (13" viewable), it handles 640×480 well, 800×600 poorly.
If screen is 15" (14" viewable), it handles 800×600 well, 1024×768 poorly.
If screen is 17" (16" viewable), it handles 1024×768 well, 1280×1024 poorly.
If screen is 19" (18" viewable), it handles 1280×1024 well, 1600×1200 poorly.
If screen is 21" (20" viewable), it handles 1600×1200 well, 1800×1440 poorly.

Those resolutions have nicknames:

Resolution	Nickname	Alternative nicknames
640×480	**minimal VGA**	
800×600	**Super VGA (SVGA)**	**VGA Plus**
1024×768	**eXtended GA (XGA)**	**nice SVGA or Ultra VGA (UVGA)**
1280×1024	**Super XGA (SXGA)**	
1600×1200	**Ultra XGA (UXGA)**	

For most of those resolutions, the first number (which represents the screen's width) is 4/3 as big as the second number (which represents the screen's height). Such a screen is called a "**4:3 screen**" and a **standard-ratio screen**. (An old-fashioned TV also has a 4:3 screen.) Exception: 1280×1024 has a ratio of 5/4 (written "5:4") instead of 4:3.

The typical cheap 17" CRT monitor can show 1024×768 resolution well (at 85 hertz) but shows 1280×1024 resolution poorly (at 60 hertz). The ad for such a monitor typically begins by bragging that it can display 1280×1024 but then admits it handles that resolution poorly and should be used at just 1024×768; it says:

1280×1024 @ 60Hz, 1024×768 @ 85Hz

LED monitors Best Buy sells LED monitors (which are a type of LCD monitor) in these sizes & resolutions:

Size	Resolution	Resolution's name	Ratio	Brand	Price
19.5"	1600×900	HD (high definition)	16:9	AOC	$70
24"	1920×1080	full HD	16:9	Acer	$80
27"	1920×1080	full HD	16:9	Acer	$130
25"	2560×1080	ultra-wide full HD	21.3:9	LG	$182
24"	2560×1440	quad HD	16:9	BenQ	$249
32"	1920×1080	full HD	16:9	LG	$264
29"	2560×1080	ultra-wide full HD	21.3:9	LG	$352
28"	3840×2160	4K ultra HD	16:9	Dell	$400
32"	2560×1440	quad HD	16:9	HP	$400
34"	3440×1440	ultra-wide quad HD	21.5:9	AOC	$550
32"	3840×2160	4K ultra HD	16:9	BenQ	$792

Those are the prices when this book went to press in December 2016.

A ratio of 16:9 means the width is 16/9 as big as the height. That's called "**widescreen**".

A ratio of about 21:9 means the with is about 21/9 as big as the height. That's called "**ultra-wide screen**".

Widescreen & ultra-wide screen monitors are good for watching movies but bad for reading text, since text needs more height and less width. Some monitors can pivot 90 degrees, so 16:9 becomes 9:16, which is better for text.

LCD projectors An **LCD projector** resembles an LCD monitor but projects the image onto a huge movie screen (or your room's white wall), so the image is many feet wide and can be seen by a big audience in a movie theater (or big conference room).

Built-in LCD screens LCD screens are built into all-in-smartphones, tablets, laptops, and all-in-one desktops.

Where to put a monitor According to researchers such as the government's **National Institute of Occupational Safety and Health (NIOSH)**, here's where you should put a monitor so you'll be comfortable while you're working at the computer:

Put the monitor slightly lower than your eyes, so you look *down* at the monitor (instead of looking up, which would strain your neck). When you're looking at the center of the monitor's screen, you should be looking down slightly (at an angle that's 15 degrees below horizontal).

Put the monitor a moderate distance from your face. NIOSH recommended that the distance from your eyes to the center of the monitor's screen be 17 inches; but that recommendation was made several years ago, when the typical monitor screen was just 12-inch. Now screens are bigger, so you need to sit farther from the screen to see the whole screen: a distance of 23 inches feels good to me.

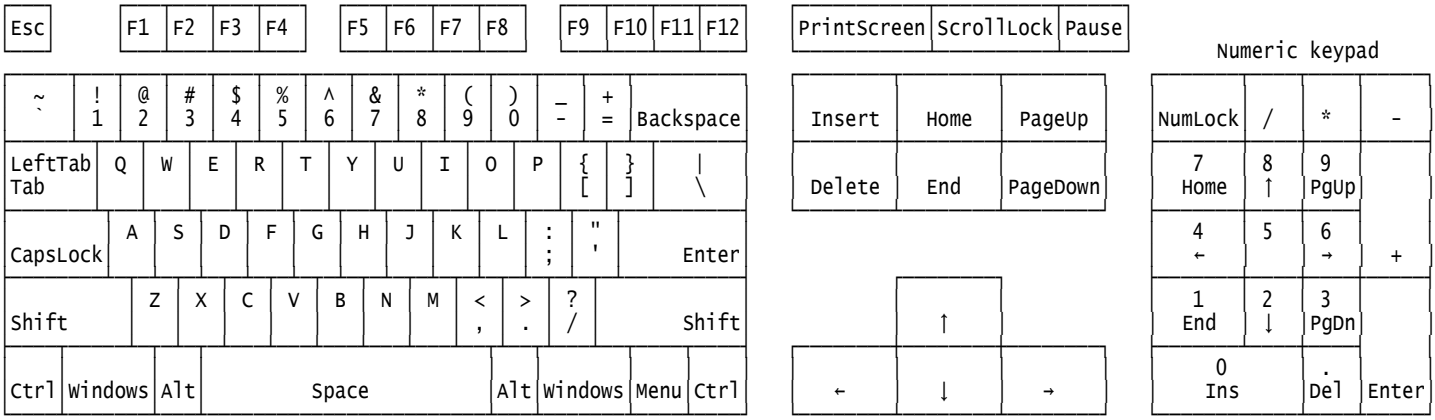
Keep the room rather dark, to avoid having light reflected off the monitor's surface. **Put the monitor perpendicular to any light source**, so no light source shines directly onto the monitor's screen (which would create an annoying reflection) and no light source shines directly onto the monitor's back (since such a light source would also be shining into your eyes and create an annoying glare).

Keyboards

The usual way to communicate with the computer is to type messages on the computer's **keyboard**.

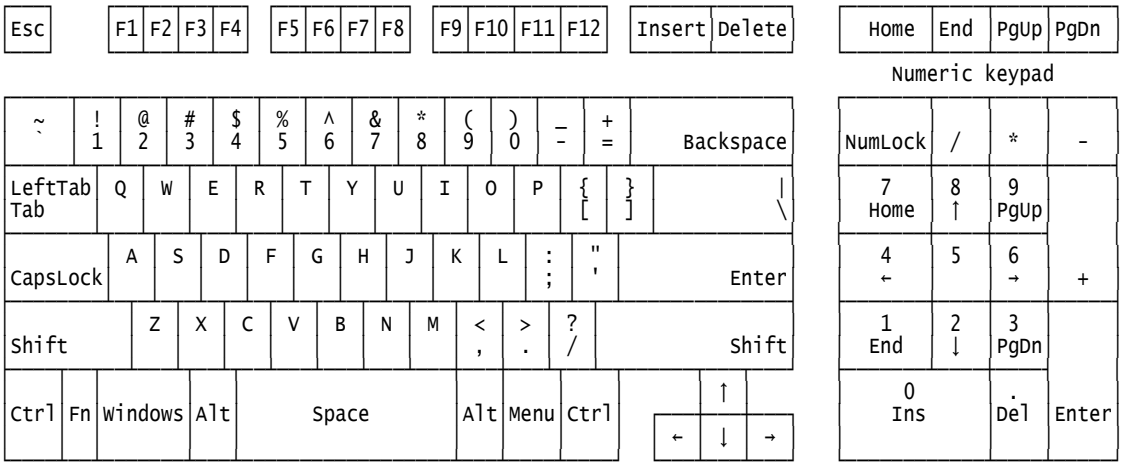
In 1981, IBM invented a keyboard containing **83 keys**. That keyboard is called the **XT keyboard**, because it was used on the original IBM PC and the IBM PC XT.
In 1986, IBM began selling a fancier keyboard, containing **101 keys**. It's called the **AT keyboard**, because it was used on the IBM PC AT.
In 1995, Microsoft began selling an even fancier keyboard, containing **104 keys**. It's called the **Windows keyboard**, because it contains extra keys for Windows.

"104 keys" became the standard. Microsoft, IBM, and competitors all sold keyboards containing 104 keys, arranged like this:

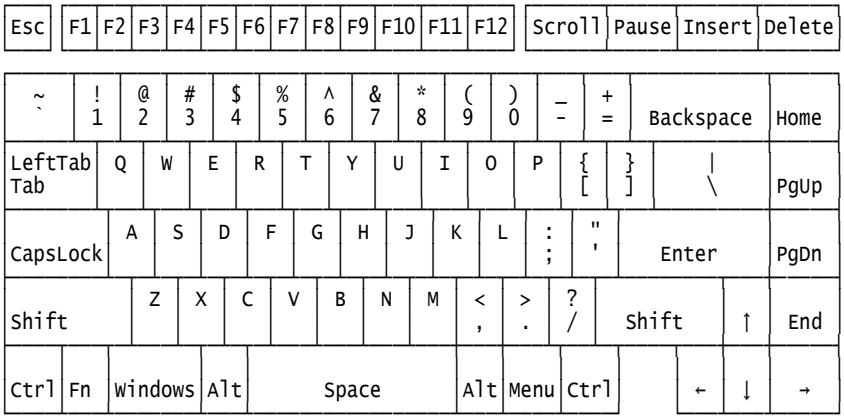


Later, an Fn key was added, squeezed between the Ctrl and Windows keys (which are at the bottom-left corner).

Those keys are for desktop computers. Laptop computers are smaller, so they have fewer keys. Good classic laptop computers (such as the Hewlett-Packard G71-340US) have 101 keys, arranged like this:



Smaller laptop computers (such as the Compaq CQ5-110US) have just 86 keys, arranged like this:



Each keyboard can print all the letters of the alphabet (from A to Z), all the digits (from 0 to 9), and these symbols:

Symbol	Official name	Nicknames
.	period	dot, decimal point, point, full stop
,	comma	cedilla
:	colon	dots, double stop
;	semicolon	semi
!	exclamation point	bang, shriek
?	question mark	ques, query, what, huh, wildchar
"	quotation mark	quote, double quote, dieresis, rabbit ears
'	apostrophe	single quote, acute accent, prime
`	grave accent	left single quote, open single quote, open quote
^	circumflex	caret, hat
~	tilde	squiggle, twiddle, not
=	equals	is, gets, takes
+	plus	add
-	minus	dash, hyphen
_	underline	underscore, under
*	asterisk	star, splat, wildcard
&	ampersand	amper, amp, and, pretzel
@	at sign	at, whorl, strudel
$	dollar sign	dollar, buck, string
#	number sign	pound sign, pound, tic-tac-toe
%	percent sign	percent, grapes
/	slash	forward slash, rising slash, slant, stroke
\	backslash	reverse slash, falling slash, backwhack
|	vertical line	vertical bar, bar, pipe, enlarged colon
( )	parentheses	open paren & close paren, left paren & right paren
[ ]	brackets	open bracket & close bracket, square brackets
{ }	braces	curly brackets, curly braces, squiggly braces
<>	brockets	angle brackets, less than & greater than, from & to

For example, the symbol * is officially called an "asterisk". More briefly, it's called a "star". It's also called a "splat", since it looks like a squashed bug. In some programs, an asterisk means "match anything", as in a card game where the Joker's a "wildcard" that matches any other card.

In the diagram, I wrote the words "Shift", "Backspace", "LeftTab", "Tab", "Enter", "Windows", and "Menu" on some keys. To help people who don't read English, keyboard manufacturers usually put symbols on those keys.

The Shift key shows a fat arrow pointing up.
The Backspace key shows an arrow pointing left.
The Tab key shows arrows crashing into walls.
The Enter key shows an arrow that's bent (going down and then left).
The Menu key shows a diagonal arrow pointing up at a menu.
The Windows key shows a flying window (having 4 curved windowpanes).

Stare at *your* computer's keyboard and find these keys:

Key	Where to find it
Tab	the Tab key is left of the Q key
Backspace	104 keys: the Backspace key is left of the Insert key 101 keys: the Backspace key is left of the Num Lock key 86 keys: the Backspace key is left of the Home key
Shift	the left Shift key is left of the Z key the right-hand Shift key is right of the question-mark key
Enter	the Enter key is above the right-hand Shift key
Windows	usually, any Windows keys are next to Alt keys (if 86 keys but weird, the Window key is next to the Pause key)
Menu	usually, the Menu key is next to the right-hand Ctrl key (if 86 keys but weird, the Menu key is in the top-right corner)

The keyboard contains special keys that help you do special activities (such as moving around the screen while you type):

Key	Usual purpose
↑ or ▲	move up, to the line above
↓ or ▼	move down, to the line below
← or ◄	move left, to the previous character
→ or ►	move right, to the next character
Home	move back to the beginning
End	move ahead to the end
Page Up or PgUp	move back to the previous page
Page Down or PgDn	move ahead to the next page
Tab	hop to the next field or far to the right
Enter	finish a command or paragraph
Pause	pause until you press the Enter key
Print Screen or PrtSc	copy from screen onto paper or computer's clipboard
Shift	capitalize a letter
Caps Lock	change whether all letters are automatically capitalized
Num Lock	change whether keyboard's right side produces numbers
Scroll Lock or ScrLk	change how text moves up & down
Insert or Ins	change whether extra characters inserted in text's middle
Delete or Del	delete the current character
Backspace or BkSp	delete the previous character
Escape or Esc	escape from a mistake
Windows	show you Windows' Start menu
Menu	show you a shortcut menu
F1	get help from the computer
F2, F3, etc.	do special activities
Control or Ctrl	do special activities
Alternate or Alt	do special activities

The Caps Lock, Num Lock, Scroll Lock, and Insert keys are called **toggle keys**: they create special effects, which end when you press the toggle key again.

Shift Key

If a key has two symbols on it, the key normally uses the bottom symbol. To type the top symbol instead, press the key *while holding down the Shift key*.

Number Keys

To type a number easily, use the keys in the top row of the keyboard's main section. (For example, to type 4, press the key that has a 4 and a dollar sign.)

Numeric keypad On a desktop computer or big laptop computer, the keyboard's far-right keys are in a rectangle called the **numeric keypad**, which begins with the NumLock key and includes all the numbers. **If you're a beginner, I recommend keeping your hands off the numeric keypad**: use the other number keys instead.

If you insist on using the numeric keypad, here's how it works:

The keys on the numeric keypad work normally (generating numbers) just while the Num Lock light glows. (The Num Lock light is usually near the Num Lock key and labeled "Num Lock", but on some computers the light is farther away and labeled "1".) Usually that light glows, and you should let it keep glowing. If you want to turn that light off (or turn it back on again), tap the Num Lock key. **When the Num Lock light is off, the keys on the numeric keypad don't generate numbers; instead, they imitate the edit keys** (Home, End, PgUp, PgDn, Ins, Del, and arrows).

Fn or multimedia confusion

While holding down the Fn key, you can tap another key. The result depends on which computer you have.

Here's what happens on my laptop computer made by Acer (the "Aspire V5-571P-6866"):

Keys	What the computer will do
Fn with F3	turn off wireless communication (or turn it back on)
Fn with F4	sleep (until you press a key)
Fn with F5	use (or stop using) external monitor instead of built-in screen
Fn with F6	turn off the screen's backlight (until you press a key)
Fn with F7	turn off the touchpad (or turn it back on)
Fn with F8	turn off the speakers (or turn them back on)
Fn with F9	turn off the keyboard's backlight (or turn it back on)
Fn with F12	turn on the scroll lock (or turn it back off)
Fn with ▲	increase the speaker volume
Fn with ▼	decrease the speaker volume
Fn with ►	increase the screen's brightness
Fn with ◄	decrease the screen's brightness
Fn with Home	play (or pause the playing of) a music CD (or a DVD movie)
Fn with Pg Up	stop playing a music CD (or a DVD movie)
Fn with Pg Dn	play the previous track of a music CD (or DVD movie)
Fn with End	play the next track of a music CD (or DVD movie)

Here's what happens on my old laptop computer made by Hewlett-Packard (the "HP G71-340US"):

Keys	What the computer will do
Fn with Esc	give details about your computer's hardware & software
Fn with F1	explain how to use the computer
Fn with F2	help you print onto paper
Fn with F3	access the Internet (by running Internet Explorer or Microsoft Edge)
Fn with F4	use (or stop using) external monitor instead of built-in screen
Fn with F5	sleep (blank the screen until you tap the power button)
Fn with F6	lock (hide the screen's info until a password is typed)
Fn with F7	decrease the screen's brightness
Fn with F8	increase the screen's brightness
Fn with F9	play (or pause the playing of) a music CD (or DVD movie)
Fn with F10	stop playing a music CD (or a DVD movie)
Fn with F11	play the previous track of a music CD (or DVD movie)
Fn with F12	play the next track of a music CD (or DVD movie)
Fn with numeric keypad's +	increase the speaker volume
Fn with numeric keypad's -	decrease the speaker volume
Fn with numeric keypad's *	turn off the speakers (or turn them back on)

But the Fn key has changed:

On **new** computers by **Microsoft, HP, Lenovo, and Toshiba**, the Fn key works the **opposite** way: to control multimedia (volume, tracks, and extra devices), press keys F1 through F12 *without* holding down the Fn key; if you hold down the Fn key, the computer will perform older tricks instead (such as run a program you wrote). That new method is *not* used yet by Acer, Asus, or Dell.

For example, here's what happens on my new laptop computer made by Hewlett-Packard (the "HP Notebook 15-ay091ms"):

Key	What the computer will do
F1	explain how to use the computer
F2	decrease the screen's brightness
F3	increase the screen's brightness
F4	use (or stop using) external monitor instead of built-in screen
F6	turn off the speakers (or turn them back on)
F7	decrease the speaker volume
F8	increase the speaker volume
F9	play the previous track of a music CD (or DVD movie)
F10	play (or pause the playing of) a music CD (or DVD movie)
F11	play the next track of a music CD (or DVD movie)
F12	use (or end) **airplane mode** (which shuts down all wireless signals)

In this book, when I say to tap keys F1 through F12, try tapping them with or without the Fn key, to discover whether pressing the Fn key helps or hurts what you wish to accomplish.

Missing keys

If your keyboard is missing the Menu key and the two Windows keys, don't worry: those 3 keys are unimportant, since most folks prefer to use a mouse instead of tapping those keys. If you wish, you can substitute other keys instead:

Instead of tapping the Menu key,
tap the F10 key while holding down the Shift key.

Instead of tapping a Windows key,
tap the Esc key while holding down the Ctrl key.

If your desktop's keyboard is ancient, it has just 83 keys and you suffer:

Your keyboard is missing the Menu key and the two Windows keys.

Your keyboard is missing the F11 and F12 keys. (The F1 through F10 keys are arranged in two columns down the keyboard's left edge, instead of being spread out across the keyboard's top.)

Your keyboard is missing the second Ctrl key, the second Alt key, the second Enter key, and the second / key.

Your keyboard is missing the Pause key. (Instead, you must tap the NumLock key while holding down the Ctrl key.)

The PrintScreen key is labeled "PrtSc" and works just while holding down the Shift key. (If you don't hold down the Shift key, the PrtSc key acts as a second * key.)

Your keyboard is missing the 4 arrow keys and these 6 editing keys: Insert, Delete, Home, End, PageUp, and PageDown. (To perform those functions, you must press number keys after you've turned off the NumLock.)

83-key keyboards work just with outdated computers. If you're using an 83-key keyboard, that's proof your computer is outdated! Buy a new computer system!

Kinds of keyboards

When buying a keyboard, you have many choices.

You can buy an **XT** keyboard (83 keys), **AT** keyboard (101 keys), **augmented AT** keyboard (101 keys plus an extra copy of the backslash key), or **Windows** keyboard (101 keys plus 3 special keys that help run software called "Windows").

You can buy a **standard-size** keyboard (with a ledge above the top row, for placing your pencil or notes), **compact** keyboard (which has no ledge and consumes less desk space), **foldable** keyboard (which folds in half, as if you're closing a book, so it consumes half as much desk space when not in use), or **split** keyboard (whose left third is separated from the rest, so you can have the comfort of typing while your forearms are parallel to each other).

You can buy a **tactile** keyboard (which gives you helpful feedback by making a click whenever you hit a key), **silent** keyboard (which helps your neighbors by not making clicks), or **spill-resistant** keyboard (which is silent and also doesn't mind having coffee or soda spilled on it).

Pointing devices

If you feed the computer a picture (such as a photograph, drawing, or diagram), the computer will analyze the picture and even help you improve it. To feed the computer a picture of an object, you can use 4 methods.

Method 1 Point a traditional **video camera** (or camcorder) at the object, while the camera is wired to the computer.

Method 2 Take a picture of the object by using a **digital camera** (which contains a disk or RAM chips that record the image) then transfer the image to a computer.

Method 3 Draw on paper, which you then feed to an **optical scanner** wired to the computer. Of the optical scanners that cost under $150, the best are Microtek's **X6** (which handles colors the best) and Visioneer's **One Touch** (which is much easier to use and reads words the best but handles colors less accurately).

Method 4 Draw the picture by using a pointing device wired to the computer. The pointing device can be a **touchscreen**, **graphics tablet**, **mouse**, **trackball**, or **joystick**.

Let's look at method 4 more closely.…

Touchscreens

A **touchscreen** is an invisible overlay that covers the screen and lets you draw with your finger.

Graphics tablets

A **graphics tablet** is a computerized board that lies flat on your desk. To draw, you move either a pen or your finger across the board. Modern laptop computers include a tiny graphics tablet (called a **touchpad** or **glidepad**), stroked with your finger and built into the keyboard (in front of the Space bar).

Mice

A **mouse** is a computerized box that's about as big as a pack of cigarettes. To draw, you slide the mouse across your desk, as if it were a fat pen.

When you slide a traditional mouse, a ball in its belly rolls on the table. The computer senses how many times the ball rotated and in what direction.

A newer kind of mouse, called an **optical mouse**, has no ball in its belly. Instead, the mouse shines a light down onto your desk, radar-like, and notices how the mouse moved.

The first mouse was invented at Xerox's **Palo Alto Research Center (PARC)**. The first company to provide mice to the general public was **Apple**, which provided a free mouse with every Lisa and Mac computer. Now a free mouse comes with each desktop IBM PC and clone, too.

Microsoft Mouse The nicest mouse for the IBM PC is the **Microsoft Mouse**. Its first version was boring, but then came an improved version, nicknamed "**The Dove Bar**" because it was shaped like a bar of Dove soap. It felt great in your hand; but trying to draw a picture by using that mouse — or *any* mouse — was as clumsy as drawing with a bar of soap.

Then came a further improvement, nicknamed "**The Dog's Paw**" because it was shaped like a dog's lower leg: it was long with an asymmetrical bump (paw) at the end. It felt even better than The Dove Bar, if your hand was big enough to hold it.

The next improvement, nicknamed "**The Wheel Mouse**", looked like The Dog's Paw but added a wheel you could rotate with your fingers.

A newer version, nicknamed "**The Sneaker**" and officially called the **Intellimouse Pro**, resembles the Wheel Mouse but its left side is taller, like the raised arch of a fancy sneaker.

Mice from no-name manufacturers cost under $10. Microsoft made a cheap mouse too, called the **Home Mouse**, in the shape of a home, with the mouse's cord coming out of the chimney. Microsoft's newer cheap mouse is called the **Basic Mouse**; it's small enough to be used by kids, lefties, and short people.

The newest mice have no cords: they're **wireless**.

Trackballs

A **trackball** is a box that has a ball sticking out the top of it. To draw, just put your fingers on the ball and rotate it. Some laptop computers have a trackball built into the keyboard.

Technologically, a trackball's the same as a typical mouse: each is a box containing a ball. For a trackball, the ball sticks *up* from the box and you finger it directly; for a traditional mouse, the ball hides *underneath* and gets rotated when you move the box. The mouse feels more natural (somewhat like gripping a pen) but requires lots of desk space (so you can move the box).

The trackball was invented first. The mouse came later and has become more popular — except on laptop computers, which use touchpads and sometimes trackballs, to save space.

Joysticks

A **joystick** is a box with a stick coming out of its top. To draw, you move the stick in any direction (left, right, forward, back, or diagonally) as if you were the pilot of a small airplane.

Sound

You can make the computer hear and produce sounds.

Speakers

To produce sounds, the standard computer includes **speakers**.

One tiny speaker hides inside the system unit. It's called the **internal speaker**. That speaker's main purpose is to beep at you if you make a mistake.

A pair of **stereo speakers** are bigger and can produce good, loud stereo music. Hey, baby, let's rock!

Those stereo speakers are usually separate boxes that sit outside the system unit. (Exception: some Compaq and Mac computers hide the stereo speakers in the monitor; most laptop computers hide the stereo speakers in the keyboard.)

If your computer is fancy, it includes a *trio* of stereo speakers: the third speaker is called the **subwoofer** and produces a big, loud, booming bass.

If your computer is extra-fancy, it gives you **surround sound**, where you're surrounded by 4 normal speakers (front left, front right, back left, and back right) plus a subwoofer, making a total of 5 speakers. Since that system includes 4 normal speakers plus 1 subwoofer, it's called a **4.1 speaker system**.

If your computer is even fancier (super-duper fancy), it gives you 5 normal speakers (front left, front right, back left, back right, and center) plus a subwoofer, making a total of 6 speakers. Since that system includes 5 normal speakers plus 1 subwoofer, it's called a **5.1 speaker system**.

Sound card

To handle the stereo speakers, a standard computer's system unit contains a **sound card**.

The most popular sound card is the **Sound Blaster**, made by a company called **Creative Technology**, founded by Mr. Sim Wong Hoo in Singapore. It's still run by him there, and he owns 35% of the stock, making him rich. Creative Technology is called "the Singapore surprise" because it surprises novices who think the best hardware companies are all based in the US & Japan. It was the first Singapore company to be listed on the Nasdaq stock exchange. Its US division is based in California and called **Creative Labs**.

Fancy computers speak words by including circuitry called a **speech synthesizer**.

Microphone

The newest computers come with a **microphone (mike)**. By using the mike, you can make the computer record sounds. For example, you can make the computer record the sound of your voice and imitate it, so the computer sounds just like you!

Printers

A computer usually displays its answers on a screen. If you want the computer to copy the answers onto paper, attach the computer to a **printer**, which is a device that prints on paper. The computer transmits your request through a cable of wires running from the back of the computer to the back of the printer.

A computer's advertised price usually does *not* include a printer and cable. The cable costs about $10; the typical printer costs about $100.

Printers are more annoying than screens. Printers are noisier, slower, consume more electricity, need repairs more often, and require you to buy paper and ink. But you'll want a printer anyway, to copy the computer's answers onto paper to hand to your computerless friends. Another reason to get a printer is that a sheet of paper is bigger than a screen and lets you see more info at once.

To get a printer cheaply, walk into chains of discount superstores, such as **Staples** (which sells all kinds of office supplies and some computer equipment) and **OfficeMax** (which resembles Staples but charges less for printers and is now owned by **Office Depot**).

Kinds of printers

3 kinds of printers are popular.

An **inkjet printer** contains tiny hoses that squirt ink at the paper. It typically costs about $50.

A **laser printer** looks like a photocopier. Like a photocopier, it contains a rotating drum and inky toner. It prints faster and more beautifully than an inkjet printer. Like a photocopier, it's expensive: it typically costs about $250.

A **dot-matrix printer** contains tiny pins that put ink onto paper by smashing against an inked ribbon. It prints slower & uglier than the other kinds of printers but has one big advantage: its ink costs less. This kind of printer typically costs about $250.

Consumables

Besides paying for the printer, you must also pay for **consumables**: ink, paper, and electricity.

Ink After you've bought the printer and used it for a while, the ink supply will run out, so you must buy more ink.

In the typical **dot-matrix printer**,
the inked ribbon costs about $5 and lasts about 1000 pages,
so it costs about a half a penny per page. That's cheap!

In the typical **inkjet printer**,
the ink cartridge costs about $20 and lasts about 500 pages,
so it costs about 4 cents per page. That's expensive!

In the typical **laser printer**,
the toner cartridge costs about $80 and lasts about 4000 pages,
so it costs about 2 cents per page. That's moderate!

Those prices assume you're printing black text. If you're printing graphics or color, the cost per page goes up drastically. For example, full-color graphics on an inkjet printer cost about 50¢ per page.

If you use your printer a lot, you must buy ink often: every few months.

The cost adds up: after a few years, you'll discover that the total cost of all the ink you've bought is more than the cost of the printer! If a printer is advertised at a low price, beware: the "almost free" printer is just a ruse to get you to spend lots of money on ink. (It's like buying an "almost free" razor, which is just a ruse to get you to spend lots on blades.)

Paper You must buy paper, which costs about 1 cent per sheet if you buy a small quantity (such as a **ream**, which is 500 sheets), or a half a cent per sheet if you buy a large quantity (such as a **case**, which is 5000 sheets). For low prices on paper, go to **OfficeMax**, **Sam's Club**, or **Staples**.

Electricity You must pay for **electricity** to run the printer; but the electricity's cost is negligible (much less than a penny per page) if you turn the printer off when you're not printing.

Warning: if you leave a laser printer on even when not printing, its total yearly electric cost can get high, since the laser printer contains a big electric heater. (You might even notice the lights in your room go dim when the heater kicks on.)

Inkjet printers

An **inkjet printer** contains tiny hoses that squirt ink at the paper. The hoses are called **nozzles**. They're in a device called a **print head**. The typical print head contains 144 nozzles.

When you use an inkjet printer, the print head moves across the paper, from left to right, its nozzles squirting ink at the paper, until it reaches the paper's right edge. Then the paper jerks up slightly, the print head moves back to the left again, and the process is repeated.

When using an inkjet printer, you hear the ink squirting at the paper, the print head moving across the paper, and the paper jerking up.

When you run out of ink, you're supposed to buy another **ink cartridge**, which is a tank containing ink.

Most inkjet printers can print in color. They mix together the three primary ink colors (red, blue, and yellow) to form all the colors of the rainbow.

3 main manufacturers The first popular inkjet printers were made by **Hewlett-Packard (HP)**. Later, **Epson** and **Canon** started making inkjet printers also.

The inkjet printers from all 3 of those companies are excellent. Each company makes a wide variety of inkjet printers, at prices ranging from about $25 to about $1000. Canon's inkjet printers are the best: all major reviewers rate Canon's **Pixma** printers tops, for printing color photos (and ordinary stuff, too) with high quality, inexpensively.

Each manufacturer has its own brand names:

HP's inkjet printers are called **Deskjets** and **Officejets**.

Epson's old inkjet printers were called **Styluses**. Its new inkjet printers are called **Expressions** and **WorkForces**.

Canon's old inkjet printers are called **Bubble Jets**. Its new inkjet printers, which print photos better, are called **Pixmas**.

Most printers are designed for the IBM PC but can also handle the Mac. Special Mac-only models are also available: HP's Mac-only models are called **DeskWriters**; Canon's Mac-only models, called **Stylewriters**, were marketed by Apple.

How does the ink get out of the nozzle and onto the paper?

In inkjet printers by HP and Canon, a bubble of ink in the nozzle gets heated and becomes hot enough to burst and splash onto the paper. Epson's inkjet printers use a different technique, in which the nozzle suddenly constricts and forces the ink out.

When using an inkjet printer, try different brands of paper.

Some brands of paper absorb ink better. If you choose the wrong brand, the ink will **wick** (spread out erratically through the strands of the paper's fiber). Start by trying cheap copier paper, then explore alternatives. The paper brand you buy makes a much bigger difference with inkjet printers than with dot-matrix or laser printers. Canon's printers are the best at tolerating paper differences, but Canon's ink is water-based and smears slightly if the paper or envelope gets wet (from rain or a sweaty thumb).

3 new competitors HP, Canon, and Epson are being attacked by 3 aggressive competitors (**Lexmark**, **Brother**, and **Xerox**).

> **Lexmark** printers cost the least but require expensive ink cartridges, so Lexmark printers are a good deal just if you print rarely.
>
> **Brother** printers always offer good value (good quality at low prices).
>
> **Xerox** was a dying company but has improved recently, so don't ignore it!

Dual-cartridge color Inkjet printers come in several styles. The most popular style is **dual-cartridge color**. If you buy this style of inkjet printer, you can insert two ink cartridges simultaneously, side by side.

One cartridge contains black ink. The other cartridge contains the color trio (red, blue, and yellow). The computer mixes together all 4 (black, red, blue, and yellow) to form all possible colors. That method is called the **4-color process**.

Epson's most famous such printer was the **Stylus Color 777**, which discount dealers sold for $89.

> It prints precisely: the resolution is 2880 dots per inch vertically, 720 dots per inch horizontally, and the dots are squirted onto the paper neatly, without splatter. It prints fast: up to 8 pages per minute for black, 6 pages per minute for color. Those high speeds are obtained just while printing text in low resolution (360 dots per inch). To print a color photo in high resolution takes 1½ minutes for 4"×6", 3 minutes for 8"×10". It comes with a 1-year warranty. The cartridges are long-lasting: they'll print 600 pages of black text, 300 pages of color text; before the ink runs out and you must insert new cartridges. The black print head contains 144 nozzles; the color print head contains 144 nozzles (48 per color).

To compete against that printer and Epson's newer printers, **Canon** offered several competitors. Canon's cheapest was the **Bubble Jet Color 2100 (BJC-2100)**, which listed for $100 but came with a $50 rebate, bringing the final cost down to just $50.

> It prints 720×360 dpi, 5 ppm black, 2 ppm color, 1-year warranty. The price includes a cartridge containing all 4 colors. An all-black cartridge costs extra and is needed to achieve the "5 ppm black" speed.

HP offers this now:

HP Printer	Black	Color	Duty cycle	Price
Deskjet 1010	20 ppm, 600 dpi, 6.2¢	16 ppm, 600 dpi, 15.9¢	1,000 pages/month	$35

In that chart, "price" is the list price (discount dealers charge less), **duty cycle** is how many pages per month the printer can reasonably handle (without overheating and without "worn or loose" parts or "slow speed" making you curse excessively). The number of cents is the cost of the ink to print a typical page:

> That cost assumes you play list price for an **extended-life (XL) cartridge** (which costs more than the standard cartridge but includes more ink). It assumes you cover just 5% of the page with black ink, or 30% of the page with colored ink, so most places on the paper remain white. That cost includes just the cost of the ink, not the cost of the paper.

Single-cartridge color A cheaper style is **single-cartridge color**. This category lets you insert either a black cartridge or a color cartridge, but you cannot insert both cartridges simultaneously.

If you try to print black while the color cartridge is in, the computer tries to imitate "black" by printing red, blue, and yellow on top of each other. That produces a "mud" instead of a true black, and it's also very slow. If you try to make such a printer reproduce a photograph, the image produced looks slightly "muddy", "washed-out", with poor contrast.

But the price is deliciously low!

The most famous such printer was the **Canon**'s **BJC-1000**., which sold for $75 minus a $30 rebate, bringing the cost down to $45.

> It comes in a box that includes one color cartridge (to get you started) but no black cartridge (which costs extra). The printer produces just 720×360 black, 360×360 color. The printer is very slow: just 4 ppm black, 0.6 ppm color. Its black print head contains just 64 nozzles; it color print head contains just 48 nozzles (16 per color).

It was discontinued when Canon invented a better printer, the BJC-2100.

Lexmark's **Z-12 Color Jetprinter** was a single-cartridge color printer that was better than the BJC-1000. It cost $50.

> Like the BJC-1000, its price included a color cartridge but no black cartridge (which cost extra). Lexmark claims "1200 dpi" and "6 ppm black, 3 ppm color". Lexmark also includes discount coupons so you can get good software cheap.

Portable You could buy these portable inkjet printers, which are tiny and weigh little: Brother's **MP-21C** ($240, 2 pounds), Canon's **BJC-80** ($190, 4 pounds), and Canon's **BJC-50** ($305, 2 pounds, prints slower and more crudely than the BJC-80 but has the advantage of weighing less). They all work slowly, print less beautifully than desktop printers, and can't handle big stacks of paper.

Instead of buying a portable printer, consider buying Canon's BJC-1000. At 4.8 pounds, it weighs just *slightly* more than a portable printer and tends to work faster, print more beautifully, handle paper better, and cost less!

Wide-carriage Most inkjet printers handle just normal-width paper, which is 8½ inches wide. Canon, Epson, and HP all make expensive inkjet printers that can print wider. To print colors on wider paper, get Canon's **BJC-4550** ($269, 11"-by-17" paper) or Epson's **Stylus 1520** ($449, 17"-by-22").

4-cartridge color Suppose you're printing a picture that contains lots of red but not much blue or yellow. When you use up all the red ink in a tricolor cartridge, you must throw the whole cartridge away, even though blue and yellow ink remain in the cartridge. What a waste!

Canon's **BJC-3000** prevents such waste and sold for just $99.

> It uses 4 separate cartridges (a black cartridge, a red cartridge, a blue cartridge, and a yellow cartridge), so when the red ink runs out you can discard the red cartridge without having to discard any blue or yellow ink. It prints 9ppm black, 4ppm color.

HP offers these now:

HP printer	Black	Color	Duty cycle	Price
Officejet 6100	34ppm,1200×600dpi,3.2¢	31ppm,4800×1200dpi,9¢	12,000pages/month	$80
Officejet 8100	35ppm,1200×600dpi,1.6¢	35ppm,4800×1200dpi,7.2¢	25,000pages/month	$150
Officejet X451dn	55ppm,1200×1200dpi,1.3¢	55ppm,2400×1200dpi,6.8¢	50,000pages/month	$150

Laser printers

A **laser printer**, like an office photocopier, contains a drum and uses toner made of ink. The printer shines a laser beam at the drum, which picks up the toner and deposits it on the paper.

LaserJet 5 For the IBM PC, the most popular laser printers are made by Hewlett-Packard (HP), whose laser printers are called **LaserJets**. After inventing its first LaserJet, HP invented a better version (the **LaserJet 2**), then an even better version (the **LaserJet 3**), then an even better version (the **LaserJet 4**).

Finally, in 1996, HP invented a truly great version: the **LaserJet 5**. I used it to print earlier editions of this book. It's terrific! Here are its specs:

> It can print 12 pages per minute (12 **ppm**). It can print 600 dots per inch (600 **dpi**); and it uses a trick called **Resolution Enhancement Technology (RET)**, which can shift each dot slightly left or right and make each dot slightly larger or smaller. That makes the printing nearly as beautiful as if there were twice as many dots per inch (1200 dpi).
>
> Its ROM contains the definitions of 45 **fonts** (typestyles). Each of those fonts is **scalable**: you can make the characters as big or tiny as you wish. You also get a disk containing the definitions of 65 additional scalable fonts: put that disk into your computer, copy those font definitions to your computer's hard disk, then tell your computer to copy those font definitions to the printer's RAM. So altogether, the printer can handle two kinds of fonts: the 45 **internal fonts** that were inside the printer originally plus **soft fonts** that are copied into the printer's RAM from the computer's disks.
>
> The printer contains 4 megabytes of RAM, so it can handle lots of soft fonts and graphics on the same page. Moreover, the printer uses a trick called **data compression**, which compresses the data so that twice as much data can fit in the RAM (as if the RAM were 8 megabytes).

Discount dealers were selling it for $988.

Cheaper LaserJets For folks who couldn't afford a LaserJet 5 at $988, HP invented a cheap **Personal version** (called the **LaserJet 5P**) and an even cheaper **Lower-cost version** (called the **LaserJet 5L**).

Afterwards, HP invented an improved 5P (called the **6P**) and an improved 5L (called the **6L**).

New LaserJets HP has stopped selling all those LaserJets (the LaserJet 1, 2, 3, 4, 5, 5P, 5L, 6P, and 6L). Now HP sells new LaserJets that are even better and cost less!

These print just monochrome (black):

Printer	Resolution	Speed	RAM	Processor	Duty cycle	Price
LaserJet P1102w	600 dpi	19 ppm	8M	266MHz	5,000 pages/month	$100
LaserJet P1606dn	600 dpi	26 ppm	32M	400MHz	8,000 pages/month	$210
LaserJet M401n	1200 dpi	35 ppm	128M	800MHz	50,000 pages/month	$230
LaserJet P3015n	1200 dpi	42 ppm	128M	540MHz	100,000 pages/month	$500
LaserJet M601n	1200 dpi	45 ppm	512M	800MHz	175,000 pages/month	$650
LaserJet M602n	1200 dpi	52 ppm	512M	800MHz	225,000 pages/month	$950

These can print in color:

Printer	Resolution	Speed	RAM	Processor	Duty cycle	Price
LaserJet Color M251nw	600 dpi	14 ppm	128M	750MHz	30,000 pages/month	$300
LaserJet Color M451nw	600 dpi	21 ppm	128M	600MHz	40,000 pages/month	$400
LaserJet Color M551nw	1200 dpi	33 ppm	1G	800MHz	75,000 pages/month	$520
LaserJet CP4025n	1200 dpi	35 ppm	512M	800MHz	100,000 pages/month	$950
LaserJet CP4525n	1200 dpi	42 ppm	512M	800MHz	120,000 pages/month	$1300

All those LaserJets are better than the charts imply, since they use RET (to make the resolution seem nearly twice as high as what's in the chart) and data compression (to make the RAM hold twice as much data as what's in the chart).

Those are the prices advertised by HP. Discount dealers charge less.

Duty cycle In that chart, **duty cycle** means how many pages per month the printer can print reliably (without overheating and without "worn or loose" parts making you curse excessively).

If the duty cycle is under 20,000 pages/month,	the printer "looks flimsy".
If the duty cycle is between 20,000 and 60,000,	the printer "looks solid".
If the duty cycle is over 60,000,	the printer "looks invincible, built like a tank".

Processor When your computer's system unit sends data to the LaserJet, the LaserJet handles that data with the help of a **printer processor chip**, which hides inside the printer. The charts show how fast the printer processor chip can think.

Paper size Each LaserJet printer in the charts can handle **letter-size paper** (8½ inches wide, 11 inches tall) and **legal-size paper** (8½ inches wide, 14 inches tall). If you want to handle **tabloid-size paper** instead (11"x17"), you must buy a **wide-format printer**, which costs more and goes slower.

Printer codes When your computer wants to give the printer an instruction (such as "draw a diagonal line across the paper" or "make that scalable font bigger"), the computer sends the printer a code.

HP's LaserJets understand a code called **Printer Control Language (PCL)**, invented by HP.

> The newest versions of PCL are **PCL 5e** (which is plain), **PCL 5c** (which can handle colors), and **PCL 6** (which can handle 1200 dpi). They're understood by the new LaserJets. Older LaserJets understand just older versions of PCL and can't perform as many tricks.
>
> Most IBM-compatible laser printers understand PCL, so that they imitate HP's laser printers, run the same software as HP's laser printers, and are **HP-compatible**.

Some laser printers understand a different code, called **PostScript (PS)**, invented by a company called **Adobe**.

> Back in the 1980's, when PCL was still very primitive, Postscript was more advanced than PCL. The fanciest laser printers from HP's competitors used PostScript. The very fanciest laser printers were bilingual: they understood both PCL and PostScript.
>
> Now that PCL has improved, it's about as good as PostScript. PCL printers cost less to manufacture than PostScript printers.

In PostScript, each command that the computer sends the printer is written by using English words. Unfortunately, those words are long and consume lots of bytes. In PCL, each command is written as a brief series of code numbers instead. Since PCL commands consume fewer bytes than Postscript commands, the computer can transmit PCL commands to the printer faster than Postscript commands, and PCL commands can fit in less RAM.

Some Apple Mac programs require a PostScript printer.

Most new LaserJet printers understand both PCL and PostScript.

HP's competitors HP has many competitors.

> **NEC**'s printers tend to go faster.
> **Lexmark**'s printers tend to go faster and print more dpi (to produce finer text and photographs).
> Printers from **Panasonic**, **Brother**, and **Oki** tend to cost less; they're bargains.
> Printers from **Kyocera** cost less to run, because their toner (ink) cartridges last longer & cost less per page.

But I recommend buying from HP, because people who own HP LaserJets are *very* happy, including me!

HP LaserJets are more reliable than other brands, need repairs less often than other brands, cause fewer software headaches than other brands, cost just *slightly* more than other brands, and let you buy more toner from your local store more easily. The only exception to my "buy HP" advice is HP's Color LaserJets, which always get worse ratings than **Magicolor** laser printers, which are made by **Konica Minolta**. But you shouldn't buy a color laser printer anyway: color laser printers are too expensive; and they're much slower than black-only laser printers, even when printing just black! To get color, buy a nice, cheap color inkjet printer instead!

Dot-matrix printers

A **dot-matrix printer** contains a few **guns**, as if it were a super-cowboy whose belt contains several holsters.

Each gun shoots a pin at a ribbon that's covered with ink. When the pin's tip hits the ribbon and smashes the ribbon against the paper, a dot of ink appears on the paper. Then the pin retracts back into the gun that fired it.

Since each gun has its own pin, the number of guns is the same as the number of pins.

9-pin printers If the printer is of average quality, it has 9 guns — and therefore 9 pins. It's called a **9-pin printer**.

The 9 guns are stacked on top of each other, in a column that's called the **print head**. If all the guns fire simultaneously, the pins smash against the ribbon simultaneously, so the paper shows 9 dots in a vertical column. The dots are very close to each other, so that the column of dots looks like a single vertical line. If just *some* of the 9 pins press against the ribbon, you get fewer than 9 dots, so you see just *part* of a vertical line.

To print a character, the print head's 9 guns print part of a vertical line; then the print head moves to the right and prints part of another vertical line, then moves to the right again and prints part of another vertical line, etc. Each character is made of parts of vertical lines — and each part is made of dots.

The pattern of dots that makes up a character is called the **dot matrix**. That's why such a printer's called a **9-pin dot-matrix printer**.

Inside the printer is a ROM chip that holds the definition of each character. For example, the ROM's definition of "M" says which pins to fire to produce the letter "M". To use the ROM chip, the printer contains its own CPU chip and its own RAM.

When microcomputers first became popular, most dot-matrix printers for them were built by a New Hampshire company, **Centronics**. In 1980, Japanese companies took over the marketplace. Centronics went bankrupt. The 2 Japanese companies that dominate the industry now are **Epson** and **Panasonic**.

Epson became popular because it was the first company to develop a disposable print head — so that when the print head wears out, you can throw it away and pop in a new one yourself, without needing a repairman. Also, Epson was the first company to develop a low-cost dot-matrix impact printer whose dots look "clean and crisp" instead of looking like "fuzzy blobs". Epson was the main reason why Centronics went bankrupt.

Epson is part of a Japanese conglomerate called the **Seiko Group**, which became famous by timing the athletes in the 1964 Tokyo Olympics. To time them accurately, the Seiko Group invented a quartz clock attached to an electronic printer. Later, the quartz clock was miniaturized and marketed to consumers as the "Seiko watch", which became the best-selling watch in the whole world. The electronic printer, or "E.P.", led to a better printer, called the "son of E.P.", or "EP's son". That's how the Epson division was founded and got its name!

Epson's first 9-pin printer was the **MX-80**. Then came an improvement, called the **FX-80**. Those printers are obsolete; they've been replaced by Epson's newest 9-pin wonders, the **FX-880** (which costs $250) and the **FX-1180** (which can handle extra-wide paper and costs $380). Epson's cheapest and slowest 9-pin printer is the **LX-300+** ($190). You can get those prices from discount dealers (such as Tri State).

For a 9-pin printer, I recommend buying the **Panasonic 1150** instead, because it prints more beautifully and costs just $149 from discount dealers. Too bad it can't handle extra-wide paper!

Besides Epson and Panasonic, four other Japanese companies are also popular: **NEC**, **Oki**, **Citizen**, and **Star**.

7-pin printers Although the average dot-matrix printer uses 9 pins, some older printers use just 7 pins instead of 9. Unfortunately, 7-pin printers can't print letters that dip below the line (g, j, p, q, and y) and can't underline. Some 7-pin printers print just capitals; other 7-pin printers "cheat" by raising the letters g, j, p, q, and y slightly.

24-pin printers Although 9 pins are enough to print English, they're *not* enough to print advanced Japanese, which requires 24 pins instead.

The first company to popularize 24-pin printers was **Toshiba**. Its printers printed Japanese — and English — beautifully. 24-pin Toshiba printers became popular in America because they print English characters more beautifully than 9-pin printers.

Epson and all the other Japanese printer companies copied Toshiba. The best cheap 24-pin printers are the **Panasonic 2130** ($230 at Office Depot) and the **Epson LQ-590** (which is sturdier, easier to operate, and costs $280 at OfficeMax). The cheapest 24-pin printer that handles wide paper is the **Epson LQ-2090** ($460 at Office Depot).

24-pin printers print more beautifully than 9-pin printers but print slower, are less rugged, and don't bang hard enough to print multiple copies on thick multi-part forms.

In standard 24-pin printers, the even-numbered pins are slightly to the right of the odd-numbered pins, so you see two columns of pins. After firing the even-numbered pins, the print head moves to the right and fires the odd-numbered pins, whose dots on paper overlap the dots from the even-numbered pins. The overlap insures that the vertical column of up to 24 dots has no unwanted gaps.

In fancier 24-pin printers, the 24 pins are arranged as a diamond instead of two columns, so that the sound of firing pins is staggered: when you print a vertical line you hear a quiet hum instead of two bangs.

Beyond 24 pins The fastest dot-matrix printers use multiple print heads, so they can print several characters simultaneously.

Fights about printer technology

Now let's plunge into technical details of printer technology.

Impact versus non-impact A printer that smashes an inked ribbon against the paper is called an **impact printer**.

The most popular kind of impact printer is the dot-matrix printer. Other impact printers use daisy wheels, thimbles, golf balls, bands, chains, and drums. They all make lots of noise, though manufacturers have tried to make the noise acceptable by putting the printers in **noise-reducing enclosures** and by modifying the timing of the smashes.

A printer that does *not* smash an inked ribbon is called a **non-impact printer**.

Non-impact printers are all quiet! The most popular non-impact printers are inkjet printers and laser printers. Other non-impact printers are **thermal printers** (whose hot pins scorch the paper), and **thermal-transfer printers** (which melt hot colored wax onto the paper). Unfortunately, thermal printers require special "scorchable" paper; thermal-transfer printers require expensive ribbons made of colored wax.

Resolution If a printer creates characters out of dots, the quality of the printing depends on how fine the dots are — the "number of dots per inch", which is called the **print resolution**.

A traditional **laser printer** prints 300 dots per inch. Modern laser printer can print 1200 dots per inch.

The typical **inkjet printer** can print 600 dots per inch. That's not quite as good as a modern laser printer but still adequate.

A **24-pin dot-matrix printer** prints just 180 dots per inch. It's okay for writing letters to people you're trying to impress, but it's not as impressive as an inkjet or laser printer.

A **9-pin dot-matrix printer** is the ugliest of all: it usually prints just 72 dots per inch vertically.

Paper Laser printers and most inkjet printers accept a stack of ordinary copier paper. You put that paper into the printer's **paper tray** (which is also called the **paper bin** and also called the **cut-sheet paper feeder**).

Some dot-matrix printers can handle stacks of ordinary copier paper, but most dot-matrix printers handle paper differently. To pull paper into the printer, dot-matrix printers can use 2 methods.

The simplest method is to imitate a typewriter: use a rubber roller that grabs the paper by friction. That method's called **friction feed**. Unfortunately, friction

is unreliable: the paper will slip slightly, especially when you get near the sheet's bottom edge.

A more reliable method is to use paper that has holes in the margins. The typical dot-matrix printer has **feeder pins** that fit in the holes and pull the paper up through the printer very accurately. That method, called **pin feed**, has just one disadvantage: you must buy paper having holes in the margins.

If your printer uses pin feed and is fancy, it has a clamp that helps the pins stay in the holes. The clamp (with its pins) is called a **tractor**. You get 2 tractors: one for the left margin and one for the right. A printer having tractors is said to have **tractor feed**. Usually the tractors are **movable**, so you can move the right-hand tractor closer to the left tractor, to handle narrower paper or mailing labels.

A **dual-feed** printer can feed the paper *both* ways — by friction and by pins — because it has a rubber roller and also has sets of pins. The printer's left edge has a lever: if you pull the lever one way, the paper will rub against the roller, for friction feed; if you pull the lever the other way, the paper will rub against the pins instead, for pin feed.

Most dot-matrix printers have dual feed with movable tractors.

Paper having holes in it is called **pin-feed paper** (or **tractor-feed paper**).

Like a long tablecloth (folded up and stored in your closet), pin-feed paper comes in a long, continuous sheet that's folded. Since it comes folded but can later be unfolded ("fanned out"), it's also called **fanfold paper**. It's perforated so you can rip it into individual sheets after the printer has printed on it. If the paper's fancy, its margin is perforated too, so after the printing you can rip off the margin and its ugly holes, leaving you with what looks like ordinary typing paper.

The fanciest perforated paper, called **micro-perf**, has a perforation so fine that when you rip along the perforation, the edge is almost smooth.

Most printers can use ordinary typing paper (or copier paper), which is 8½ inches wide. Pin-feed paper is usually an inch wider (9½ inches wide), so that the margins are wide enough to include the pinholes.

Some printers can handle pin-feed paper that's extra-wide (15 inches). Those **wide-carriage printers** typically cost about $130 more than standard-width printers.

Speed The typical printer's advertisement brags about the printer's speed by measuring it in **characters per second (cps)** or **lines per minute (lpm)** or **pages per minute (ppm)**. But those measurements are misleading.

Don't trust the speed of a **laser printer**:

To justify a claim of "8 pages per minute", Apple salesmen noticed that their LaserWriter 2 NT printer took a minute to produce 8 *extra* copies of a page. They ignored the wait of *several minutes* for the *first* copy! Like Apple, most other laser-printer manufacturers say "8 pages per minute" when they should really say: "1/8 of a minute per additional copy of the same page".

Don't trust the speed of a **dot-matrix printer**:

The advertised speed ignores how long the printer takes to jerk up the paper. For example the typical "80-cps" printer will print 80 characters within a second but then take an extra second to jerk up the paper to the next line, so at the end of two seconds you still see just 80 characters on the paper.

Epson advertised its LQ-850 dot-matrix printer as "264 cps", but it achieved that speed just when making the characters small and ugly (few dots per inch). To print characters that were large and pretty, the speed dropped to 73 cps.

Panasonic advertised its KX-P1091 dot-matrix printer as "192 cps", but it achieved that speed just if you threw an internal switch that made the characters even uglier than usual!

So don't trust any ads about printer speed! To discover a printer's true speed, hold a stopwatch while the printer prints many kinds of documents (involving small characters, big characters, short lines, long lines, draft quality, letter quality, and graphics).

Cables

Some modern printers can communicate with computers wirelessly.

But if a printer is traditional, a cable of wires runs from the printer to the computer's main part (the system unit). The cable costs about $8 and is *not* included in the printer's advertised price: the cable costs extra.

One end of the cable plugs into a socket at the back of the printer. The cable's other end plugs into "a socket at the back of the system unit", called the computer's **printer port**.

When the computer wants the printer to print some data, the computer sends the data to the printer port. Then the data flows through the cable to the printer.

Serial versus parallel The cable from the system unit to the printer contains many wires. Some are never used: they're in the cable just in case a computer expert someday figures out a reason to use them. Some of the wires in the cable transmit info about scheduling: they let the computer and printer argue about when to send the data.

If the computer's port is **serial**, just one of the wires transmits the data itself. If the computer's port is **parallel**, 8 wires transmit the data simultaneously. A parallel port tends to be faster than a serial port, since a parallel port transmits 8 streams of data simultaneously. Unfortunately, a parallel cable is limited to shorter distances (about 12 feet instead of 50 feet), since it's hard to keep 8 signals strong and synchronized over long distances.

Classic cables Back in the 1970's, the typical serial cable contained 25 wires (1 of which transmitted the data). That cable was called the **recommended standard 232C serial cable (RS-232C cable)**. At that time, the typical parallel cable contained 36 wires (8 of which transmitted the data), using a scheme invented by a printer manufacturer called **Centronics** and called the **industry-standard Centronics-compatible parallel cable (Centronics cable)**.

IBM printer cable In 1981, when IBM invented the IBM PC, IBM decided the 36-wire parallel cable was silly, since just 8 of the wires transmitted data; so IBM switched to a 25-wire cable instead; but to be compatible with the 36-wire printers already invented, IBM glued a 36-pin connector to the printer's end of the cable; so the cable has 36 pins on the printer's end but just 25 pins on the system unit's end. That weird cable is called an **IBM-compatible parallel printer cable (IBM printer cable)**.

If that cable is fancy enough to handle transmissions in both directions, it's called a **bidirectional IBM printer cable**. If it's even fancier and can handle transmissions *quickly* in both directions, it's called an **Institute of Electrical & Electronics Engineers standard 1284 cable (IEEE 1284 cable)**.

If the system unit's circuitry for handling the IBM printer cable is ordinary, you have a **standard parallel port (SPP)**.

If that port's circuitry is faster, you have an **enhanced parallel port (EPP)**. If that port's circuitry is even faster, it's called an **extended capability port (ECP)**, which transmits data about 10 times as fast as SPP. Most new computers have ECP ports. To make full use of an IEEE 1284 cable, you need an ECP port and an ECP-capable printer.

USB cable In 1988, when Apple invented the iMac computer, Apple decided the 25-wire serial cable was silly, so Apple switched to a 4-wire serial cable instead, called the **Universal Serial Bus cable (USB cable)**. Later, manufacturers of IBM-PC compatible computers copied Apple's idea of using the USB cable for printing.

Old printers for IBM-compatible PCs used the IBM printer cable.
New printers for IBM-compatible PCs use the USB cable instead.

The USB cable can be used for many other purposes, too:

The USB cable is the most popular cable for attaching a scanner. You can also use a USB cable to attach a keyboard and mouse. The typical smartphone comes with a USB cable, to attach to a charger and to communicate with a bigger computer.

The USB cable is **hot-swappable**: you can plug and unplug USB devices from the USB cable, even while they and the system unit are turned on, without damage. The system unit automatically figures out which USB devices are plugged into it at the moment.

The first version of USB was called **USB 1**. Later came faster versions, called **USB 1.1**, **USB 2**, and **USB 3**. Then came a compact (tiny) version, called **USB-C**.

Software

The information stored in the computer is called **software**. Most software stays in RAM temporarily and is erased from RAM when you no longer need it. But *some* software stays in the computer's circuits *permanently*: it hides in the ROM and is called **firmware**.

To feed firmware to the computer, put extra ROM chips on the motherboard or insert a ROM cartridge. To feed other kinds of software to the computer, use the keyboard, disk, or tape: type the info on the keyboard, or insert a disk or tape containing the info.

You can feed the computer four kinds of software: an **operating system**, a **language**, **application programs**, and **data**. Let's look at them.…

Operating systems

An **operating system (OS)** is a set of instructions that explains to the CPU how to handle the keyboard, the screen, printer, disk drives, and mouse.

BIOS versus DOS

In a standard IBM-compatible PC, the operating system is divided into two parts.

The operating system's fundamental part is in the motherboard's ROM chips and called the **Basic Input/Output System** (**BIOS**, pronounced "buy oss" or "buy us"). The operating system's advanced part is on a disk and is called the **disk operating system** (or **DOS**, which is pronounced "doss").

From MS-DOS to Windows

The first DOS for the IBM PC was invented by IBM and a company called **M**icro**s**oft **(MS)**. That DOS was called **IBM PC-DOS** or **MS-DOS**. It came on a floppy disk.

Version 1 came on a floppy disk and stayed there.

Version 2 came on a floppy disk but could be copied to a hard disk. (Version 1 couldn't handle hard disks.)

Versions 3, 4, 5, and 6 were even better: like version 2, they came on floppy disks and could be copied to the hard disk but could also be supplemented by **Windows** (a set of extra floppy disks, invented by Microsoft, which let the computer perform tricks, such as dividing the screen into "windows of info" and letting you use a mouse instead of just a keyboard).

Windows' first version (**Windows 1**) and its early improvements (**Windows 2** and **Windows 3**) were just supplements to MS-DOS. To use them, you had to buy MS-DOS first. They were supplements (called **shells**) that tried to hide MS-DOS's ugliness (just like a clamshell hides an ugly clam); they made MS-DOS look prettier. People bought the ugly operating system (MS-DOS) plus the operating-system shell (Windows) to create a new **operating environment**.

In 1995, Microsoft invented a better version of Windows, called **Windows 95**, which performed more tricks and was a complete operating system: it did *not* require you to buy MS-DOS first; it was *not* just a shell.

Windows 95 came on a floppy disk plus a CD-ROM disk. To use Windows 95, you (or the dealer) had to copy the floppy disk and CD-ROM disk to the hard disk.

After Windows 95, Microsoft invented further improvements. Here are the years:

In 1995 came **Windows 95**.
In 1998 came **Windows 98**.
In 1999 came **Windows 98 Second Edition (Windows 98 SE)**.
In 2000 came **Windows Millennium Edition (Windows Me)**.
In 2001 came **Windows eXPerience (Windows XP)**.
In 2006 came **Windows Vista**.
In 2009 came **Windows 7**.
In 2012 came **Windows 8**.
In 2013 came **Windows 8.1**.
In 2015 came **Windows 10**.
In 2021 came **Windows 11**.

Most computer programs require Windows XP or later. Such programs refuse to run if you bought just earlier Windows or MS-DOS.

Corporate Windows Big corporations running big networks used a fancy "corporate" version of Windows called **Windows New Technology (Windows NT)**, invented in 1993. The year 2000 brought an improved version, called **Windows 2000**. In 2001, Windows XP replaced them and made them obsolete, but later Microsoft invented another corporate version, called **Windows Server**.

Unix

AT&T's Bell Laboratories invented an operating system called **Unix**.

It's pronounced "you nicks", so it sounds like "eunuchs", which are castrated men. (Be careful! A female computer manager who seems to be saying "get me eunuchs" probably wants an operating system, not castrated men.)

"Unix" is an abbreviation for "UNICS", which stands for "UNified Information & Computing System".

The original version of Unix ran just on DEC minicomputers used by just one person at a time. Newer versions of Unix can handle *any* manufacturer's maxi, mini, or micro and even handle networks of people sharing computers simultaneously.

Linux A Finnish programmer named **Linus Torvalds** (whose first name is pronounced "lee nuss") invented a Unix imitation called "**Linu**s Uni**x**" or **Linux** (pronounced "lee nucks"). It's free!

It runs on 386, 486, and Pentium computers and also on Atari and Commodore Amiga computers. The most popular way to get it is as part of a **distribution** (which includes Linux plus extras), published by **Ubuntu** (pronounced "oo-BOON-too") or **Mandrake** or **SuSE** or **Red Hat**.

Ubuntu's distribution, which comes from England, is free.

Mandrake's distribution, which comes from France, is cheap and nice.

SuSE's distribution, which comes from Germany and the USA, is the easiest and most pleasant.

Red Hat's distribution, which comes from the USA, includes the most features for setting up a network.

Most tablets and smartphones run **Android**, which is a souped-up version of Linux. Amazon's **Kindle** is an e-reader that runs a modified version of Android.

Solaris **Sun Microsystems** (which was recently bought by **Oracle**) makes **Sparc** minicomputers, which are used as graphics/engineering workstations and Internet servers. Sparc minicomputers use the **Solaris** operating system, which is a souped-up version of Unix. Though Solaris is intended for Sparc minicomputers, you can get a version of Solaris that runs on microcomputers containing an Intel CPU.

Unix versus Windows Though many programmers adore Unix, it won't outsell Windows, since Unix is harder to learn and had its main features stolen by MS-DOS & Windows. But Unix networks are more reliable than Window networks and form the basis of the Internet.

From Mac OS to macOS

Apple's Mac computers have used its own operating system, called **Mac OS**.

To invent Windows, Microsoft copied many features from Mac OS, so Windows is very similar to Mac OS.

Versions 1-9 of Mac OS were invented completely by Apple. Version 10 of Mac OS is based on Unix instead: it's a version of Unix modified to resemble and surpass Mac OS 9. To emphasize Mac OS 10's Olympic greatness, Apple writes it in Roman numerals (like this: **Mac OS X**), which Apple says to pronounce as "Mac oh ess ten". Apple will forgive you if you say "Mac oh ess ex", which sounds like "Mac — oh! — is sex!", since Mac OS X is the sexy operating system that makes the Mac gorgeously appealing.

Recently, Apple changed the name from **Mac OS X** to just **OS X** and now **macOS**.

iOS

Apple's tablet (the **iPad**), smartphone (the **iPhone**), and modern music player (the **iPod Touch**) use an operating system called **iOS**, which is based on Mac OS but has this advantage: it can handle touchscreens.

Old computers

Old computers used old operating systems:

Computers	Operating system
Apple 2	Apple DOS or Pro DOS
Radio Shack's TRS-80	TRSDOS (pronounced "triss doss")
DEC's Vax minicomputers	Virtual Memory System (VMS)
Ancient microcomputers	Control Program for Microcomputers (CP/M)
IBM maxicomputers	Multiple Virtual Storage (MVS) or Virtual Machine with Conversational Monitor System (VM with CMS)

Languages

Languages that humans normally speak — such as English, Spanish, French, Russian, and Chinese — are called **natural languages**. They're too complicated for computers to understand easily.

To communicate with computers, programmers use **computer languages** instead. The most popular computer languages are **Basic**, **Visual Basic**, **Python**, **Java**, **JavaScript**, **C**, **C++**, **C#**, **Perl**, and **PHP**.

Each is a tiny *part* of English — a part small enough for the computer to master. To teach the computer one of those tiny languages, you feed the computer a disk (or ROM chips or copy software from the Internet) containing definitions of that tiny language's words.

Of those computer languages, Basic is the easiest to learn. Python resembles Basic but tries to be more modern. JavaScript is the best for creating small programs on the Internet. The other languages are harder to learn but can perform different tricks.

Although those languages have become the most popular, many others were invented.

Back in the **1960's**, the most popular languages were **Fortran** (which let computers do advanced calculations for engineering and scientific research) and **Cobol** (which let computers do accounting for big corporations).

During the **1980's**, most schools taught elementary-school kids to program in **Logo**, high-school kids to program in **Basic**, college kids to program in **Pascal**, graduate computer-science students to program in **C** (which was the forerunner of C++), and business students to program in **Cobol** (for maxicomputers) and **dBase** (for microcomputers).

Later, colleges switched to teaching college kids **Java** instead of Pascal. Now colleges have switched to teaching **Python** instead.

This book discusses *many* languages, so you become a virtuoso!

Internet

The **Internet** is an international network of computers that share info. You can make *your* computer become part of the Internet too!

Web The most popular part of the Internet is the **World Wide Web (WWW)**, where people publish **Web pages** that everybody using the Internet can view. To view Web pages and browse through them, you need a program called a **Web browser**. The most popular Web browsers are Microsoft's **Edge**, Microsoft's **Internet Explorer (IE)**, Google's **Chrome**, Apple's **Safari**, and Mozilla's **Firefox**. They're all free.

Some Web pages let you copy software from the Internet to your own computer's hard disk. Copying from the Internet is called "**downloading** from the Internet." Copying *to* the Internet is called "**uploading** to the Internet."

E-mail If you attach your computer to the Internet, you can send **electronic mail (email)** to another computer on the Internet, if you have an **email program**.

The most popular email programs are **Gmail** (by Google), **Yahoo Mail**, and several by Microsoft (**Windows Mail**, **Windows Live Mail**, **Outlook**, and **Outlook Express**).

Apps

The computer will do whatever you wish — if you tell it how. To tell the computer how to do what you wish, you feed it a **program**, which is a list of instructions written in a computer language. To feed the computer a program, type the program on the keyboard, or buy a disk containing the program and put that disk into the drive, or download the program from the Internet, or buy ROM chips containing the program.

Before buying a program, make sure it will work with *your* computer. For example, if a disk says "for Windows", it will work with a modern IBM-compatible PC but not with the typical Apple Mac computer.

A person who invents a program is called a **programmer**.

Becoming a programmer is easy: you can become a programmer in just a few minutes! Becoming a *good* programmer takes longer.

You can buy two kinds of programs. The most popular kind is called an **application program (app)**: it handles a specific application, such as payroll or psychotherapy or chess. The other kind of program is called a **system program**: it teaches the computer how to handle various kinds of hardware and various computer languages. An operating system (such as Windows or Unix) is mainly a collection of system programs, bundled together to form a nice package. Application programs are usually purchased separately, though a *few* apps are included in the operating system's price.

You'll want several kinds of apps. Here are the most popular.…

Word processing

A **word-processing program** helps you write and edit sentences and paragraphs, to create memos, letters, reports, research papers, articles, and books. It also helps you edit what you wrote. What you wrote is called the **document**.

A word-processing program's main purpose is to manipulate *paragraphs*.
To manipulate drawings, get a **graphics program** instead.
To manipulate a table of numbers, get a **spreadsheet program**.
To manipulate a list of names (such as customers), get a **database program**.

Most operating systems include a simple word-processing program.

Operating system	Simple word-processing program included
MS-DOS	Edit
Classic Windows	Windows Write
Modern Windows	WordPad
Mac OS 6	TeachText
Mac OS 7, 8, 9	SimpleText
Mac OS X	TextEdit
iOS	Notes
Android for Samsung	Memo

Those simple word-processing programs are very limited. For example, those word-processing programs for Windows & Mac aren't smart enough to correct your spelling.

Most businesses use a fancier word-processing program instead, called **Microsoft Word**. It can correct your spelling and perform many other tricks. Versions are available for Windows & Mac. Its main competitor is **WordPerfect**, which costs less and is published by a company called **Corel**.

Instead of saying "word-processing program", it's shorter to say just "**word processor**", but beware: "word processor" can mean a program, a person, or a machine. Yes, "word processor" can mean 3 things:

"A word-processing program." Example: "Does this computer include a word processor, such as Microsoft Word?"

"A person who knows how to use a word-processing program." Example: "I'd like to hire a word processor (such as Joan Smith) who'll type my book for $15 per hour."

"A computerized typewriter whose only purpose is to run a word-processing program." Example: "Instead of buying a full computer, I want a cheaper machine, such as the Brother Word Processor."

How word processing began Back in the 1950's, 1960's, and 1970's, computers were used mainly to manipulate lists of numbers, names, and addresses. Those manipulations were called **data processing (DP)**, so the typical computing center was called a **data-processing center (DP center)**, run by a team of programmers and administrators called the **data-processing department (DP department)**.

Those old computer systems were complex, expensive, and unreliable, run by big staffs that had to do continuous repairs, reprogramming, and supervision. They were bureaucratic & technological nightmares. The term "data-processing" got a bad reputation. Secretaries who wanted to write and edit reports preferred to use simple typewriters rather than deal with the dreaded "data-processing department".

When easy-to-use word-processing programs were finally invented for computers, secretaries were afraid to try them because computers had developed a scary reputation. The last thing a secretary wanted was a desktop computer, which the secretary figured would mean "desktop trouble".

That's why the term "**word processing**" was invented. IBM, Wang, and other manufacturers told the secretaries, "The machines we'll put on your desks are *not* dreadful computers but rather souped-up typewriters. You like typewriters, right? Then you'll love these cute little machines too!. We call them **word processors**. Don't worry: they're not data-processing equipment; they're not computers."

The manufacturers were lying: their desktop machines *were* computers. To pretend they weren't computers, the manufacturers called them **word processors** and omitted any software dealing with numbers or lists. The trick worked: secretaries acquired word processors, especially the **IBM Displaywriter** and **Wang Word Processor**. Today's secretaries are unafraid of computers, understand Windows and Macs, and run word-processing programs on them.

Historic word-proccessing programs During the early 1980's, these word-processing programs were popular:

Electric Pencil (the first word-processing program for microcomputers), **Wordstar** (which was more powerful), **Multimate** (the first program that made the IBM PC imitate a Wang word-processing machine), **Displaywrite** (which made the IBM PC imitate an IBM Displaywriter word-processing machine), **PC-Write** (shareware you could try for free before sending a donation to the author), and **Xywrite** (which ran faster than any other word processor)

But by 1991, most users had switched to **WordPerfect 5.1**, which ran on the IBM PC (and several other computers) and could perform many fancy tricks.

All those word-processing programs were awkward to learn and use. Beginners preferred these simpler word-processing programs:

PFS Write (for the IBM PC), **IBM Writing Assistant** (which was a modified version of PFS Write), **Q&A** (which also included a database program), **Bank Street Writer** (for the Apple 2), and **Mac Write** (which was invented by Apple for the Mac and sometimes given away free)

But those word-processing programs couldn't perform as many tricks as WordPerfect 5.1, which remained the business standard that secretaries were required to learn and use.

In 1992, Microsoft invented **Windows 3.1** (the first version of Windows good enough to become popular). Companies and consumers began switching from DOS to Windows and wanted a good word-processing program for Windows. Unfortunately, WordPerfect 5.1 used DOS, not Windows. Windows 3.1 included a word-processing program called **Write**, but it was stripped down.

The first *good* word-processing programs for Windows were **Ami** (which is the French word for "friend") and an improved version (**Ami Pro**), both published by a company called Samna, which got bought by Lotus, which got bought by IBM, which eventually changed the name to **Word Pro**.

Microsoft invented a word-processing program called **Microsoft Word**. Its DOS version was awkward, but its Mac & Windows versions improved and eventually became even better than Ami Pro and Word Pro.

A good Windows version of **WordPerfect** became available but too late (because Microsoft prevented WordPerfect's developers from learning how write good Windows programs). By then, most companies had already decided to switch to the Windows version of Microsoft Word, though WordPerfect remained popular among lawyers and their secretaries.

What to buy The best word-processing program is **Microsoft Word**, which is part of **Microsoft Office** (for Windows & the Mac) and also part of **Microsoft 365**.

To pay less, some people use **Microsoft Works** (which crudely imitates Microsoft Office for Windows) or **iWork** (which crudely imitates Microsoft Office for the Mac). To pay nothing, you can use **WordPad** (which is part of modern Windows) or **TextEdit** (which is part of the Mac) or **OpenOffice** (a free Internet download that imitates an outdated version of Microsoft Office) or **LibreOffice** (an improvement over OpenOffice).

Spreadsheets

To analyze a company, accountants examine the company's financial data (each month's expenses and revenues) and arrange all those numbers to form a huge "table of numbers", **spread** across a big **sheet** of paper. That's called a **spreadsheet**. A spreadsheet is a table of numbers, spread across either a sheet of paper or the computer's screen. For example, this spreadsheet deals with money:

```
           January   February
Income   $9,030.95 $12,486.99
Expenses $7,000.55  $9,210.75
----------------------------
Profit   $2,030.40  $3,276.24
```

A spreadsheet can show how many dollars you earned (or spent or plan to spend), how many goods you have in stock, how people scored in a test (or survey or scientific experiment), or any other numbers you wish!

A **spreadsheet program** lets you create a spreadsheet on the computer screen. Type any numbers you wish. For example, you can type amounts of money (for accounting), scores (from sports or student exams), measurements (from science-lab experiments or sociology surveys), or your ratings of members of the opposite sex. The spreadsheet program lets you type those numbers, edit them, and analyze them.

The typical spreadsheet program can automatically do these things:

- compute the total, average, percentages, and other statistics for each row & column
- rearrange the data (to put the topics in alphabetical order or from "best" to "worse")
- draw pretty graphs summarizing the results
- copy all that to paper and disk
- automatically change all the sums, averages, percentages, and graphs whenever you edit the original data

It's great for analyzing budgets, scientific experiments, statistics, and you!

Best spreadsheet programs Most businesses use a spreadsheet program called **Microsoft Excel**. It requires Windows or a Mac. Its main competitor is Corel's **Quattro Pro**, which requires Windows.

Historic spreadsheet programs The first spreadsheet program was invented in 1979. It was designed by Dan Bricklin and coded by Bob Frankston. (That means Dan decided what features & menus the program should have, and Bob wrote the program.) They called the program **VisiCalc** because it was a "visible calculator". VisiCalc's first version ran on the Apple 2 computer; later versions ran on the Radio Shack TRS-80 and IBM PC.

The second spreadsheet program was called **SuperCalc** because it was superior to VisiCalc. It was invented by a company called Sorcim (which is "micros" spelled backwards). It ran on computers using the CP/M operating system. The most popular CP/M computer — the Osborne 1 — came with a free copy of SuperCalc. Later versions of SuperCalc ran on the Apple 2 and IBM PC.

Multiplan was the first spreadsheet program that could handle multiple spreadsheets simultaneously — and the relationships among them. Invented by Microsoft, it ran on a greater variety of computers than any other spreadsheet program.

Context MBA was the first spreadsheet program that had extras: besides handling spreadsheets, it also handled graphs, databases, word processing, and telecommunications. But it ran slowly, its word processing was limited (it couldn't center and wouldn't let you set tab stops), and it required a strange operating system (the Pascal P System). It was invented in 1981 by Context Management Systems, which later invented an MS-DOS version called **Corporate MBA**.

All those spreadsheet programs became irrelevant in 1983, when a much better spreadsheet program was invented. It was designed by Mitch Kapor and coded by Jonathan Sachs for the IBM PC. They called the program **1-2-3**, because it ran fast and was supposed to handle 3 things: spreadsheets, graphs, and word processing. But when Jonathan examined Context MBA, he realized that putting a good word processor into 1-2-3 would consume too much RAM and make the program run too slowly, so he omitted the word processor and replaced it with a stripped-down database processor instead. Mitch and Jonathan called their company **Lotus Development Corporation**, because Mitch was a transcendental-meditation instructor who contemplated lotus flowers.

After inventing 1-2-3, Jonathan Sachs tried to invent a program called "1-2-3-4-5," to handle the same 5 tasks as Context MBA: spreadsheets, graphs, databases, word processing, and telecommunications. But while developing it, he realized it was becoming too big and confusing, so he stopped developing it and quit the company. Other Lotus employees finished that program and renamed it **Symphony**; but as he feared, it was a big confusing mess whose word processor was awful. Most businesses bought just 1-2-3 instead.

Other companies invented cheap imitations of 1-2-3. The imitations were called **1-2-3 twins**. The first 1-2-3 twins were **The Twin** (published by Mosaic Software) and **VP-Planner** (published by Paperback Software). Lotus sued both of those publishers and put them out of business.

In 1983 — the same year that Lotus invented 1-2-3 — Apple invented **Lisa Calc**. It was the first spreadsheet program to use a mouse. It ran just on the Lisa computer, which was expensive ($8,000). When Apple began selling the Mac computer the next year (1984), Microsoft began selling **Multiplan for the Mac**, which ran on the Mac and combined the best features of Multiplan and Lisa Calc. The next year (1985), Microsoft invented a further improvement, called **Excel** because it's excellent. Like 1-2-3, Excel handles spreadsheets, graphs, and databases.

Apple wanted to sue Microsoft for inventing the Windows operating system (which makes the IBM PC resemble a Mac). To avoid the suit, Microsoft agreed to put Excel on **just the Mac** for a year. Exactly one year later, Microsoft put Excel on the IBM PC, so now **Excel runs on both the Mac and the IBM PC. It's the best spreadsheet program.**

Another fine spreadsheet program is called **Quattro**, because it's what came after 1-2-3. It was invented by Borland, which later invented an improved version, **Quattro Pro**. In 1994, Borland sold Quattro Pro to another company (Novell), which later sold it to Corel, so now Quattro Pro is published by Corel.

What to do Get a spreadsheet program! The best spreadsheet program, **Excel**, requires you to buy Windows or a Mac (though stripped-down versions of Excel are available for other platforms).

To pay less, you can use the stripped-down spreadsheet programs that are part of **Microsoft Works** (for Windows) or **AppleWorks** (which has sometimes been called **Claris Works** and is available for the Apple 2, Mac, and Windows).

Danger: compulsive perfectionism

The most successful business programs make work be fun, by turning work into a video game. That's why word-processing programs and spreadsheet programs are so successful — they let you move letters & numbers around the screen, edit the errors by "zapping" them, and let you press a button that makes the screen explode with totals, subtotals, counts, and other info.

Sometimes, word processing can be *too* much fun. Since it's so much fun to edit on a word processor, people using word processors edit more thoroughly than people using typewriters or pens. Word processing fosters **compulsive perfectionism**.

Word-processed documents wind up written better than non-electronic documents but take longer to finish. According to a survey by Colorado State, people using word processors take about 30% longer to generate memos than people using pens, and the word-processed memos are needlessly long.

Danger: intimidation

Word-processing and spreadsheet programs can become weapons that mesmerize people into believing everything you say — even if what you're saying is wrong.

For example, suppose you want to submit a budget. If you scribble the budget on a scrap of paper, nobody will take you seriously; but if you put your data into a spreadsheet program that spits out beautifully aligned columns with totals, subtotals, percentages, bar charts, and pie charts, your audience will assume your budget's carefully thought out and applaud it, even though it's just a pretty presentation of the same crude guesses you'd have scribbled on paper.

Similarly, if you want to talk somebody into believing your idea, scribbling it on a scrap of paper won't impress anybody. Instead, print the idea beautifully, using a word processor to create headlines, footnotes, etc. That will make the idea seem carefully thought out, even if the thought is actually the same garbage.

Try it! If you're a kid, write a formal report on why your dessert tonight should be strawberry ice cream instead of vanilla. After submitting it to your Mom, submit it to an ice-cream company and watch yourself get praised, quoted, and hired! That's what marketing is all about: bad ideas, nicely packaged.

Pictures

A **graphics program** helps you create pictures that are pretty or bizarre or whatever else you want! You'll want to get several types of graphics programs.

One type is called a **paint program**. It lets you draw pictures easily. These paint programs are the most famous:

Program	Characteristics
Mac Paint	the first paint program; ran on Mac OS; no longer marketed
Deluxe Paint	best early paint program; ran on Commodore Amiga and MS-DOS; no longer marketed
Paintbrush	came free as part of Windows 3, which is no longer marketed
Windows Paint	comes free as part of modern Windows (Windows 95 and later)
Corel Painter	fanciest paint program; imitates oil painting, charcoal, etc.; for Mac and Windows
Kid Pix	best paint program for kids; lots of fun; includes stars and many other kid shapes

Another type is called a **drawing program**. It resembles a paint program but specializes in drawing straight lines instead of squiggles. It's best for drawing pictures of things that have straight lines, such as buildings, machines, and charts for technical illustrations. These drawing programs are the most famous:

Program	Characteristics
Microsoft Draw	included free as part of Microsoft Word and some other Microsoft products
Corel Draw	the fanciest drawing program for Windows
Adobe Illustrator	an old program; still the professional standard; expensive; for Mac and Windows.

Another type is called a **computer-aided drafting & design program (CAD program)**. It resembles a draw program but does more math.

For example, it can print mock blueprints, showing the lengths of all parts. It can compute the surface area (square feet) of any shape, so you can compute how much material to buy to build your structure and cover it. It lets you give fancy geometric commands, such as "draw a 37-degree angle, but make the point be round instead of sharp, so nobody gets hurt" or "draw a circle that goes through these three points" or "draw a line that grazes these two circles, so it's tangent to them".

The most famous CAD program is **AutoCAD**, which is extremely expensive ($1400 *per year*, after your free 30-day trial). **AutoCAD LT** is a "light" version that costs less ($360 per year). **TurboCAD Deluxe** is much cheaper (just $130 *total*, not per year).

A **photo editor** lets you put a photo into the computer (by using a digital camera or scanner) and see the photo on the computer's screen. Then it lets you edit the photo: it lets you crop out the irrelevant parts, cover scratches and embarrassing details, improve the contrast and brightness and colors, remove red-eye (caused when eyes become accidentally red from the flashbulb), and add special dramatic effects. On smartphones, tablets, and other modern computers, the **Camera app** includes a photo editor. For fancier editing of photos, professionals use **Photoshop** (for Windows & Mac) or a stripped-down version called **Photoshop Elements**.

A **video editor** lets you edit the home movies a camcorder creates. On smartphones, tablets, and other modern computers, the **Camera app** includes a video editor. For fancier editing of photos, professionals use **Adobe Premiere** (for Windows & Mac) or a stripped-down version called **Adobe Premiere Elements** or **Pinnacle Studio** (which is easier). Windows XP & Vista (which are no longer marketed) included **Windows Movie Maker**, which is even easier.

If you give a speech, you can make it more interesting by using a **presentation program**, which lets the audience watch "slides" while they listen to you. Each slide can include photos, charts, and notes. The most famous presentation program is **PowerPoint**, by Microsoft.

Desktop publishing

To write and print a simple document, you can use a word-processing program. But to print a fancier document, use a **desktop-publishing program** instead, such as **Microsoft Publisher**, which is part of Microsoft Office (and part of Microsoft 365). A **desktop-publishing program** resembles a word-processing program but lets you more easily create newsletters, newspapers, magazines, posters, and signs, by letting you more easily include pictures, captions, multiple columns, and jumps (such as "continued on page 5").

Famous programs These desktop-publishing programs are the most famous:

Program	Characteristics
PageMaker	the first desktop-publishing program, for Mac & Windows, expensive, by Adobe
InDesign	from Adobe, newer and better than PageMaker
Quark XPress	competed against PageMaker and became the most popular, but then InDesign beat it
Microsoft Publisher	cheap, easy to learn, the best for beginners, lacks advanced features, for Windows
Print Shop	cheap, easy; was popular in 1980's but too limited, beaten by Microsoft Publisher

PageMaker The first popular desktop-publishing program was **PageMaker**, invented in 1985 by Paul Brainerd, who'd been a newspaper executive. PageMaker let you combine words and graphics to form a newspaper page that includes a mix of headlines, columns of articles, photographs, diagrams, captions, and ads. PageMaker let you see the page on your computer's screen and move words & graphics by using a mouse. PageMaker's first version ran on the Mac and used Apple's laser printer (the LaserWriter).

Such a program could have been called a "page-layout", "page-composition", or "computer-aided publishing" program. But to sell the program, he coined a new term: a **desktop-publishing program**, because it used the Mac's "desktop" screen to help publishing, and because it let you run your own publishing company from a desktop in your home without hiring graphic artists, typesetters, and other outside help.

The PageMaker program and the term "desktop publishing" became instant hits. Many novice authors, publishers, and designers bought Macs just to run PageMaker. They used PageMaker to create newspapers, newsletters, reports, books, flyers, posters, and ads. Most ad agencies bought Macs & PageMaker to create ads. Even today, most ad agencies use Macs, not IBM-compatibles.

The IBM PC couldn't handle desktop publishing at all, until Windows (and a competitor called **Gem**) improved enough so the IBM PC's screen could look Mac-like. Finally, a Windows version of PageMaker became available.

PageMaker's competitors Competitors to PageMaker arose. Now your main choices are **PageMaker**, **Quark XPress**, and **InDesign**.

Here's how they compare:

PageMaker (for Mac & Windows) is the easiest to learn. It's the best for handling graphics and short ads.
Quark XPress is the best for handling text and fonts. Its Mac version is better than its Windows version.
InDesign (for Mac & Windows) tries to combine the best features of PageMaker and Quark XPress.

Merger PageMaker was published by Paul Brainerd's company, Aldus. In 1994, Aldus merged into a company called **Adobe**, which had invented many other desktop-publishing tools, including Postscript (the font system used in Apple's Laserwriter), Illustrator (a draw program), and Photoshop (a photo-manipulation program).

Difficulties Desktop-publishing software can be confusing. That's why PageMaker is often called "PageWrecker", Quark XPress is called "Quark Distress", and InDesign is called "UnDesign".

Frames Like a word-processing program, a desktop-publishing program lets you type words onto the screen. But when you start using a desktop-publishing program, you must first divide your screen (and page) into boxes. Each box is called a **frame**.

In one frame, type a headline. In another frame, put a picture. To create the picture, use the desktop-publishing program's draw tools or **import** a drawing (or painting or photo) you created using some other graphics program. In another frame, put a table of contents or an index. In another frame, put an ad. In another frame, put column 1 of an article. In another frame, put column 2.

You can **link** one frame to another. For example, you can link column 1 to column 2, so if you type an article that's too long to fit in column 1, the excess will **spill** into column 2.

You can link a frame on page 1 to a frame on page 7, so if an article's too long to fit on your newspaper's front page, it will continue on page 7. (Continuing on a far-away page is called a **jump**. Newspapers do it frequently. I wish they didn't!)

Master page If most pages in your newspaper resemble each other, create a **master page** that shows how the typical page should look. On the master page, put frames for each column, and at the page top put a header that includes the page number and your newspaper's name & date (so when a reader rips out an article, the reader knows where it came from).

Special pages can diverge from the master.

Clutter The typical beginner makes the mistake of trying to be too fancy. Use just a *few* typestyles and frames per page, to avoid making your publication seem a disorganized, cluttered mess.

Put enough frames on your page to add spice; but if you add too many frames, your publication will look chopped-up, dicey, as amateurish as an oil painting by a 2-year-old kid given his first paint box.

Adding some frames will make it look spicy.
Too many frames will make it look dicey.

Gentle control shows a master who knew.
Out-of-control shows a kid who acts 2.

Mozart's music was masterfully charming because its overall structure was simple, though it had a few subtle surprises. Imitate him.

Cheaper solutions

Professional desktop-publishing programs can be expensive, $500 each.

Kiddle pub Cheaper, easier desktop-publishing programs have been invented, for kids and novices. The most famous is **Print Shop**, published by Broderbund.

It's particularly good at creating greeting cards, posters, and banners. The first version was popular among kids using Apple 2 computers because it was amazingly easy to use, though the graphics it produced were low-resolution and crude.

It's been translated to the Mac, IBM PC, and most other computers, too. The newest versions produce slightly better graphics but are harder to learn.

Print Shop's price dropped to $50 because nobody wants it anymore. Instead, folks want **Microsoft Publisher**.

Like Print Shop, Microsoft Publisher can produce greeting cards, posters, and banners. Better than Print Shop, it can handle high-resolution graphics and tiny fonts well and produce professional-looking newspapers, newsletters, reports, business cards, and origami paper airplanes. It produces a great-looking document with fake words, which you replace with your *own* words. It lets you fine-tune your publication's graphics and layouts by using your mouse and professional desktop-publishing techniques.

Bill Gates, who ran Microsoft, liked the design of Microsoft Publisher so much that he took the design team's head and married her! (They recently got divorced.)

Microsoft Publisher is pricey: it lists for $140. But **Microsoft Publisher is included free as part of Microsoft 365 Business Standard.**

Word processing Recently, word-processing programs have grown to include many desktop-publishing features.

The first word-processing program that let you create frames was **Ami Pro**. Other word-processing programs copied Ami Pro's idea of permitting frames, so now you can create frames in WordPro (which is Ami Pro's successor), Microsoft Word, and WordPerfect.

If what you're writing has a simple layout, with very few frames or graphics per page, use a word-processing program instead of a desktop-publishing program.

How I published this book I wrote this book by using just Microsoft Word. I got by with Microsoft Word instead of a desktop-publishing program because I kept my layout simple, with very few frames and graphics per page.

For most of this book, I used just 8 fonts:

This font is called "Times New Roman". It's from Microsoft. I used it for most of my writing. It's therefore called my "body-text font". I used the 10-point size for most of the text, 8½-point for small text (which I put in boxed paragraphs, like this). Unlike other Times Roman fonts, Microsoft's has the nice property: when working in small font sizes (such as 8½-point), each digit is as wide as two blank spaces, and each period takes up as much space as one blank space. That makes it easy to keep the columns lined up! (Microsoft wants you to line up columns by using fancy features such as "tables" and "decimal tabs", but pressing the space bar is simpler.)

This is "Times New Roman Italic". It's elegant but hard to read, so I use it rarely, just for emphasis, such as to emphasize the word "not".

This is "Tahoma", from Microsoft, used in Windows XP menus. It resembles Helvetica or Arial but is clearer: for example, it makes the capital "I" look different from a small "L".

This is "Tahoma Bold". I used it for column headings (at the top of tables) and for words being defined. To make defined words less overwhelming, I made them 1 point smaller than the surrounding text: I made them 9-point Tahoma Bold when surrounded by 10-point Times New Roman; I made them 7½-point Tahoma Bold when surrounded by 8½-point Times New Roman.

`This is "Lucida Console". It's monospaced, which means each character has the same width. It's used in the Windows XP "Notepad" program.`

This is "Andy Italic" widened (scaled to 125% of original width) and with a gray background. It's lively! I used this combo (Andy Italic 125% grayed) at the top of each sub-subchapter. Andy Italic is not from Microsoft: I got it from a CD-ROM disk that contains 2500 fonts I bought that disk for just $18 at Sam's Club. The disk is published by Summitsoft (www.summitsoft.com).

This is "Comic Sans MS Italic" with a gray background. It's supposed to look funny, like a comic book, so it makes the reader feel cheery. It's easy to read and from Microsoft. I used it in big type (20-point and boxed) at the top of each subchapter.

This is "Flaemische Kanzleischrift" with a gray background. It's an elegant script, the kind of thing you'd put on a wedding invitation or the label of a fine wine or fine piano. Unfortunately, some of its letters are very hard to read, and some bugs make it hard to use. I used it in huge type (33½-point and boxed) at the top of each chapter, to encourage you to think this is a fine book! I got it from Summitsoft's 2500-font disk.

So here's a summary of what I did. Typical text (like you're reading now) is Times New Roman 10-point (with 11-point line spacing, so there's a 1-point gap between lines).

Typical small text (like you're reading now) is Times New Roman 8½-point (with 9½-point line spacing), boxed. Emphasized words (*like this*) are Times New Roman Italic. Windows menus (like this) are Tahoma. Column headings (**like this**) are Tahoma Bold. Defined words (**like this**) are Tahoma Bold, 1 point smaller. Monospaced computer output (`like this`) is Lucida Console.

Bigger headings have a gray background: they're Andy Italic 125% (**like this**), Comic Sans MS Italic (*like this*), or Flaemische Kanzleischrift (*like this*).

To squeeze as much info as possible onto each page without clutter, I set my left and right margins at .5", top margin at .3", bottom margin at .6" (to leave space for the footer), and distance between columns at .3".

The typical page contains 2 columns, each 3.6" wide. When I needed a wider column (to hold a wide table or graphic), I widened the column to 4.8" instead, so the page's other column shrunk to 2.4". On a few pages, I used 3 narrow columns, each 2.3".

Databases

A **database program** helps you manipulate long lists of data, such as names addresses, phone numbers, and comments about your acquaintances (friends & enemies, students & teachers, customers & suppliers, employees & hobby buddies). It puts all that data about your life and business onto a disk, which acts as an electronic filing cabinet.

Then it lets you **edit** that data. For example, you can insert extra data in the middle of the list. The program lets you **view** the data in any order you wish (such alphabetical order, ZIP-code order, or chronological order) and **print** that view onto paper.

The program can **search** through all that data and find, in just a few seconds, the data that's unusual. For example, it can find everybody whose birthday is *today*, or everybody who's blond and under 18, or everybody who lives out-of-state and has owed you more than $100 for over a year. It can generate mailing lists, phone directories, sales reports, and any other analysis you wish.

It's called a **database program** or **database management system (DBMS)** or **information retrieval system**. The terms are synonymous.

A database program is like a word processing program: it lets you type info, put it onto a disk, edit it, and copy it onto paper.

In a word processing system, the info's called a **document**, consisting of paragraphs which in turn consist of sentences.

In a database system, the info's called a **file** (instead of a document); it consists of records, which in turn consist of fields.

Since a database program resembles a word processor, a word processor can act as a crummy database program. But a *good* database program offers these extras, which the typical word processor lacks:

A good database program can **alphabetize**, **put info into numerical order**, and **check for criteria**. For example, you can tell it to check which customers are women under 18 who have light red hair and live in a red-light district, make it print their names and addresses on mailing labels in ZIP-code order, and make it print a phone book containing their names and numbers. Database programs are potent and serve as nasty tools to invade people's privacy!

A database resembles a spreadsheet (which organizes info to form a table). Many people use the Excel spreadsheet program as a crummy database program.

Microsoft wants you to use a database program called **Microsoft Access**. It requires Windows. Unfortunately, it's hard to master.

You might be happier with an easier database program instead, such as **FileMaker Pro**, which is published by a division of Apple and runs on Macs and Windows. Other famous database programs are **Approach** (for Windows and published by IBM's Lotus division), **Oracle** (for large corporations), **Q&A** (for beginners using MS-DOS), **Sesame** (which imitates Q&A but handles Windows), **dBase** (for MS-DOS or Windows), and **FoxPro** (which resembles dBase but is fancier).

Jargon In an old-fashioned office without a computer, you see a filing cabinet containing several drawers:

One drawer is "Customers"; another is "Employees"; another drawer is "Suppliers". Each drawer contains alphabetized index cards.

Each drawer is called a **file**. For example, the drawer that contains information about customers is called the **customer file**; another drawer is the **employee file**; another drawer is the **supplier file**. The entire filing cabinet, which contains all info about your company, is called the **database**.

The drawer labeled "Customers" contains a card about each customer. The first card might be labeled "Adams, Joan"; it contains all known information about Joan Adams: it contains her name, address, phone number, everything she bought, how much she paid, how much she still owes, and other personal information about her. That card is called her **record**. Each item of info on that card is called a **field**.

If the card is a pre-printed form, it allows a certain amount of space for each item. For example, it might allow just 30 characters for the person's name. The number of characters allowed in a field is called the **field's width**. In that example, the Name field's width is 30 characters.

Example Here's a file about amazing students in the School of Life:

```
Last name: Smith                        First name: Suzy
Age: 4              Class: 12
Comments: Though just 4 years old, she finished high school because she's fast.

Last name: Bell                         First name: Clara
Age: 21             Class: 10
Comments: The class clown, she never graduated but had fun trying. Super-slow!

Last name: Smith                        First name: Buffalo Bob
Age: 7              Class: 2
Comments: Boringly normal, he's jealous of his sister Suzy. Always says "Howdy!"

Last name: Kosinski                     First name: Stanislaw
Age: 16             Class: 11
Comments: He dislikes Polish jokes.

Last name: Ketchopf                     First name: Heinz
Age: 57             Class: 1
Comments: His pour grades make him the slowest Ketchopf in the West.

Last name: Nixon                        First name: Tricky Dick
Age: 98             Class: 13
Comments: The unlucky President, he disappointed our country. He's a corpse.

Last name: Walter                       First name: Russy-poo
Age: 74             Class: 0
Comments: This guy has no class.
```

That file consists of 7 **records**: Suzy Smith's record, Clara Bell's record, Buffalo Bob Smith's record, Stanislaw Kosinski's record, Heinz Ketchopf's record, Tricky Dick Nixon's record, and Russy-poo Walter's record. Each record consists of 5 **fields**: Last name, First name, Age, Class, and Comments. The Age and Class fields are narrow; the Comments field is very wide.

Historic programs Many database programs have been invented. Here are the best.

PFS Most database programs are hard to use. In 1980, John Page invented the first *easy* database program. He called it the **Personal Filing System (PFS)**.

It ran on Apple 2 computers. He developed it while sitting in his garage.

He showed the program to two friends: Fred Gibbons and Janelle Bedke. The three of them tried to find a company willing to market his program, but no company was interested, so they decided to market the program themselves by forming a company, **Software Publishing Corporation**.

The program became very popular. Software Publishing Corporation became a multi-million-dollar corporation. It developed improved versions of PFS for the Apple 2 family, Radio Shack models 3 & 4, Commodore 64, Mac, and IBM PC. The fanciest version of PFS is **Professional File**, which ran on the IBM PC using the DOS operating system.

The company also invented a word processor, whose IBM version is called **Professional Write**. It works well with Professional File. You can write a memo by using Professional Write, build a mailing list by using Professional File, then use those programs together to print personalized copies of your memo to everybody on your mailing list.

Software Publishing Corporation invented an even easier program, called **PFS First Choice**. It includes the easiest parts of both Professional File and Professional Write. It also includes spreadsheets, graphics, and communication.

In 1988, John Page and Janelle Bedke got bored and quit the company. Fred Gibbons and the rest of his staff hung on but sold PFS First Choice to **Spinnaker**, which later became part of **Softkey**, which later became part of **The Learning Company**, which later became part of the **Mattel** toy company.

Those products (PFS, Professional Write, Professional File, and PFS First Choice) are no longer marketed. Exciting new competitors took their place. Here they are.…

Q&A Inspired by the PFS series, a company called **Symantec** developed a similar program, called **Q&A**.

Q&A uses almost the same commands and keystrokes as the first IBM version of PFS but understands many extra commands, making Q&A much more powerful than the PFS series. Q&A handles just two topics — databases and word processing — but very well! It's easy (almost as easy as the PFS series) and powerful enough to handle the computing needs of most businesses. Q&A is the database program I use to run my own business.

Symantec has stopped selling Q&A. An improved version was sold by **Professional Computer Technology**, but that company stopped marketing Q&A and wants Q&A customers to switch to a newer database program using similar keystrokes: the **Sesame Database Manager**, by **Lantica**, for $79.

Reflex **Reflex** was the first database program that let you view your data in 5 ways: a **form view** (a filled-in form showing a record), a **list view** (a big spreadsheet showing the whole file), a **graph view** (a graph of all the data), a **report view** (a report on the entire file, with subtotals), and a **crosstab view** (a table of totals for statisticians).

Reflex can show you many views simultaneously, by dividing your screen into windows. As you edit the view in one window, the views in other windows change simultaneously. For example, if one window shows numbers and another window shows a graph, the graph changes automatically as you edit the numbers.

Reflex is partly a database program and partly a spreadsheet. Many of Reflex's features were copied by Microsoft's spreadsheet, Excel.

Reflex was published by **Borland**, which has stopped marketing it, because competition from newer database programs has become too fierce.

Relational databases Reflex is a **simple flat-file system**, which means it manipulates just one file at a time. Q&A goes a step further: while you're editing a file, Q&A lets you insert data from a second file.

Software that goes even further than Q&A and lets you edit 2 files simultaneously is called a **relational database program** (or **relational database management system** or **relational DBMS**).

The most popular relational database programs for DOS were **dBase**, **FoxPro**, and **Paradox**. You could customize them to meet *any* need, because they include complete programming languages.

Another relational database program for DOS was **Alpha 4**. It let you accomplish some tasks more easily than dBase, FoxPro, and Paradox but lacked a programming language.

Windows wars Programmers have been trying to invent database programs for Windows. Going beyond DOS programs, Windows database programs let the screen display pretty fonts and photos.

The first popular Windows database program was **Approach**, now published by the Lotus division of IBM.

Borland invented Windows versions of **dBase** and **Paradox** and a new Windows database program called **Delphi**. Microsoft has invented a Windows version of **FoxPro** and a new Windows database program called **Microsoft Access**. Alpha Software invented **Alpha 5**, which resembles Alpha 4 but handles Windows and is also programmable.

The most popular database program for the Mac is **FileMaker Pro**. It's as easy as Q&A! It's published by Claris, which is owned by Apple. It runs on the Mac but is also available for Windows.

Microsoft Works includes a database program that's very limited. For example, it can't handle big mailing lists, since it's limited to 32,000 records.

Symantec invented a Windows version of **Q&A**, but Q&A's Windows version is hated by everybody.

It's worse than the DOS version and worse than all other major Windows databases. If you still use Q&A, stick with Q&A's DOS version.

Though Q&A for Windows is terrible, the other Windows database programs are fine. Here's the hierarchy:

The simplest Windows database program is the database part of **Microsoft Works**; but it comes with no instruction manual, and you'll outgrow the program's abilities. Microsoft has stopped marketing it.

The next step up is **FileMaker Pro**. It's wonderful! It's more powerful than the Microsoft Works database — it performs more tricks and handles a wider variety of problems. It comes with a decent instruction manual.

The next step up is **Approach**, because it's more powerful than the Microsoft Works database and Filemaker Pro: it performs more tricks and handles a wider variety of problems. But it's harder to learn & use. Unlike Microsoft Works and Filemaker Pro, it's relational. But it's still not programmable.

The next step up (in power and complexity) is **Alpha 5**. It's relational and also programmable! But its programming language is small.

The next step up is **Microsoft Access**. Its programming language is bigger.

The next step up is the triumvirate: the Windows versions of **dBase**, **FoxPro**, and **Paradox**. They're powerful, fancy, and more than most folks can understand. If you buy one of them, you'll probably admire the big box it comes in, put it on the shelf, and invite friends to visit you and admire your big box, but you won't figure out how to use it.

What to buy To make your life *easy*, use one of the *easy* database programs: Q&A for DOS, Microsoft Works, or FileMaker Pro. Go beyond them just if your database needs are too complex for them to handle.

Even if your database needs are complex, begin by practicing with an *easy* database program first, so you master database fundamentals easily and quickly without getting distracted by needlessly complex details.

Complex database programs are like sneakers with untied shoelaces: though their overall design can let you perform amazing feats, you'll probably trip, get bloodied, and have to call in a computer "first-aid squad", which is a team of high-priced computer consultants.

To avoid the need for consultants, use Microsoft Works, FileMaker Pro, or Q&A.

In general, the best database program to use is **FileMaker Pro**. It's published by Claris, which is owned by Apple. It's the most popular database program for Mac computers, and a Windows version is also available.

Like Q&A, it's easy to learn how to use. It has two main advantages over Q&A: it can handle databases that are more advanced, and its Windows version is excellent. (Q&A's Windows version is terrible.) FileMaker Pro has been nicknamed "Q&A for Windows, done right." It's also been nicknamed "Microsoft Access, made reasonable" (because Microsoft Access is unreasonably hard).

The newest version of FileMaker Pro is **FileMaker Pro 19**. Unfortunately, it's expensive: it lists for $540. You can download a 45-day trial version free if you fill a form at:

claris.com/trial

Office suites

Instead of buying a word-processing program, a spreadsheet program, and other programs separately, you can buy an **office suite**, which includes them all!

MS Office The best and most popular office suite is **Microsoft Office (MS Office)**. The newest version, **MS Office 2016**, requires Windows 7, 8, 8.1, or 10. The list price is $400 because Microsoft wants rich people & companies to pay that, but Microsoft has invented many schemes to squeeze a few bucks out of normal folks too. Here are the schemes for you to take advantage of:

The $400 price is for the **Professional** edition, which includes 7 programs: Word, Excel, PowerPoint, OneNote (for organizing your materials), Outlook, Publisher, and Access.

Just $230 gets you the **Home & Business** edition instead, which omits Publisher & Access, so you get 5 programs.

Just $150 gets you the **Home & Student** edition, which resembles the Home & Business edition but omits Outlook (so you get just 4 programs) and is illegal to use for anything serious: you're not licensed to use it for any business work, government work, non-profit work, or in schools; it's licensed just for doing homework & fun stuff at your home, though Microsoft doesn't have much ability to enforce that restriction.

You can buy programs individually (a la carte) instead of a suite, for $110 per program.

If you buy any of those deals, you're restricted to using it on just **1 computer**: you're not allowed to copy it to a second computer. If you want to use it on a second computer, you must buy a second copy.

A popular alternative, which is what Microsoft *really* wants you to do, is to *rent* MS Office instead of buying it. The most popular rental program is called **Office 365 Home** and is an amazingly good deal! The rental fee is just $10 per month or $100 per year. It includes all 7 programs plus 2 extra features (extra **OneDrive** online storage & some free **Skype** videoconferencing calls). The license includes the right for **5 people** to use the software simultaneously, and each person can use it on 3 devices (a normal computer plus a tablet plus a phone), for a total of **15 devices**. It also gives you **free upgrades** to all future versions of MS Office! There's just one "catch": like the Home & Student edition, it's illegal to use for anything serious, though most users ignore that restriction.

Here's a cheaper deal, called **Office 365 Personal**: it's the same as Office 365 Home, except the rental fee is just $7 per month or $70 per year, and is for just **1 person** (not 5), on 3 devices (a normal computer plus a tablet plus a phone). Special deal: if you're graduating from college about now, you pay just $35 for the first year of rental (instead of $70).

Microsoft offers special deals for colleges: college students, teachers, staff, and recent graduates can get parts of Office cheaply or even free! Those deals are called **Office 365 Education**, **Office 365 Education E5**, and **Office 365 University**. Ask your college's computer department which choices apply to your college.

You can get a **free 1-month trial version** of Office 365 Home from Microsoft's Website. But you must tell Microsoft your credit-card number, and your credit card will be billed for additional months unless you cancel before the first month ends.

If you buy Microsoft Office at the same time as a computer, dealers often charge $20 less. For example, dealers often sell the Home & Student edition (which is the most popular) for just $130 (instead of $150) and sell the first year of the 365 Personal edition for $50 (instead of $70).

If you have a Mac instead of Windows, you must use Microsoft Office's Mac versions, which omit Publisher & Access.

WordPerfect Office The main competitor to Microsoft Office is Corel's **WordPerfect Office**. The newest version is called **WordPerfect Office X8**; it costs $400 for the Professional edition, $250 for the Standard edition, $100 for the Home & Student edition. You can get a stripped-down version, called **Corel Office**, for just $50.

OpenOffice Another competitor to Microsoft Office is Apache's **OpenOffice**, which is put together by volunteers who let you download it free from the Internet. It imitates an old version of Microsoft Office. It used to be called **Star Office** and was a commercial product, but now it's free.

LibreOffice Similar to OpenOffice, LibreOffice is free. Recently, LibreOffice has improved faster than OpenOffice. Many people have switched from OpenOffice to LibreOffice.

Integrated programs

Instead of buying an office suite, you can pay less by getting a cute little program, called an **integrated program**, which does a little bit of everything!

The best integrated programs have been **iWork**, **Microsoft Works**, and **Q&A**.

iWork is the best integrated program for handling desktop publishing. It also handles word processing, spreadsheets, databases, presentations, painting, and drawing. It's published by Apple, which used to call it **AppleWorks** and **Claris Works**. You get it *free* if you buy a new Mac, iPad, or iPhone.

Microsoft Works was the best integrated program for handling word processing and spreadsheets, but Microsoft stopped making it.

Q&A was the best integrated program for handling databases. (Unfortunately, it handled word processing poorly, didn't handle spreadsheets and all, and ran best just if you had the DOS operating system.) Symantec stopped making it, but I still use it & love it — which is why is still use DOS instead of Windows for my databases! If you've been using the DOS version but need to switch to Windows, try **Sesame Database Manager**, which imitates the database part of Q&A, runs in Windows & Linux, and can be downloaded from **Lantica Software** (in Pennsylvania at 800-410-6315) for $79.

Accounting

You can get a checkbook program. It helps you balance your checkbook, track your expenses (and categorize them so you can get tax deductions), manage your credit cards, track your investments (stocks, bonds, and bank accounts), and compute your net worth.

The first program to do that well was **Quicken**, published by **Intuit**. Then Microsoft invented a competing program, called **Microsoft Money**, which was easier, but recently Microsoft gave up trying to sell it. Quicken and Microsoft Money are fine for personal use or to run tiny businesses.

If your business has lots of employees, you'll want a program that's better at "paying your employees" and "billing your customers". The easiest powerful program is Intuit's **QuickBooks**, which is a souped-up version of Quicken. Other accounting programs, which are even more powerful (and slightly harder to learn how to use), are **Sage 50c Accounting** (formerly called **Peachtree Complete Accounting**) and **Mind Your Own Business** (which is called **MYOB** and was invented in Australia).

Vertical software

Software that can be used by a *wide variety* of businesses is called **horizontal software**. Programs for word processing, spreadsheets, and databases are all examples of horizontal software.

Software targeted to a specific industry is called **vertical software**. Programs specifically for doctors, lawyers, and real-estate management are all examples of vertical software.

Vertical software is expensive because it can't be mass-marketed to the general public and isn't available from discount dealers. The typical vertical-market program costs about $1000, whereas the typical horizontal-market program costs about $100 from discount dealers.

Until the price of vertical software declines, use horizontal software instead. With just a few hours of effort, you can customize horizontal software to fit your own specific needs.

Viruses

Nasty programmers have invented **computer viruses**, which are programs that purposely damage your other programs and can sneakily copy themselves onto every disk and e-mail message that you share with friends. Some viruses also try to steal your identity, especially your passwords and credit-card numbers. To avoid catching a virus, protect yourself in 5 ways:

Update your versions of Windows and other software, since new software contains more built-in protections against viruses. For example, Windows 10 includes more anti-virus protections than previous Windows. One of Windows 10's built-in protections is **Windows Defender** (which was previously called **Windows Security Essentials**).

If you wish, buy extra anti-virus programs, such as **Norton AntiVirus**. But the protections built into the newest update to Windows 10 are good enough to cover most situations.

Don't trust any phone calls or on-screen messages saying you're infected. Those claims often come from crooks (pretending to be banks or Microsoft). They try to scare you into revealing your password or paying for "protection."

Don't trust any emails that claim to be from a friend and tell you to click something exciting but are written generically without mentioning your name. They might mention your friend's name, but that name was stolen by crooks.

Read this book's Security chapter, which has more info about kinds of viruses.

Data

The typical program comes on a CD-ROM disk. To use the program, put its CD-ROM disk into the CD-ROM drive. Then copy the program to your hard disk.

The CD-ROM disk containing the program might also contain lots of music, video, and other data. If the data is too big to fit on the hard disk, you must keep the CD-ROM disk in the drive while running the program, so the computer can access whatever part of the CD-ROM's data is needed at the moment.

Some programs let you create your own data, by typing the data at your keyboard. The computer stores that data on the hard disk. You should occasionally copy that data onto a floppy disk, as a backup copy, to protect yourself in case the hard disk gets damaged.

Software companies

Will your computer be pleasant to use? The answer depends on which software you buy. Software companies will influence your life more than any hardware manufacturer.

Here are famous software companies.

Microsoft

The most important software company is **Microsoft**, which takes in about 85 billion dollars of revenue per year. It makes the most popular operating system (**Windows**) and the most popular office suite (**Microsoft Office**).

The company's main founder is **Bill Gates**.

Because of Microsoft's success, when he was 30 he became a billionaire and appeared on the cover of Time magazine. When he turned 40 (on October 28, 1995), he was worth 14.7 billion dollars.

At the beginning of 1997, he was worth 24 billion dollars. Seven months later, at the end of July, he was worth 40 billion dollars. 2 years later, in mid-1999, he was worth 100 billion dollars! He became the world's richest person.

100 billion dollars is a lot of money! For example, even if you earn 100 million dollars per year, you'd have to work 1000 years to get what Bill had. 100 billion dollars was enough to give $360 to each American, or $16 to each person on the planet. 100 billion one-dollar bills, if laid end-to-end, would stretch to the moon and back, 20 times. Programmers often measure their salaries in **microbills**, where a **microbill** is defined as being a millionth of Bill Gates' worth, so a microbill became $100,000.

Bill didn't have 100 billion dollars cash in his pocket: most of his billions were just on paper, invested in Microsoft stock: he owned 12% of Microsoft, whose stock was overpriced.

Bill promised to donate 95% of his wealth to worthy causes. To start that process, he and his wife Melinda created the **Bill & Melinda Gates Foundation**, which has given big grants to libraries, schools, and third-world health agencies. When I was writing this book in July 2021, Bill was still rich: Bill's net worth was 124 billion dollars, even though he'd already given away many billions. He was the 4th richest person in the world, after Jeff Bezos (worth 177 billion dollars because he owned Amazon), Elon Musk (worth 151 billion dollars because he owned Tesla), and Bernard Arnault (worth 150 billion dollars because he owned Christian Dior). They're the 4 richest people in the world!

Bill is semi-retired from Microsoft. Now he devotes just ⅓ of his time to Microsoft, where he gives advice to the new CEO (Satya Nadella); he spends the other ⅔ of his time giving his money away — by helping Melinda run their non-profit.

Microsoft is the most diversified software company:

It's sold operating systems (**MS-DOS** and **Windows**), a word-processing program (**Microsoft Word**), a spreadsheet program (**Excel**), a desktop-publishing program (**Microsoft Publisher**), database programs (**Access** and **FoxPro**), an integrated program (**Microsoft Works**), a computerized encyclopedia (**Encarta**), programming languages (**Visual Basic**, **Visual C#**, and others), and a wide variety of other software. It's the main software publisher for the IBM PC & Mac. It also wrote the versions of Basic used by primitive computers (such as the Apple 2 family, Radio Shack TRS-80, Commodore 64, and Commodore Amiga).

It also sells hardware (such as **mice**, **keyboards**, **Surface** computers, and **Xbox** game-playing system) and Internet services (such as the **Bing** search engine and **MSN**).

Microsoft continually develops new products because of pressure from competitors. For example, Microsoft was forced to improve Microsoft Word because of competition from WordPerfect and improve Microsoft C because of competition from Borland's C. Those continual pressures to improve keep Microsoft a vibrant, dynamically changing company.

Novell

Novell invented **Netware** & **Intranetware**, which are programs that help create computer networks.

In 1994, Novell bought **WordPerfect Corporation** (which made the most popular word-processing program, WordPerfect).

Novell's purchase was natural, since both companies were in Utah. WordPerfect Corporation sold out to Novell because WordPerfect Corporation was having financial trouble, since many customers were switching to Microsoft Word, which had improved dramatically.

In 1994, Novell also bought **Quattro Pro** (a top-rated spreadsheet program invented by a company called **Borland**). Borland sold Quattro Pro to Novell because Borland was having financial trouble competing against Microsoft.

Novell was founded by Ray Noorda. Novell's next CEO, Robert Frankenberg, tried to make the company smaller and more manageable, so in 1996 he sold WordPerfect and Quattro Pro to a Canadian company, **Corel**, which was famous for inventing a graphics program called **Corel Draw**.

In 2004, Novell bought a German company called **SuSE** (which made the nicest version of Linux, **SuSE Linux**).

In 2011, **Attachmate** bought Novell. In 2014, **Micro Focus** bought Attachmate. In 2017, Micro Focus bought the software part of **Hewlett-Packard Enterprise Company**. In 2020, Micro Focus had 3 billion dollars in sales, 3 billion dollars in profit, and 12,000 employees.

Lotus

Lotus made the most popular spreadsheet program (which was **1-2-3**). For too many years, Lotus sat on its laurels, and customers gradually began to switch to competitors such as Microsoft Excel and Quattro Pro. We expected Lotus to die.

But during the 1990's, Lotus displayed good taste and made wise moves:

It dramatically improved 1-2-3. It bought a company called **Samna**, which made the nicest word-processing program (**Ami Pro**), so Ami Pro became a Lotus product. It began selling **Freelance** (an easy-to-use presentation program) and **Notes** (which helps people send electronic mail to each other and edit each other's documents).

In 1995, IBM bought Lotus, so now Lotus is part of IBM.

Borland

Borland was started by Philippe Kahn, who grew up in France.

To study math, Philippe went to a university in Zurich, Switzerland, where he got curious about computers and decided to take a computer class.

The university offered 2 introductory classes: one explained how to program using a language called **PL/I**, the other explained how to program by using a language called **Pascal** instead. Since Pascal was brand new then, nobody had heard of it, so 200 students signed up for PL/I and just 5 students signed up for Pascal. Philippe signed up for Pascal because he hated big classes. His professor was Pascal's inventor, Niklaus Wirth.

In 1983, Philippe went to California and started a computer company. Since he was an illegal alien, he tried to pretend he was thoroughly American and named his company **Borland**, in honor of the land that produced astronaut Frank Borman. His first product was **Turbo Pascal**, which he'd created back in Europe with the help of two friends.

Most other versions of Pascal were selling for hundreds of dollars. Philippe read a book saying people buy mail-order items on impulse only if priced under $50, so he charged $49.95. The book and Philippe were right: at $49.95, Turbo Pascal became a smashing success.

Later, Philippe improved Turbo Pascal and raised its price to $149.95. He also bought other software publishers and merged them into Borland, so Borland became huge.

Philippe occasionally experimented with dropping prices. For example, he dropped the price of Borland's spreadsheet program, **Quattro Pro**, to just $49.95, even though Quattro Pro was in some ways better than 1-2-3, which Lotus was selling for about $300. Microsoft's head, Bill Gates, said that the competitor worrying him the most was Borland, because he feared Philippe would pull another publicity stunt and drop prices below $50 again, forcing Microsoft to do the same.

During the 1980's, Borland bought 2 companies that invented wonderful database programs: **Reflex** and **Paradox**. Borland eventually stopped selling Reflex, but Paradox lived on longer.

Paradox's main competitor was **dBase**, published by a company called **Ashton-Tate**. Philippe decided to win the competition against Ashton-Tate the easy way: he *bought* Ashton-Tate, so Borland published *both* Paradox and dBase.

Philippe said he bought Ashton-Tate mainly to get his hands on Ashton-Tate's mailing list, so he could sell dBase users on the idea of converting to Paradox.

But Philippe paid too much for Ashton-Tate, whose products, employees, and mailing lists were all becoming stale. Since Ashton-Tate was bigger than Borland, Philippe had to borrow lots of money to buy Ashton-Tate, and he had trouble paying it back. Buying Ashton-Tate was his biggest mistake.

By 1994, he was having trouble competing against Microsoft's rapidly improving products and trouble repaying the money he'd borrowed to finance the takeover of Ashton-Tate. Financially strapped, he sold Novell his crown jewel, Quattro Pro, and gave Novell the right to make a million copies of Paradox.

Novell's founder, Ray Noorda, said candidly he wasn't thrilled by Quattro Pro but wanted to buy it anyway, just as an excuse to give Philippe some money, so Philippe could stay in business and scare Microsoft, so Bill Gates would devote his energy to fighting Philippe instead of fighting Novell.

In 1995, Philippe stepped down from heading Borland.

He spent most of his time running a start-up company called **Starfish Software**, which Motorola bought in 1998 then resold to Nokia, which made cell phones using Starfish Software's patents. Nokia eventually sold its phone business to **Microsoft**.

Borland changed its name to "Inprise", then changed back to "Borland" again, then became part of **Micro Focus**.

Symantec

My favorite database program, **Q&A**, is published by **Symantec**.

Like Lotus, Symantec shows good taste in acquisitions: it bought 2 companies making good versions of the C programming language (**Lightspeed** and **Zortech**) and also bought 2 companies making **DOS utility programs** that fix DOS's weaknesses (**Peter Norton Software** and **Central Point Software**). Now Symantec takes in 3½ billion dollars per year.

Symantec tries hard to improve all those acquired products, but I wish it would improve Q&A instead! I'm sad to see Q&A, the world's best database program, be neglected and fall into obsolescence.

Specialized companies

Oracle and **CA** make software that runs on computers of all sizes: maxicomputers, minicomputers, and microcomputers.

Oracle's software handles databases. Oracle takes in 9 billion dollars per year. Oracle was founded by Larry Ellison, who still runs the company. Since he owns 24% of Oracle's stock, he's a multibillionaire, nearly as rich as Bill Gates, and yes, he's still single!

CA's software handles accounting (such as bill-paying, bill-collecting, inventory, and payroll). CA was founded by a Chinese immigrant on Long Island, New York: Charles Wang (pronounced "wong", not "wang"). Try saying this sentence fast: "wong" is right, "wang" is wrong. In August 2000, Charles Wang retired and turned the company over to another immigrant (Sanjay Kumar, who came from Sri Lanka when he was 14 years old). CA's software is so boring that consumers don't know it exists, but CA is huge, though shrinking: it used to take in 5 billion dollars per year but now takes in just 4½ billion. 25% of CA's stock is owned by a single rich man: Swiss billionaire Walter Haefner.

Intuit makes programs that handle accounting on microcomputers. Intuit's programs are cheap: under $100.

Intuit's most popular accounting programs are **Quicken** (which tracks expenses and balances your checkbook), **QuickBooks** (which handles all major business accounting), and **Turbo Tax** (which helps you fill in your 1040 income-tax form for the IRS). Turbo Tax used to be published by a company called **Chipsoft**, but Intuit bought Chipsoft in 1994.

In 1995, Microsoft tried to buy Intuit — and Intuit agreed — but Microsoft changed its mind when the Justice Department accused Microsoft of becoming too big a monopoly.

Intuit takes in 4 billion dollars per year.

Adobe makes **Postscript** software (used in many laser printers), **Photoshop** (which edits photographs), and **Acrobat** (which does desktop publishing and lets you easily transmit the results by Internet). In 1994, Adobe bought **Aldus** (the company that invented the first desktop-publishing program, **PageMaker**). Adobe takes in 4 billion dollars per year.

Autodesk publishes **AutoCAD**, which is the fanciest program for handling computer-aided design (CAD). Autodesk takes in 2 billion dollars per year.

Electronic Arts (EA) makes excellent educational games and low-cost tools for budding young artists and musicians. It's also the world's biggest producer and distributor of video games for computers and for video-game machines (such as Sony's PlayStation and Microsoft's Xbox). It takes in 4 billion dollars per year.

Buying software

You'll want 4 kinds of software:

an **operating system** (which teaches the CPU how to handle the keyboard, screen, printer, and disks)

a **computer language** (such as Basic)

application programs (such as a word-processing program, a spreadsheet program, and a database program)

data

When shopping for a computer, beware: its advertised price usually does *not* include all 4 kinds of software. Check which software is included.

The typical program has a high **list price**, which is called the **manufacturer's suggested retail price (MSRP)**. But the typical computer store will charge often charge a lower price (the **street price**), and mail-order dealers charge an even lower price, the **mail-order price**. Another way to get a low price is to visit a discount store, such as Best Buy or Staples or Sam's Club, when that item is on sale, or check their Websites.

Version upgrades

If you already own an older version of the program, you can switch to the new version cheaply, by asking for the **version upgrade**, which costs less than the full price. You can order the version upgrade at your local computer store, or from mail-order dealers, or directly from the program's publisher.

To qualify for the version upgrade, you must *prove* that you already own an older version of the program. You can do that in several ways:

If you're ordering directly from the program's publisher, the program's publisher will check its records to verify that you had sent in your registration card for the previous version. If you're ordering at a local computer store, bring in the official instruction manual that came with the old version: the store will rip out the manual's first page (the title page) and mail it to the publisher. If you lost that manual, you can instead give the store Disk 1 of the old version's set of disks. The store needs the *original* title page or disk; copies are not accepted. If you're ordering from a mail-order dealer, send the dealer the title page by mail or fax.

Some manufacturers (such as Microsoft) use a simpler way to qualify you for the version upgrade: when you install the new version, it automatically searches your computer's hard disk for the old version and refuses to run if the old version is missing.

If you bought the old version shortly before the new version came out, you can get the new version free! Just phone the publisher and ask for the **free version upgrade**.

Here's how you prove you bought the old version shortly before the new version came out (where "shortly before" is usually defined as meaning "within 60 days"): mail either your dated sales slip or a "free version-upgrade certificate" that came in the old version's box. Though the upgrade is "free", you must pay for shipping the disks, unless the upgrade is available by downloading from the Internet.

Competitive upgrades

If you don't own an older version of the program, you can't get the version-upgrade price. Here's the best you can do:

If you already own a competing program (such as a different brand of word processor that competes against the word processor you're trying to buy), ask for the **competitive-upgrade price**. It's usually slightly higher than the version-upgrade price. Get it from your local store, mail-order dealer, or directly from the publisher.

Copying software

If you buy a program on disks, you should make backup copies of the disks. Use the backup copies in case the original disks get damaged.

You're *not* allowed to give copies of the disks to your friends. That's against the law! If your friends want to use the program, they must buy it from the software publisher or a dealer, so the programmer receives royalties.

If you give copies to your friends and become a lawbreaker, you're called a **pirate**; making the copies is called **piracy**; the copies are called **pirated software** or **hot software**. Don't be a pirate! Don't distribute hot software!

Some software publishers use tricks that make the computer refuse to copy the program. Those tricks are called **copy protection**; the software is **copy protected**. But even if the software publisher doesn't use such tricks, it's still against the law to make copies of the program for other people, since the program is still copy*righted*.

If your friends want to try a program before buying it, don't give them a copy of the program! Instead, tell your friends to visit you and use the program while they sit at your computer. That's legal, and it also lets you help your friends figure out how to use the software.

If you buy a version upgrade, you're *not* allowed to give the older version to a friend to use on a different computer. You must destroy the older version — or keep it just for emergencies, in case the newer version stops working.

Trial versions

Besides sitting at a friend's computer, another way to "try before you buy" is to phone the program's publisher and ask for a free **demo disk**.

Although some demo disks are just useless animated ads, the best publishers provide useful demo disks (called **trial-size versions**) that closely imitate the full versions. For example, the typical trial-size version of a word-processing program has nearly all the features of the full version but refuses to print memos that are more than a page long and refuses to copy your writing onto a disk. Trial-size versions are nicknamed **crippled software**, because each trial-size version has one or two abilities cut off. Playing with crippled software is a great way to give yourself a free education!

Another type of **trial version** is the **limited-time version**, which is free for the first month or two then requires you to pay if you want to continue using it afterwards.

Freeware

Software you're allowed to copy and use freely is called **freeware**. For example, most demo disks and trial-size versions are freeware.

Most software invented by schools, government agencies, and computer clubs is freeware. Ask!

Shareware

Shareware is software that comes with a plea: although the author lets you copy the software and try it, you're encouraged to mail the author a contribution if you like what you tried.

The suggested contribution, typically $25, is called a **registration fee**. It makes you a **registered user** and puts you on the author's mailing list, so the author can mail you a printed manual and newer versions of the software.

Though most shareware authors merely "ask" for contributions, other shareware authors "demand" that you send a contribution if you use the software for longer than a month. Software for which a contribution is "demanded" is called **guiltware** — because if you don't send the contribution, the author says you're guilty of breaking the law.

To get shareware, copy it from a friend or download it from the Internet.

Beta versions

After inventing a program, its publisher must **test** it, to make sure it works on many kinds of computer equipment and in many situations. At first, the publisher's employees test the program on their own computers: that's called **alpha testing**. Next, the publishing company lets *outsiders* try the still-not-quite-perfected program: that's called **beta testing**.

The outsiders who try it are called **beta testers**; the version being tested by outsiders is called a **beta version**. Beta versions are sometimes distributed for free or at a reduced price; but if you use a beta version, don't rely on it, since it hasn't been perfected yet; and it might be programmed to automatically stop working when the final version is invented.

Special deals

If your office wants many employees to use a program, ask the publisher for a **site license**, which permits your company to make copies for all employees in the office. Typically the employees are *not* allowed to take the copies home: the copies must all be used at the same site.

If you're in a school and trying to teach kids how to use a program, ask the publisher for a trial-size version or **academic version** or **educational site license**.

If you own 2 computers and want to put the same program on both, you must typically buy 2 copies of the program. For example, if you want to put Windows on 2 computers, you must buy 2 copies of Windows (to avoid piracy), unless both computers are on the same site and you have a site license. Microsoft and some other major software publishers permit this exception, called the **portable-computer rule**:

If you're sitting at a computer, and you're the main person who uses that computer (so no other human uses it more than you), you're allowed to copy application programs from that computer to a portable computer (so you can work while you're traveling and take your work from office to home and to client sites); but just *you* are allowed to run that program on your portable computer (not other colleagues, not other family members, not friends). This rule lets you copy just application programs (such as Microsoft Word), not operating systems (such as Windows), not programming languages (such as C). Moreover, the application programs must have been purchased normally (not site-licensed).

Complete systems

Let's see how to put all the pieces together and create a complete system.

IBM's early computers

During the 1950's, 1960's, and most of the 1970's, IBM's computers were all big. IBM ignored the whole concept of microcomputers for many years.

Eventually, IBM created microcomputers. But IBM's first microcomputers, the IBM 5100 and IBM System 23, weren't taken seriously — not even by IBM.

The IBM PC

When many IBM customers began switching to Apple 2 microcomputers to handle spreadsheets, IBM got alarmed, so IBM decided to develop an improved microcomputer, called the **IBM Personal Computer (IBM PC)**, which would be more powerful than Apple 2 computers.

To invent the IBM PC, IBM created 3 secret research teams who competed against each other. The winner was the research team headed by Philip "Don" Estridge in Boca Raton, Florida. His team examined everything created by the other microcomputer companies (Apple, Radio Shack, Commodore, etc.) and combined their best ideas, to produce a relatively low-cost computer better than all competitors.

Don's team developed the IBM PC secretly. IBM didn't announce it to the public until August 12, 1981.

The IBM PC was a smashing success: IBM quickly became the #1 microcomputer company — and Apple dropped to #2.

Improved versions

After inventing the IBM PC, IBM invented improved versions:

Month	Computer's long name	Short name	Nickname	Main new feature
1981 August	IBM Personal Computer	IBM PC	**PC**	many!
1983 March	IBM PC eXTended	IBM PC XT	**XT**	hard drive (instead of just floppy)
1984 August	IBM PC AdvancedTechnology	IBM PC AT	**AT**	faster CPU (286 instead of 8088)
1987 April	IBM Personal System 2	IBM PS/2	**PS/2**	better color video

After 1987, IBM invented many other improved versions.

While IBM was inventing improvements, IBM's competitors invented imitations called **clones**, which were often better than IBM's originals. Here's how they all compared.…

Hard drive

The **PC** didn't have a hard drive. Here's what happened afterwards:

The **XT** included a 10M hard drive.
The **AT** included a 20M hard drive. AT clones typically included a 40M hard drive.
Modern computers include hard drives that hold 12,500 times as much: 500G or even more!

RAM

RAM has grown:

The **PC** typically came with 64K, 128K, or 256K of RAM.
The **XT** typically came with 256K, 512K, or 640K of RAM.
The **AT** typically came with 512K, 1M, or 2M of RAM.
The **PS/2** typically came with 1M, 2M, or 4M of RAM.
Modern computers come with 1,000 times as much RAM: 4G or even more!

CPU

The **PC** and **XT** each contained an Intel 8088 CPU chip at 4.77MHz. Most XT clones ran twice as fast (and thus called **turbo** XT clones) because they contained an 8088-1 chip at 10MHz.

The **AT** contained an Intel 286 chip (which works more efficiently than an 8088) at 6MHz. In 1986, IBM switched to 8MHz. AT clones ran at 12MHz.

The **PS/2** came in many models: depending on how wealthy you were, you could choose an 8086 chip at 8MHz, a 286 chip at 10MHz, a 386SX chip at 16MHz, a 386DX chip at 16, 20, or 25 MHz, or several 486 models.

Modern computers contain an Intel Pentium chip or AMD Athlon chip. They run at about 2800MHz (which is 2.8GHz).

Keyboard

The **PC**'s keyboard contained 83 keys:

26 keys contained the letters of the alphabet.

10 keys (in the top row) contained the digits.

10 keys (on the keyboard's right side) contained the digits rearranged to imitate a calculator.

13 keys contained symbols for punctuation & math.

14 keys gave you control. They let you edit your mistakes, create blank spaces and capitals, etc.

10 function keys (labeled F1 through F10) could be programmed to mean whatever you wished!

The keyboard was designed by Don Estridge personally. To fit all those keys on the small keyboard, he had to make the Enter and Shift keys smaller than typists liked.

Above the top row of keys, he put a shelf to hold pencils. To make room for that shelf, he put the 10 function keys at the left side of the keyboard, even though it would have been more natural to put the F1 key near the 1 key, the F2 key near the 2 key, etc.

The **XT**'s keyboard was the same, but XT clones rearranged the keys to make the Enter and Shift keys bigger.

The **AT**'s keyboard made the Enter and Shift keys bigger and included 1 extra key (making a total of 84 keys). In January 1986, IBM began selling a bigger AT keyboard that included 101 keys and put the function keys in the top row (near the pencil ledge) instead of at the left.

Modern computers include 3 extra keys to handle modern Windows (making a total of 104 keys) and often include even more keys, to handle the Internet!

Removable disks

For the **PC**, IBM used 5¼-inch floppy disks holding just 160K. Then IBM switched to 180K, then 360K. The **XT** used 360K disks also. The AT used **1.2M** disks. All those disks were 5¼-inch.

The **PS/2** used 3½-inch disks instead, because they were sturdier, more reliable, easier to carry, and permitted the drive & computer to be smaller. Those 3½-inch disks typically held 1.44M. (Exceptions: the cheapest PS/2 models handled just 720K; some experimental models could handle 2.88M.)

Modern computers use CD and DVD disks instead of floppy disks.

Video

The PC's base price didn't include a monitor — or even a video card to attach the monitor to.

Color versus monochrome When IBM announced the **PC**, it announced two kinds of video cards. One kind attached to a color monitor and was called the **Color Graphics Adapter (CGA)**. The other kind attached to a monochrome monitor and was called the **Monochrome Display Adapter (MDA)**.

Which was better: CGA or MDA?

CGA had 2 advantages: it could handle **colors** and **graphics**.
MDA had 2 advantages: it could produce **prettier characters** (though no graphics) and could **underline**.

CGA could handle these display modes:

a graphic showing 4 colors, at a resolution of 320×200 a graphic in black-and-white, at a resolution of 640×200 characters (each an 8×8 matrix, 80 characters per line, 25 lines per screen, 1 of 16 colors per character)

MDA could handle this display mode:

characters (each a 9×14 matrix, 80 characters per line, 25 lines per screen, 1 of 4 styles per character)

Hercules A company called **Hercules** invented the **Hercules graphics card**, which resembled the MDA but could also display black-and-white graphics on the monochrome monitor. Several companies made video cards imitating the Hercules card; those imitations were called **Hercules-compatible graphics cards**.

Hercules could handle these display modes:

a graphic in black-and-white, at a resolution of 720×350 characters (each a 9×14 matrix, 80 characters per line, 25 lines per screen, one of 4 styles per character)

EGA In September 1984, IBM invented the **Enhanced Graphics Adapter (EGA)** and an **EGA monitor** to go with it. That combination was better than CGA: it produced more colors and higher resolution. It could handle these display modes:

a graphic showing 16 colors, at a resolution of 640×350 characters (each an 8×14 matrix, 80 characters per line, 25 lines per screen, one of 16 colors per character)

Unfortunately, it was too expensive for most folks.

VGA The **PS/2** came with an even better color monitor, called a **Video Graphics Array color monitor (VGA color monitor)**, and a VGA chip on the motherboard to go with it. That combination produced even more colors and even higher resolution. It could produce many thousands of colors (262,144 colors!), though you could display just 256 of them simultaneously. IBM figured out a way to make the VGA chip cheaply, so it became popular. It could handle these display modes:

a graphic showing 16 colors, at a resolution of 640×480 a graphic showing 256 colors, at a resolution of 320×200 characters (each a 9×16 matrix, 80 characters per line, 25 lines per screen, one of 16 colors per character) characters (each an 8×16 matrix, 80 characters per line, 30 lines per screen, one of 16 colors per character)

VGA downgrades For folks too poor to afford the VGA chip, IBM invented an cheaper good chip, called the **Multi-Color Graphics Array chip (MCGA chip)**, which produced fewer simultaneous high-resolution colors. It could handle these display modes:

a graphic in black-and-white, at a resolution of 640×480 a graphic showing 256 colors, at a resolution of 320×200 characters (each an 8×16 matrix, 80 characters per line, 25 lines per screen, one of 16 colors per character)

For folks who couldn't afford a VGA color monitor, IBM invented a cheaper VGA monitor, which displayed shades of gray instead of colors.

VGA upgrades **Modern computers** come with better VGA monitors and chips, producing a resolution of 1024×768 or even higher.

Power supply

Inside the system unit, the **PC** contained a power supply, which transformed AC current to DC and could produce 63½ watts of power. It also contained a fan that acted as a farting ass: it sucked hot air from inside the computer and blew it out the computer's backside.

The **XT** contained a stronger power supply that could produce 135 watts, to help it handle the hard drive.

The **AT** contained an even stronger power supply: 192 watts. AT clones contained an even stronger power supply: 200 watts.

Modern computers use modern circuitry, which is more energy-efficient and doesn't require so much power. Some modern computers get by with just 135 watts. Tall towers containing extra circuitry sometimes contain bigger power supplies: 200 or 300 watts.

In modern computers, the power supply does *not* act as a farting ass. Instead, it pushes the air in the opposite direction. It sucks in air from outside the computer, so it acts as a nose: it breathes in fresh air.

Don't put your new computer back-to-back with an old computer. If you do, the new computer will breathe in the old computer's hot farts!

Bus

A computer's motherboard contains slots, to hold printed-circuit cards.

8-bit PC bus The **PC**'s motherboard contained 5 slots, to hold printed-circuit cards. The motherboard's 62 wires running to and through the slots were called the **bus**. Since it was in the PC, it was called the **PC bus**.

Of the 62 wires, just 8 carried data. The other 54 wires were "bureaucratic overhead" that helped control the flow.

Since just 8 wires carried data, the bus was called an **8-bit data bus**, its slots were called **8-bit slots**, and the printed-circuit cards you put into the slots were called **8-bit cards**.

The **XT**'s motherboard used the same PC bus but included 8 slots instead of 5.

16-bit AT bus The **AT**'s motherboard used a wider bus: 98 wires instead of 62. Of the 98 wires, just 16 carried data, so the bus was called a **16-bit data bus**. It was called the **AT bus**. That 98-wire technique was called the **Industry Standard Architecture** (**ISA**, pronounced "eye suh"). The bus was therefore also called the **ISA bus**, its slots were called **ISA slots**, and the printed-circuit cards you put into the slots were called **ISA cards**.

32-bit bus Later computers used an even wider bus: a **32-bit data bus**!

If you had a **PS/2** computer based on a 386 or 486 chip, it used a 32-bit bus called the **Micro Channel**. That technique was called **Micro Channel Architecture (MCA)**. Into its slots, you put **MCA cards**.

If you had a **clone** containing a 386 or 486, and the clone was fancy, it used a 32-bit bus technique called **Extended ISA** (**EISA**, pronounced "ee suh"). Its bus was called the **EISA bus**; into its slots, you put **EISA cards**.

If your computer is **modern** (containing a Pentium or Athlon or Sempron or Duron or K6), it uses a 32-bit bus technique called **Peripheral Component Interconnect (PCI)**. Its bus is called the **PCI bus**; into its slots, you put **PCI cards**. The nice thing about PCI cards is that the computer can automatically figure out what each card's purpose is, so you can just plug the card into the slot and start using the card immediately: that feature is called **plug & play**, though sometimes it works imperfectly (which is why cynics call it **plug & pray**).

1-bit USB bus If your computer is very **modern**, it contains a 32-bit PCI bus but also contains a second bus, called the **Universal Serial Bus (USB)**, which is a 1-bit bus that's slow but has 3 nice properties: all USB devices are **plug-&-play**, **external** (so you can install them without opening the system unit's case), and **hot-swappable** (so you can insert, remove, or swap the devices safely even while the power is still on). The typical modern computer has 1, 2, 3, or 4 USB slots, which are on the system unit's back wall and called **USB ports**.

Multimedia

The **PC**'s price included no mouse, no microphone, no modem, no speakers (except for a tiny internal speaker that just beeped), and no CD or DVD drive, because all those devices were too expensive then. The **XT**, **AT**, and **PS/2** had the same disappointments.

Modern computers come with a mouse, a microphone, a modem, stereo speakers (2 of them or 3 or 5!), and a DVD drive.

Search for perfection

I'd like to tell you about a company that makes reliable, powerful computers, charges you very little, and is a pleasure to call if you ever need technical help.

That's what I'd *like* to tell you, but I haven't found such a company yet! If you find one, let me know!

Each month, I falsely think I've finally found my hero company. I give its name to folks like you who call me for advice. But my hoped-for hero eventually gets accused by my customers of degenerating into despicable behavior. How depressing! I've been writing this book for about 50 years and have yet to find a company I still feel proud about. I'm disgusted.

Hero companies rise but then fall because they suffer through this business cycle:

When the company begins, it's new and unknown, so it tries hard to get attention by offering low prices. It also tries to help its customers by offering good service.

When news spreads about how the company offers low prices and good service, the company gets deluged with more customers than it can handle — and it's also stuck answering phone calls from old customers who still need help but aren't buying anything new.

To eliminate the overload, the company must either accept fewer customers (by raising prices — or lowering them slower than the rest of the industry), or offer less service per customer (by refusing to hire enough good staff to handle all the questions). In either case, the company becomes less pleasant. Its heroism is relegated to history, and the company becomes just one more inconsequential player in the vast scheme of computer life.

What's in store for you

This chapter portrays the players.

Warning: these portraits are anatomically correct — they show some companies are pricks.

The computer industry's a soap opera in which consumers face new personal horrors daily. I wrote this in September 2016, but you can get the newest breathtaking episode of the computer industry's drama, *How the Screw-You Turns*, by phoning me anytime. I'll tell you the newest dirt about wannabe and were-to-be hero companies. So before buying a computer, **phone me at 603-666-6644** to get my new advice free. Tell me your needs, and I'll try to recommend the best vendor for *you*. Before phoning me, become a knowledgeable consumer by reading this chapter.

Best Buy, Staples, and competitors

To get the lowest prices for decent computers, buy from **Best Buy**, **Staples**, **Walmart**, **Sam's Club**, **Target**, or the **online Microsoft Store**.

Here's what they charged when this section was written in February & March 2022. Every Sunday, prices change and usually drop, so you'll probably pay less!

Laptop computers

Here's what those outlets charged for laptop computers with Windows 11:

Type	Screen size	RAM	Drive	CPU	Price
Minimal	14" 1366×768	4G	flash drive 64G	Intel Celeron	$190
Standard	15.6" 1366×768	8G	flash drive 256G	Intel Core i3	$350
Luxury	15.6" 1920×1080 touch	16G	flash drive 512G	Intel Core i7	$780

Here are examples of that pricing:

Maker	Screen size	RAM	Drive	CPU	Price
HP	14" 1366×768	4G	flash drive 64G	Intel Celeron	$190 at Best Buy
Asus	14" 1600×768	4G	flash drive 128G	Intel Celeron	$200 at Best Buy
Lenovo	15.6" 1920×1080	4G	flash drive 256G	Intel Gold	$300 at Staples
Lenovo	15.6" 1366×768	8G	flash drive 256G	Intel Core i3	$350 at Best Buy
HP	15.6" 1366×768 touch	8G	flash drive 256G	AMD Ryzen 3	$400 at Best Buy
Gateway	15.6" 1920×1080	8G	flash drive 512G	AMD Ryzen 7	$499 at Walmart
Asus	15.6" 1920×1080	8G	flash 256G + hard 1T	Intel Core i7	$700 at Best Buy
HP	15.6" 1920×1080 touch	16G	flash drive 512G	Intel Core i7	$780 at Best Buy

All-in-one computers

Here's what those outlets charged for all-in-one computers with Windows 11:

Type	Screen size	RAM	Drive	CPU	Price
Minimal	21.5" 1920×1080	4G	flash drive 128G	Intel Celeron	$380
Standard	23.8" 1920×1080 touch	8G	flash drive 256G	AMD Ryzen 3	$600
Luxury	27" 1920×1080 touch	16G	flash drive 1T	Intel Core i7	$1400

Here are examples of that pricing:

Maker	Screen size	RAM	Drive	CPU	Price
HP	21.5" 1920×1080	4G	flash drive 128G	Intel Celeron	$380 at Best Buy
HP	21.5" 1920×1080 touch	8G	hard drive 1T	AMD Ryzen 3	$499 at Walmart
HP	23.8" 1920×1080 touch	8G	flash drive 256G	AMD Ryzen 3	$600 at Best Buy
HP	27" 1920×1080	8G	flash drive 512G	AMD Ryzen 5	$709 at Walmart
Lenovo	27" 1920×1080 touch	8G	flash drive 256G	Intel Core i5	$749 at Walmart
HP	23.8" 1920×1080 touch	12G	flash drive 1T	AMD Ryzen 7	$1020 at Best Buy
Dell	27" 1920×1080 touch	16G	flash drive 512G	Intel Core i7	$1300 at Best Buy
HP	27" 1920×1080 touch	16G	flash drive 1T	Intel Core i7	$1400 at Best Buy

Tablet computers

Here's the cost of tablet computers (having touchscreens):

Type	System	Screen size	RAM	Flash	CPU	Price
Minimal	Android 11	7" 1024×600	2G	16G	2 GHz quad-core	$59
Standard	iPadOS 15	10.2" 2160×1620	3G	64G	A13	$329
Luxury	Windows 11	13" 2880×1920	16G	1T	Core i7	$2000

Here are examples of that pricing.
Walmart sells these by "Onn" (which is Walmart's own brand):

Model	System	Screen size	RAM	Flash	CPU	Price
100026191	Android 11	7"	2G	16G	2 GHz quad-core	$59
100003561	Android 10	8"	2G	32G	2 GHz octa-core	$79
100011886	Android 11	10.1"	2G	32G	2 GHz quad-core	$98
100043279	Android 10	10.1"	3G	32G	2 GHz octa-core	$147
100043279	Android 11	11.6"	4G	64G	2 GHz octa-core	$199

Amazon makes these:

Model	System	Screen size	RAM	Flash	CPU	Price
Fire 7	Fire OS	7" 1024×600	1G	16G	1.3GHz quad-core	$50
Fire 7	Fire OS	7" 1024×600	1G	32G	1.3GHz quad-core	$70
Fire HD 8	Fire OS	8" 1280×800	2G	32G	2 GHz quad-core	$90
Fire HD 8 Plus	Fire OS	8" 1280×800	3G	32G	2 GHz quad-core	$110
Fire HD 10	Fire OS	10.1" 1920×1200	3G	32G	2 GHz quad-core	$150
Fire HD 10	Fire OS	10.1" 1920×1200	3G	64G	2 GHz quad-core	$190

Best Buy sells these by Samsung:

Model	System	Screen size	RAM	Flash	CPU	Price
Galaxy Tab A7 Lite	Android 11	8.7" 1340×800	3G	32G	MediaTek MT8768T	$160
Galaxy Tab A8	Android 11	10.5" 1920×1200	3G	32G	Unisoc T618	$230
Galaxy Tab A8	Android 11	10.5" 1920×1200	4G	64G	Unisoc T618	$280
Galaxy Tab A8	Android 11	10.5" 1920×1200	4G	128G	Unisoc T618	$330

Apple makes these:

Model	System	Screen size	RAM	Flash	CPU	Price
iPad	iPadOS 15	10.2" 2160×1620	3G	64G	A13	$329
iPad	iPadOS 15	10.2" 2160×1620	3G	256G	A13	$479
iPad Air	iPadOS 15	10.9" 2360×1640	3G	64G	A14	$599
iPad Air	iPadOS 15	10.9" 2360×1640	3G	256G	A14	$749
iPad Pro	iPadOS 15	11" 2388×1668	6G	128G	M1	$799
iPad Pro	iPadOS 15	12.9" 2732×2048	6G	128G	M1	$1099
iPad Pro	iPadOS 15	12.9" 2732×2048	6G	256G	M1	$1199
iPad Pro	iPadOS 15	12.9" 2732×2048	6G	512G	M1	$1399
iPad Pro	iPadOS 15	12.9" 2732×2048	6G	1T	M1	$1799
iPad Pro	iPadOS 15	12.9" 2732×2048	6G	2T	M1	$2199

Microsoft makes these:

Model	System	Screen size	RAM	Flash	CPU	Price
Surface Go 3	Windows 11	10.5" 1920×1280	4G	64G	Pentium Gold	$400
Surface Go 3	Windows 11	10.5" 1920×1280	8G	128G	Pentium Gold	$500
Surface Go 3	Windows 11	10.5" 1920×1280	8G	128G	Core i3	$580
Surface Pro 8	Windows 11	13" 2880×1920	8G	128G	Core i5	$860
Surface Pro 8	Windows 11	13" 2880×1920	8G	256G	Core i5	$1000
Surface Pro 8	Windows 11	13" 2880×1920	16G	256G	Core i5	$1300
Surface Pro 8	Windows 11	13" 2880×1920	16G	256G	Core i7	$1400
Surface Pro 8	Windows 11	13" 2880×1920	16G	512G	Core i7	$1750
Surface Pro 8	Windows 11	13" 2880×1920	16G	1T	Core i7	$2000

Smartphones

Here's what Verizon Wireless charged for smartphones (having touchscreens):

Type	Screen size	Flash memory	Rear camera	Price
Minimal	6.5"	32G	5 megapixels	$150
Standard	6.5"	128G	48 megapixels	$400
Luxury	6.8"	512G	108 megapixels	$1300

Here are examples of that pricing:

Maker	Model name	System	Screen	Flash	Rear camera	CPU	Price
Motorola	moto g pure	Android 11	6.5"	32G	5 megapixels	Helio G25	$150
Motorola	moto g power 2021	Android 10	6.6"	64G	48 megapixels	Snapdrag 662	$250
Motorola	one 5G UW ace	Android 11	6.7"	64G	48 megapixels	Snapdrag 750	$300
Motorola	edge 5G UW	Android 11	6.8"	128G	108 megapixels	Snapdrag 778	$550
Motorola	edge 5G UW	Android 11	6.8"	256G	108 megapixels	Snapdrag 778	$600
Samsung	Galaxy A02s	Android 10	6.5"	32G	5 megapixels	Snapdrag. 450	$150
Samsung	Galaxy A03s	Android 11	6.5"	32G	5 megapixels	Helio P35	$160
Samsung	Galaxy A42 5G	Android 11	6.5"	128G	48 megapixels	Snapdrag. 750	$400
Samsung	Galaxy S22	Android 12	6.1"	256G	50 megapixels	Snapdragon 8	$800
Samsung	Galaxy S22+	Android 12	6.6"	256G	50 megapixels	Snapdragon 8	$1000
Samsung	Galaxy S22 Ultra	Android 12	6.8"	256G	108 megapixels	Snapdragon 8	$1200
Samsung	Galaxy S22 Ultra	Android 12	6.8"	512G	108 megapixels	Snapdragon 8	$1300
Apple	iPhone SE 3rd Gen	iOS 15	4.7"	64G	12 megapixels	Apple A15	$430
Apple	iPhone SE 3rd Gen	iOS 15	4.7"	128G	12 megapixels	Apple A15	$480
Apple	iPhone 12	iOS 14	6.1"	128G	12 megapixels	Apple A14	$750
Apple	iPhone 13	iOS 15	6.1"	128G	12 megapixels	Apple A15	$800
Apple	iPhone 13 Pro Max	iOS 15	6.7"	128G	12 megapixels	Apple A15	$1100
Apple	iPhone 13 Pro Max	iOS 15	6.7"	256G	12 megapixels	Apple A15	$1200
Apple	iPhone 13 Pro Max	iOS 15	6.7"	512G	12 megapixels	Apple A15	$1400
Apple	iPhone 13 Pro Max	iOS 15	6.7"	1T	12 megapixels	Apple A15	$1600

Service Besides paying for the phone, you must also pay for service.

In the U.S., these 3 big companies run **phone networks**, which send out phone signals from cellphone towers:

Verizon (which is also called **Verizon Wireless**)
AT&T (which stands for **American Telephone & Telegraph**)
T-Mobile (which is partly owned by German company **Deutsche Telekom** and recently bought **Sprint**)

T-Mobile usually charges less than Verizon and AT&T.

Instead of paying one of those companies directly, you can pay a smaller company, called a **mobile virtual-network operator (MVNO)**, which charges you even less than T-Mobile and uses the phone signals from the big 3. The most interesting MVNO is **Mint Mobile**, which advertises just $15 per month (if you prepay $45 to cover the first 3 months, then pay $180 to cover the next 12 months).

But all those **phone carriers** (the big 3 and the MVNOs) give you many choices, difficulties, confusions, and misleading ads:

You might have to add extra each month to cover federal & state **taxes**.
You might have to add extra each month to cover fake taxes (which the carriers call "**fees**").
You might have to pay an **activation fee** (such as $30 or $35) to set up your phone use the service.
Pay a surcharge ($5 or $10 per month) if you insist on paper bills instead of **automatic payments**.
If you use **too many gigabytes** of data during the month, the carrier might slow you or cut you off.
The carrier might be **incompatible** with a phone you bought from a different carrier.
The advertised price might apply just if you get a **quantity discount**, by hooking up 2, 3, 4, or 5 phones.

The carrier might give you a discount if you're switching from a competitor.
The carrier might give you a **senior discount** if your age is at least 55.
The carrier might give you a discount if you buy during a holiday sale (such as black Friday).
The carrier might sell you a **phone at a discount** (such as $800 off).

Details:

The average person uses 4 gigabytes per month. If you use more gigabytes than you paid for, you must pay a penalty (for "overage") or suffer reduced speed. Gigabytes transferred by WiFi instead of by cellphone towers are free (since you're not using the towers).

If you haven't paid for the phone itself yet, you must also pay a monthly installment (typically 1/24th of the phone's cost, for 24 months).

Stores who call themselves a "Verizon store" or "AT&T store" or "T-Mobile store" might secretly be owned independently and offer worse prices and tech support.

HP

Hewlett-Packard (HP) and **Compaq** were 2 separate companies, but in 2002 HP bought Compaq.

How HP arose

Hewlett-Packard (HP) was started by two young Stanford University graduates — Bill Hewlett and Dave Packard —in 1938, in a garage in Palo Alto, California, where they built their first product: an audio oscillator (electronic test instrument used by sound engineers), which they sold to several customers, including Walt Disney, who used 8 of them to test the sound in movie theaters showing the movie *Fantasia*.

Those boys weren't sure whether to call the company "Hewlett-Packard" or "Packard-Hewlett", so they flipped a coin. Hewlett won. They formalized the partnership on January 1, 1939.

The company grew:

Year	Revenue	Employees
1939	$5,369	2
1940	$34,396	3
1941	$106,459	6
1942	$522,803	8
1943	$953,294	45

During World War 2, HP sold the U.S. Navy devices that generated microwaves and jammed radar. Later, HP made other lab equipment, medical equipment, plotters, printers, minicomputers, and pocket calculators but was scared to enter the field of personal computers. HP developed a reputation for making equipment that was high-quality and pricey.

How Compaq arose

The *first* company that made *high-quality* IBM clones was **Compaq**. Compaq began selling them back in 1983. (Before Compaq, the only IBM clones available were crummy.)

Compaq began in a restaurant. While eating at a House of Pies restaurant, two engineers drew on the paper placemat their picture of how the ideal IBM clone would look. Instead of being a desktop computer, it would be a luggable having a 9-inch built-in screen and a handle, the whole computer system being small enough so you could pick it up with one hand. Then they built it! Since it was compact, they called it the **Compaq Portable Computer** and called the company **Compaq Computer Corporation**.

They began selling it in 1983, helped by venture-capital funding from Ben Rosen. They charged about the same for it as IBM charged for the IBM PC.

They sold it just to dealers approved by IBM to sell the IBM PC. That way, they dealt just with dealers IBM said were reliable — and they competed directly against IBM in the same stores.

They succeeded fantastically. That first year, sales totaled 100 million dollars.

In 1984, they added a hard drive into the computer and called that souped-up luggable the **Compaq Plus**. They also built a desktop computer called the **Deskpro**. Like Compaq's portable computers, the Deskpro was priced about the same as IBM's computers, was sold just through IBM dealers, and was built well — a marvel of engineering, better than IBM's.

Later, Compaq expanded: it built IBM clones in all sizes, from gigantic towers down to tiny handheld computers. Compaq computers got the highest praise — and ridiculously high prices.

On many technological issues, Compaq was the first company to innovate. For example, when Intel invented the 386 chip, the first company to use it was Compaq, not IBM.

How Compaq cheapened

Compaq was founded by Rod Canion. Under his leadership, Compaq developed a reputation for high quality and high prices. Engineers said Compaq's computers were **overdesigned** (built more sturdily than necessary for average use and therefore too expensive).

Worried about Compaq's high prices, some Compaq employees went on a secret mission, without telling Rod: they sneaked into a computer show, pretended they weren't from Compaq, pretended they were starting a new computer company, and tried to buy computer parts from Compaq's suppliers. Compaq's suppliers offered them lower prices than the suppliers were offering Compaq — because Compaq had developed a reputation as an overly fussy company to do business with.

The secret missionaries went back to Compaq and reported their findings to the board of directors, who were becoming upset at Compaq's astronomically high prices; so in 1991 the board fired Rod and replaced him with a cost cutter, Eckhard Pfeiffer (from Germany). So Pfeiffer became the new CEO. He lowered Compaq's prices, gave up the idea that Compaq should have super-high quality, and began selling through a greater variety of dealers and through mail-order.

His low-price wide-distribution strategy worked well. More people bought Compaq computers. Sales zoomed, though Compaq's "quality reputation" declined. To compete against a company called "Packard Bell" (which sold junky computers cheaply through department stores), Compaq imitated Packard Bell: Compaq lowered its prices and its service.

In February 1995, Compaq started this nasty new service policy:

> If you phoned Compaq for help, Compaq's staff asked for your credit-card number first, then listened to your question. Unless your difficulties were caused by a mistake made by Compaq Corporation, you were charged $35 per question.

Eventually, Compaq dropped that nasty policy: tech-support calls became free during the "initial period" (1 year on hardware questions, 3 months on software questions, longer if your Compaq was expensive).

HP Pavilion

In 1995, HP began manufacturing an IBM clone called the **Pavilion**, sold through local computer stores, electronics stores, office-supply stores, and department stores. Here's why the Pavilion became popular:

> HP's Pavilion cost less than Compaq's desktop computers.
> HP's service was slightly better than Compaq's.

Compaq's reaction

Compaq started having financial difficulties, for 2 reasons:

> Compaq's CEO, Eckhard Pfeiffer, made Compaq buy Digital Equipment Corporation.
>
> Compaq was having trouble competing against IBM clones priced under $700 (from companies such as HP and Packard Bell).

So in 1998, Compaq's board of directors fired Eckard.

In 1999, the board finally decided to make Compaq's next CEO be Michael Capellas, a low-key friendly computer technician that everybody liked. Most important, he was liked by Ben Rosen (the venture capitalist who funded the Compaq's founder and was still chairman of the board).

Michael created computers that were low-cost but exciting. By the year 2000, **Compaq was selling more computers than any other manufacturer**. Yes, it was selling more computers than IBM, Gateway, HP, Dell, and the rest of the gang.

Merger

The Compaq-versus-HP debate ended in 2002, when HP bought Compaq, with approval from Michael Capellas and Ben Rosen. The combo was called a "merger". The combined company is called "Hewlett-Packard", though Compaq lovers prefer to call it "Hewlett-paq" or "Hewpaq".

Michael Capellas became the assistant to HP's CEO and got the title "President", but a few months after the merger he quit HP and took on a new challenge: he became the new head of WorldCom, which had gone through a scandal. WorldCom picked him because it wanted to be led by somebody who's reputable!

Split

In 2015, Hewlett-Packard split into 2 companies:

> **HP Incorporated** is the famous part: it sells normal computers & printers, to consumers & businesses.
>
> **Hewlett-Packard Enterprise Company** sells stuff just for huge businesses (enterprises): servers, storage devices, and business software.

In the rest of this book, when I say "HP" or "Hewlett-Packard," I mean "HP Incorporated."

Recommendation

I recommend computers by HP. That's the brand I prefer, because less goes wrong with HP computers that with computers by Toshiba, Dell, Acer, and other companies.

HP tests its computers more before selling them, includes less weird junk in them, and sells them at low prices. HP's keyboards have better layouts, and HP's built-in speakers produce better sounds.

Dell

Though Compaq was the first company to make good IBM clones, its clones were expensive. The first company that sold fast IBM clones *cheaply* was **PC's Limited**, founded in 1984 by a 19-year-old kid, Michael Dell. He operated out of the bedroom of his condo apartment, near the University of Texas in Austin.

At first, his prices were low — and so were his quality & service.

Many of the computers he shipped didn't work: they were **dead on arrival (DOA)**. When his customers tried to return the defective computer equipment to him for repair or refund, his company ignored the customer altogether. By 1986, many upset customers considered him a con artist and wrote bitter letters about him to computer magazines. He responded by saying that his multi-million-dollar company was growing faster than expected and couldn't keep up with demand for after-sale service.

In 1987, Dell raised his quality and service — and prices. In 1988, he changed the company's name to **Dell Computer Corporation**.

He charged almost as much as IBM and Compaq.

His quality & service became top-notch. They set the standard for the rest of the computer industry. In speed & quality contests, his computers often beat IBM and Compaq.

In 1997, Dell officially became the top dog in the computer-quality wars: according to *PC World* magazine's surveys of its readers, Dell's computers were more reliable than any other brand, and Dell's tech-support staff did the best job of fixing problems promptly.

Dell's ads bashed Compaq for having higher prices than Dell and worse policies about getting repairs — since Dell offered on-site service and Compaq didn't.

For example, in 1991 Dell ran an ad calling Dell's notebook computer a "road warrior" and Compaq's a "road worrier". It showed the Dell screen saying, "With next day on-site service in 50 states, nothing's going to stop you." It showed the Compaq screen saying, "Just pray you don't need any service while you're on the road, or you're dead meat."

His ads were misleading. His prices were much lower than Compaq's *list* price but just *slightly* less than the discounted price at which Compaq computers were usually sold. Though Compaq didn't provide free on-site service, you could sometimes get your Compaq repaired fast by driving to a nearby Compaq dealer.

Dell tried selling through discount-store chains but gave up and decided to return to selling just by mail. While HP/Compaq stayed king of retail sales, Dell became king of mail-order sales.

Dell computers came with this guarantee: if Dell doesn't answer your tech-support call within 5 minutes, Dell will give you $25! Dell doesn't make that guarantee anymore.

Dell gave lifetime toll-free technical support for hardware questions and usually answered its phones promptly. Unfortunately, Dell reduced Windows technical support from "lifetime" to "30 days".

Dell's downfall

Though Dell's tech support used to be good, now it's terrible — because Dell decided to save money by sending most tech-support calls to Bangalore, India, where your call is answered by a person whose English is hard to understand, who doesn't understand American slang, and whose computer knowledge is minimal. After receiving many complaints from business customers, Dell's adopted this new policy: if you buy an expensive "business" computer from Dell, Dell will have your call answered in the USA; but if you buy a cheap "consumer" computer from Dell, Dell's gonna still treat you like dirt and have your call answered in India.

Carly Fiorina, who was HP's CEO, laughed at Dell and asked "Is Dell really a computer company?" since Dell doesn't really research, invent, manufacture, or service computers anymore: it just rebrands and markets computers built by others and gives hardly any support. What a disappointment!

Alienware

Alienware is a company that makes high-speed computers, for use in playing high-speed action games and doing high-speed video editing. In 2006, Dell bought Alienware, so Alienware is now wholly owned by Dell.

How to get Dell

If you want a free Dell catalog or want to chat with a Dell sales rep, phone 800-BUY-DELL.

If you want to buy a Dell computer, don't react to the first ad you see: Dell sells the same computer at many different prices. For example, prices in Dell's catalogs, magazine ads, and Web sites all differ from each other. The cheapest way to buy a Dell computer is often at **Costco** warehouse clubs. Another way to buy a Dell computer cheaply is at **Walmart**.

Acer

Acer, **Gateway**, and **eMachines** used to be 3 separate companies.

"Gateway" computers were sold mainly through mail-order.

"eMachines" computers were sold mainly through chain stores such as Best Buy and Circuit City.

"Acer" computers were sold mainly through small computer stores.

In 2004, Gateway bought eMachines. In 2007, Acer bought Gateway. So now Acer, Gateway, and eMachines are all under the same ownership.

Here are the details.…

eMachines

eMachines was the first major company that advertised modern computers for under $400 and let you buy them in many stores.

History Here's how the eMachines company began…

Tandy Corporation owned Radio Shack and a chain of discount computer superstores called **Computer City**. Tandy had trouble running Computer City and sold that chain to CompUSA. Computer City's president (Stephen Dukker) was dismayed at becoming a CompUSA vice-president, so he quit. In September 1998, he started his own company, **eMachines**, which invented cheap computer systems (under $500) and sold them to retail stores such as CompUSA. To start eMachines, he used money invested by 2 Korean companies: **Trigem** (which made eMachines' computers) and **Korea Data Systems (KDS)** (which made eMachines' monitors).

He was wildly successful. 9 months later, in June 1999, his company become the third-biggest seller of desktop&tower computers in retail stores: just Compaq and Hewlett-Packard sold more desktop&tower computers than he. In the next month, July 1999, he shipped his 1 millionth computer. In March 2000, eMachines went public, with stock selling for $8 per share. In September 2000, he shipped his 3 millionth computer.

But afterwards, eMachines fell on hard times. For example, in January 2001, eMachines' revenues (sales figures) were just half of the previous January's. That was because the prices of fancy computer decreased, so consumers decided to buy them instead of the crummy computers that eMachines sold.

Its board of directors got worried. In February 2001, the board fired Stephen Dukker and hired, as the new head, Wayne Inouye, who was Best Buy's senior vice president in charge of computer merchandising. In May 2001, the company was delisted from Nasdaq, because the shares were selling for less than $1 each. In November 2001, the board agreed to sell the whole company to KDS's owner, Lap Shun "John" Hui, and his private company, called **EM Holdings**, for $1.06 per share, 161 million dollars total.

By April 2002, eMachines had sold a total of 4 million computers since the company began. That wasn't much more than the 3 million sold by September 2000.

eMachines became number 2 in retail U.S. sales, far behind Hewlett-Packard (which sold the Hewlett-Packard and Compaq brands). Analysts worried that eMachines might go bankrupt; but in 2001, eMachines improved its computers (which had been miserable) and its tech support (which had been atrocious before Wayne Inouye spent 20 million dollars extra on tech support and customer service in 2001). Then eMachine computers became finally worth getting: they were good computers at rock-bottom prices. Consumer surveys show that computers from eMachines were more reliable and better serviced than computers from most other computer brands.

To guard eMachines from going bankrupt, the company accepted no returns from computer stores and kept few computers in stock: it repeatedly waited for small shipments to arrive by boat from its suppliers in Asia, so it occasionally ran out of computers.

When I went to buy a computer in 2001, I found myself buying an eMachines computer, because eMachines offered much lower prices than any other computer manufacturer. eMachines lived up to its new slogan, which was "the best computer and service little money can buy".

The computer I bought came with one "defect": whenever I moved the mouse, the computer made a buzzing sound. I finally figured it out: the eMachines company was too cheap to include a microphone and too stupid to remember to turn off the microphone jack, which picked up interference from mouse & monitor motions. I solved the problem by giving the computer a command to disable the microphone jack.

eMachines improved. In 2003, the eMachines company's revenue was 1.1 billion dollars (a huge number!), even though eMachines had just 138 employees.

eMachines computers remained popular for many years afterwards. They were sold in Walmart, Best Buy, and many other stores. The eMachines *con*tribution to the world of cheap computers was: *dis*tribution!

"Free" computer Back in 1999, eMachines offered an extra $400 rebate if you'd sign a 3-year contract to make Compuserve your Internet service provider. The cheapest eMachines computer would cost you "$474 minus a $75 rebate minus a $400 Compuserve rebate", making the final price be about $0. Stores advertised it as being a "free computer". That kind of ad was popular in November 1999 and sold many eMachine computers.

Such ads neglected to mention that the price did not include a monitor and that you had to sign a 3-year Compuserve contract, at a cost of $21.95 per month, so the contract would cost you a total of "36 months times $21.95", which is $790.20. Those ads were declared "misleading" by many state governments in the year 2000 — and banned.

Gateway

Gateway was the first company to sell lots of computers by mail. Gateway became the mail-order king — until Gateway stumbled and Dell zoomed ahead. Gateway's stumbling is what motivated Gateway to buy eMachines.

How Gateway arose Gateway began because of cows. In the 1800's, George Waitt began a cattle company. According to legend, he got his first herd by grabbing cattle that jumped off barges into the Missouri River on the way to the stockyards. His cattle business passed to his descendants and eventually to his great-grandson, Norm, who built the Waitt Cattle Company into one of the biggest cattle firms in the Midwest. The company was on the Missouri River, in Iowa's Sioux City (where Iowa meets South Dakota and Nebraska).

Norm's sons — Norm Junior and Ted — preferred computers to cows, so on September 5th, 1985, they started the "Gateway 2000" company in their dad's office. They told him computers are easier to ship than cows, since computers can take a long journey without needing to be fed and without making a mess in their boxes.

22-year-old Ted was the engineer and called himself "president"; Norm Junior was the businessman and called himself "vice president". Their main investor was their grandma, who secured a $10,000 loan. They hired just 1 employee: Mike Hammond.

At first, they sold just parts for the Texas Instruments Professional Computer. Soon they began building their own computers. By the end of 1985, they'd sold 50 systems, for which customers paid a total of $100,000.

Gateway grew fast:

Year	Computers sold	Revenue	Employees
1985	50 computers	$100,000	2
1986	300 computers	$1,000,000	4
1987	500 computers	$1,500,000	8
1988	4,000 computers	$11,700,000	33
1989	25,000 computers	$70,500,000	176
1990	100,000 computers	$275,500,000	600
1991	225,000 computers	$626,700,000	1,300
1992	even more computers!	$1,100,000,000	1,876
1993	even more computers!	$1,700,000,000	3,500
1994	even more computers!	$2,700,000,000	4,500
1995	1,338,000 computers	$3,700,000,000	9,300
1996	1,909,000 computers	$5,000,000,000	9,700
1997	2,580,000 computers	$6,300,000,000	13,300
1998	even more computers!	$7,500,000,000	19,300
1999	even more computers!	$8,600,000,000	21,000
2000	even more computers!	$9,600,000,000	even more employees!

That chart shows how many computers were sold during the year, the total money customers paid for them and for add-ons, and how many employees Gateway had at year's end.

Here are highlights from the history of Ted Waitt and his employees during those years:

In 1986, they moved to a bigger office in the Sioux City Livestock Exchange Building.

In 1988, Ted began a national marketing campaign by designing his own ads and running them in *Computer Shopper* magazine. His most famous ad showed a gigantic 2-page photo of his family's cattle farm and the headline, "Computers from Iowa?" The computer industry was cowed by the ad's huge size and the low prices it offered for IBM clones. In the ad, Ted emphasized that Gateway was run by hard-working, honest Midwesterners who gave honest value. (At that time, most clones came from California or Texas; but Californians had a reputation for being "flaky", and Texans had a reputation for being "lawless"). Cynics called Gateway "the cow computer", but it was a success. In September, the company moved a few miles south to a larger plant in Sergeant Bluff, Iowa. Gateway's operations there began with 28 employees.

In the summer of 1989, Gateway grew to 150 employees, so Gateway began building a bigger plant. To get tax breaks and business grants, Gateway built it upriver at North Sioux City, South Dakota, and moved there in January 1990.

In 1990, Gateway became more professional. In 1989, the "instruction manual" was 2 pages; in 1990, it was 2 books. In 1989, the "tech support staff" (which answers technical questions from customers) consisted of just 1 person, and you had to wait 2 days for him to return your call; in 1990, the tech support staff included 35 people, and you could get through in 2 minutes. In 1990, Gateway switched to superior hard drives and monitors. In 1990, customers paid Gateway 275½ million dollars, generating a net profit of $25 million.

By early 1992, Gateway was selling nearly 2,000 computers per day and had 1,300 employees, including over 100 salespeople and 200 tech-support specialists to answer technical questions. Not bad, for a company whose president was just 30! Since Gateway was owned by just Norm Junior and Ted, those two boys got rich!

In March 1993, Gateway hired its 2000th employee. In April 1993, Gateway sold its one millionth computer. In December 1993, Gateway went public, so others could buy Gateway stock. By May 1995, Gateway had become so big that it answered over 12,000 tech-support calls in one day.

On September 5th, 1995, Gateway's 6000 employees celebrated the company's 10th anniversary.

Gateway became huge (with offices worldwide in France, Germany, Ireland, Australia, and Japan) but was still headquartered in North Sioux City, a small town that was behind the times: it didn't have any traffic lights yet.

Gateway got along well with its neighbors: in fact, 2 former mayors of Sioux City became Gateway employees!

Gateway became a rapidly growing cash cow but didn't lose its sense of humor: each Gateway computer shipped to customers in a box painted to look like a dairy cow: white with black spots.

Ben & Jerry's Ice Cream sued Gateway for copying the idea of putting cow spots on packages. Meanwhile, Gateway sued a shareware distributor called **Tucows** for using spotted cows to sell computer products. Those suits got settled.

Gateway's ads Gateway became famous because of amazing photographs in its ads.

In early ads, the photos showed individuals in beautiful landscapes. Later ads showed hordes of Gateway employees dressed as Robin Hood's men in Sherwood Forest, top-hatted performers in Vegas cabarets, teenagers in a nostalgic 1950's diner with glowing neon, and movie directors applauding a ship full of pirates.

Those eye-popping photos grabbed attention. Their captions related the photos to Gateway's computers. After all that multipage image-building nonsense, came the ad's finale, which reveals Gateway's great technical specifications (specs), great service policies, and low prices.

That way of building an ad — fluff followed by stuff — succeeded. Idiots admired the photos, techies admired the specs, and everybody wanted to buy!

Gateway was the first big mail-order manufacturer to give honest pricing: the advertised price includes everything except shipping. The price even included a color monitor. All components were high-quality. A Gateway system was a *dream* system, with dreamy ads and a low price. Gateway had a friendly slogan: "You've got a friend in the business."

How Gateway fell On Millennium Day (January 1, 2000), Ted Waitt decided to semi-retire: he turned Gateway's day-to-day operations over to Jeff Weitzen, who'd worked at AT&T for 18 years then Gateway for 2. Jeff became Gateway's president and Chief Executive Officer (CEO), though Ted remained chairman of Gateway's Board of Directors.

Jeff was proud to be chosen as the man to take Gateway past the millennium. He had many inspired ideas — most of which were wrong.

He moved Gateway's executive offices to downtown San Diego, to attract executive talent who wouldn't put up with South Dakota's remoteness and harsh winters. Then Ted moved Gateway's executive offices to a San Diego residential suburb called Poway, so employees living in San Diego's suburbs wouldn't have to commute into the city. Meanwhile, manufacturing was still back in South Dakota. The company was schizophrenic.

Another example of corporate schizophrenia was Jeff's decision to "think outside the box": sell not just a box full of hardware but also sell service.

He called it the "beyond-the-box initiative". To accomplish that, he set up Gateway Country Stores in hundreds of cities — and also inside Office Max stores — so customers could walk in and get local service.

But the Gateway Country Stores were confusing, since customers there could stare at sample computers but typically couldn't walk out the door with them; classes were offered just rarely; and phoning those stores for "tech support" got you a recorded message to call headquarters instead, since the store's "tech support" was mainly restricted to selling upgrades and installing them.

The cost of running the Gateway Country Stores forced Gateway to raise computer prices, so Gateway started charging even more than HP, Compaq, Dell, and IBM. Gateway was wasting so much energy running stores that Gateway started lagging behind Dell in making manufacturing efficient.

Gateway was no longer a low-priced discounter. Gateway had forgotten its roots. Gateway's new high prices and still-substandard tech support made Gateway a company to *avoid*: Gateway was charging more than Dell and giving worse service than Dell.

Gateway's revenues plummeted, Gateway's profits turned into losses, shares of Gateway stock became nearly worthless, and Ted Waitt became non-rich.

I can't blame *all* of Gateway's problems on Jeff: the whole computer industry had a tough year in 2000, when consumers decided new computers weren't different enough from old computers to be worth upgrading to. But Jeff's moves were in the wrong direction.

In January 2001, a year after Jeff took over, he resigned, and Ted Waitt became the CEO again — but too late: Gateway had lost its luster. The prince and king of mail-order had become a pauper. Upon becoming CEO again, Ted's first act was to run an ad bragging that Gateway would match the prices of 6 big competitors: IBM, HP, Compaq, Sony, Toshiba, and Dell. That ad was stupid. Gateway was supposed to be a mail-order discounter: all it could brag about was that it wasn't more expensive than retail? The ad bombed. So did the company. In 2001, Gateway made no profit: it *lost* a billion dollars. Here's how Gateway fell:

Year	Revenue	Result
1999	$8,600,000,000	$428,000,000 profit
2000	$9,600,000,000	$241,000,000 profit
2001	$6,100,000,000	$1,034,000,000 loss

Then Ted laid off employees, closed international sales offices, closed Gateway Country Stores, made Gateway a tiny company, and reduced Gateway's reliance on mail-order computer sales: he tried to diversify into selling big-screen TV sets, digital cameras, and DVD players. Details:

By July 2002, Ted had cut half the staff, so the number of employees was down to 12,000. In 2003, the company was even smaller: revenue was just $3,402,400,000, employees were just 7,407, and the company lost "just" $514,800,000. In March 2004, Gateway bought eMachines. In April 2004, all Gateway Country Stores were shut down, and the number of Gateway employees dropped to 4,000.

I felt sad about Gateway. I was one of the first journalists to recommend Gateway. I was sorry to see Gateway go downhill.

The seeds of Gateway's downfall were already planted back in December 1993, when Gateway went public. That's when Gateway first lost sight of its roots, raised prices (to make the stockholders happy), and I stopped recommending Gateway: I switched to hungrier companies instead.

When Gateway bought eMachines in March 2004 (for 30 million dollars plus 50 million shares of Gateway common stock), the eMachines CEO (51-year-old Wayne Inouye) became the Gateway's CEO. He replaced 41-year-old Ted Waitt (though Ted remained chairman of the board of directors). That move was easy for Wayne, since Gateway's headquarters (in Poway, California) was just 50 miles from the eMachines headquarters (in Irvine, California).

Acer itself

Acer is a huge consortium of Taiwanese computer companies. It makes "Acer computers" and "Acros computers". They're especially popular in Southeast Asia and Latin America but have also been sold in U.S. computer stores and department stores.

Acer's split In 2001, Acer split into 3 companies:

The main company is still called **Acer**.

The Communications & Multimedia Division is now a separate company called **BenQ**. It's Taiwan's biggest cell phone manufacturer. It also makes CD-RW drives, CD-RW disks, printers, scanners, and screens, under its own name and also secretly for Motorola & NEC.

The Design, Manufacturing, and Services Division is now called **Wistron**. It secretly designs, manufactures, and repairs computers for Dell, HP, Fujitsu, and Hitachi. Acer owns 40% of Wistron's stock.

Combo & shut-down In 2007, Acer bought Gateway (and Gateway's eMachines division); but in 2013, Acer shut down the eMachines division.

Other IBM clones

Here are other choices to consider.…

Micro Express

Walmart, Best Buy, and Staples sell normal computers. If you want a fancier computer, consider **Micro Express**, which is a mail-order company that sells high-speed computers less expensively than Alienware. Micro Express sells cheaper computers also. Micro Express has a good reputation.

To configure your own favorite combination, phone Micro Express at 800-989-9900 or 949-460-9911 or write to Micro Express (at 8 Hammond Drive #105, Irvine CA 92618) or better yet, visit its Website at www.MicroExpress.net.

Micro Center

Though eMachines sold computers for under $500, the *first* major company to sell *good* computers for under $500 was **Micro Electronics Incorporated (MEI)**, which runs a chain of stores called **Micro Center**. It manufactures a computer called the **PowerSpec** and sells the system unit for under $500. It also sells fancier versions at higher prices.

You can buy PowerSpec computers at a Micro Center superstore (a pleasant place to shop!) or mail-order (800-382-2390).

Industrial nuts

To get the lowest computer prices, many people phoned a secret group of amazing companies that advertised in *Computer Shopper*. That group was called **the industrial nuts** because the employees were industrious, the prices were nutty, and they were in 2 Los Angeles suburbs: "City of Industry" and "Walnut". The owners and employees were mostly Chinese.

These 24 industrial nuts eventually went out of business:

A+ Computer, All Computer, Altus, Atlas Micro Logistic, Bit Computer, Comtrade, Cornell Computer Systems, CS Source, Cyberex, Digitron, EDO Micro, Enpower, Hyperdata Technology, Multiwave, Nimble, PC Channel, Premio, Professional Technologies, Quanson, Royal, Syscon Technology, Tempest Micro, Wonderex, Zenon

But these 2 are still in business:

ProStar Computers, pro-star.com, phone 888-576-6776 or 626-839-6472
837 S. Lawson St., City of Industry CA 91748

Sager, SagerNotebook.com, phone 800-669-1624 or 626-964-8682
18005 Cortney Ct., City of Industry CA 91748

Alternatives

In many towns, entrepreneurs sell computers for ridiculously low prices in computer shows and tiny stores. Before buying, check the computer's technical specifications and dealer's reputation. If the dealer offers you software, make sure the dealer also gives you official materials from the software's publisher; otherwise, the software might be an illegal hot copy.

For further advice, phone me anytime at 603-666-6644.

Apple

What's the most important computer company? IBM? Microsoft?

No! The most important computer company is **Apple**. That company had the greatest influence on how we deal with computers today.

Apple was the first computer manufacturer to popularize these ideas successfully:

screens showing colors (instead of just black-and-white)

3½-inch floppy disks (instead of 5¼-inch, which are flimsy and less reliable)
CD-ROM disks (instead of just floppy disks, which hold less data)
solid-state drives (instead of hard drives, which are slower & eat up more watts)

using a mouse (instead of just the keyboard's arrow keys and Tab keys)
using pictures (called **icons**) instead of just words
pull-down menus (coming down from a menu bar, which is at the screen's top)

touch screens
tablet computers (such as the iPad)
smart phones (such as the iPhone)

laser printers (instead of just dot-matrix printers, which print in an ugly way)
desktop publishing (instead of word processing, which can't handle beauty)
pretty fonts (instead of typewriter-style fonts, which are monospaced and ugly)
paint & draw programs (so you can create graphics easily, without math)

Apple didn't *invent* any of those ideas, but Apple was the first company to *popularize* them, make people *want* them, and thereby change our idea of what a computer should do.

3½-inch disks were invented by Sony. The first mouse was invented by the Stanford Research Institute. The first good mouse software was invented by Xerox. The first personal laser printers were invented by Hewlett-Packard. The first modern desktop-publishing program was invented by a software company, Aldus. But it was Apple's further product development and marketing that made those products *desirable*.

Though just a small percentage of the computers sold today are made by Apple, we all owe a big debt to Apple for how that company improved our world.

Here's how Apple arose and changed our lives.…

Original Apple

The original Apple computer was invented by Steve Wozniak, who was an engineer at Hewlett-Packard. In 1975, he offered the plans to his boss, who said Steve's computer didn't fit Hewlett-Packard's marketing plan, so the boss suggested Steve start his own company. Steve did.

He worked with his friend, Steve Jobs. Steve Wozniak was the engineer; Steve Jobs was the businessman. Both were young: Steve Wozniak was 22; Steve Jobs was 19. Both were college drop-outs. They'd worked together before: while high-school students, they'd built and sold **blue boxes** (which attach to phones to illegally make long-distance calls free). Steve & Steve had sold 200 blue boxes at $80 each, totaling $16,000 in illegal money.

To begin Apple Computer Company, Steve & Steve invested just $1300, which they got by selling a used Volkswagen Micro Bus and a used calculator.

They built the first Apple computer in their garage. They sold it by word of mouth, then by ads saying the price was $666.66.

The first Apple computer was primitive: it had *none* of the features for which Apple became famous later: it had no color, no 3½-inch floppy disks, no CD-ROM disks, no mouse, no icons, no pull-down menus, no touch screens, no laser printers, no desktop publishing, no pretty fonts, no paint & draw programs.

Apple 2

In 1977, Steve & Steve invented a slicker version, called the **Apple 2**. Unlike the original Apple, the Apple 2 included a keyboard and displayed graphics in color. It cost $970. It became popular because it was the first computer for under $1000 that could display colors on a TV. It was the *only* such computer for many years, until Commodore finally invented the Vic, which was even cheaper (under $300).

At first, folks used the Apple 2 just to play games and didn't take it seriously. But 2 surprise events changed the world's feelings about Apple.

MECC The first surprise was that a Minnesota government agency decided to buy lots of Apple 2 computers, put them in Minnesota schools, and write programs for them. That agency, called the **Minnesota Educational Computing Consortium (MECC)**, then distributed the programs free to other schools across America, so schools across America discovered that personal computers could be useful in education. Since the only good educational programs came from Minnesota and required Apples, schools across America bought Apples then wrote more programs for Apples, so Apple became the "standard" computer for education — just because of the chain reaction that started with a chance event in Minnesota. The chain reaction spread fast, as teachers fell in love with the Apple's color graphics.

VisiCalc The next surprise was that a Harvard Business School student and his friend at M.I.T. got together and wrote the first spreadsheet program, called **VisiCalc**. They wrote it for the Apple 2 computer, because it was the only cheap computer that had a reliable disk operating system. (Commodore's computers didn't have disks yet, and Radio Shack's disk operating system wasn't reliable yet. Apple's success was due to Steve Wozniak's brilliance: he invented a disk-controller card that was amazingly cheap and reliable.)

The VisiCalc spreadsheet program was so wonderful that accountants and business managers all over the country bought it — and had to buy Apple computers to run it on.

> VisiCalc was niftier than any other accounting program. VisiCalc proved little Apples had more ability than even gigantic IBM mainframes.
>
> Eventually, VisiCalc became available for other computers; but at first, VisiCalc required an Apple. VisiCalc's success led to Apple's.
>
> In a typical big corporation, the corporate accountant wanted to buy an Apple with VisiCalc. Since the corporation's data-processing director liked big computers and refused to buy microcomputers, the accountant who wanted VisiCalc resorted to an old business trick: he lied. He pretended to spend $2000 for "typewriters" but bought an Apple instead. He snuck it into the company and plopped it on his desk. That happened all across America, so all big corporations had thousands of Apples sitting on the desks of accountants and managers but disguised as "typewriters" or "word processors". Those Apple computers infiltrated American corporations by subversion, an underground movement that annoyed IBM so much that IBM eventually decided to invent a personal computer of its own.

Apple 2+ In 1979, Apple Computer Corporation shipped an improved Apple 2, called the **Apple 2+**.

Its main improvement was that its ROM chips contained a better version of Basic, called **Applesoft Basic**, which could handle decimals. (The old Apple 2's ROM chips handled just integers.)

Another improvement was how the Reset key acted.

> On the old Apple 2, pressing the Reset key would abort a program, so the program would stop running. Too many consumers pressed the Reset key accidentally and got upset. On the Apple 2+, pressing the Reset key aborted a program just if you simultaneously held down the Control key.

Slots In the Apple 2+ and its predecessors, the motherboard had eight slots, numbered from 0 to 7, which could hold printed-circuit cards.

> Slot 0 was for a **memory card** (containing extra RAM). Slot 1 was for a **printer card** (containing a parallel printer port). Slot 2 was for an **internal modem** (to attach a phone). Slot 3 was for an **80-column card** (to make the screen display 80 characters per line instead of 40). Slot 6 was for a **disk controller**. Cards in slots 4, 5, and 7 were more exotic.

Apple 2e In 1983, Apple shipped a further improvement, called the **Apple 2 extended, expanded, enhanced (Apple 2e)**. Most programs written for the Apple 1, 2, and 2+ also ran on the Apple 2e. Unlike the Apple 2+ keyboard (which contained just 52 keys), the Apple 2e keyboard contained **11 extra keys**, making a total of 63.

> The extra keys helped you type lowercase letters, type special symbols, edit your writing, and control your programs.
>
> For example, the Apple 2e keyboard contained 4 arrow keys (↑, ↓, ←, and →), so you could move around the screen in 4 directions easily. (The ↑ and ↓ keys were missing from the Apple 2+ keyboard.)
>
> The Apple 2e keyboard contained a Delete key, so you could delete an error from the middle of your writing easily. (The Delete key was missing from the Apple 2+ keyboard.)

Unlike its predecessors, the Apple 2e **omitted slot 0**, because the Apple 2e's motherboard contained lots of RAM (64K) and didn't need a RAM card.

The Apple 2e contained an extra slot, called **slot 3A**. It resembled slot 3 but held a more modern video card that came in two versions: the plain version let your Apple display 80 characters per line; the fancy version did the same but also included a row of 64K RAM chips, so your Apple contains 128K of RAM altogether.

The Apple 2e was invented in 1983, the same year as the IBM XT.

> An Apple 2e was generally worse than an IBM XT, because it had less RAM, fewer keys on the keyboard, worse disk drives, and a worse version of BASIC. But the Apple 2e became popular anyway, because **more educational programs and games were available for the Apple 2e than any other computer**. That's because the IBM XT was too expensive for schools to buy. Though the IBM XT became the standard computer for business, the Apple 2e became the standard computer for schools and kids.

Apple 2c In 1984, Apple created a shrunken Apple 2e called the **Apple 2 compact (Apple 2c)**. It was smaller and lighter than the Apple 2e, cost less, and consumed less electricity.

Advanced hobbyists spurned the 2c — and stayed with the 2e instead — because the 2c didn't have slots for adding cards. But the typical consumer didn't need extra cards anyway, since the 2c's motherboard included everything a beginner wanted.

Apple invented an improved Apple 2c, called the **Apple 2c+**, whose disk drive was 3½-inch instead of 5¼-inch. Apple's 3½-inch drive was technically superior to Apple's 5¼-inch drive but angered users, since most educational software still came on 5¼-inch disks and wasn't available on 3½-inch disks yet.

Apple 2GS In 1986, Apple created an improved version of the Apple 2e and called it the **Apple 2 with amazing graphics & sound (Apple 2GS)**.

Apple 2 family All those computers resembled each other, so most programs written for the Apple 2 also worked on the Apple 2+, 2e, 2c, 2c+, and 2GS.

Apple has stopped marketing all those computers, but you can still buy them as "used computers" from your neighbors.

Clones Instead of buying Apple computers, some folks bought imitations, such as the **Pineapple**, the **Orange**, the **Pear**, and the **Franklin**. The imitations were popular in the U.S., Hong Kong, and Soviet Union.

Apple sued most of those companies (because they illegally copied Apple's ROM) and made them stop building clones. But Apple permitted one clone to remain: the **Laser 128** (which imitated the Apple 2c), because that clone's designer imitated the functions of Apple's ROM without exactly copying it.

In 3 ways, the Laser 128 was *better* than an Apple 2c: it included a parallel printer port (so you could attach a greater variety of printers), a numeric keypad (so you could enter data into spreadsheets more easily), and a slot (so you could add an Apple 2e expansion card). It ran most Apple 2c programs perfectly: just 5% of the popular Apple 2c programs were incompatible. A souped-up version, called the **Laser 128EX**, went 3 times as fast.

The Laser 128 and 128EX were built by the **Laser Computer** division of **VTech**, a company that also made IBM clones.

Apple 3

Back in 1980, shortly after the Apple 2+ was invented, Apple began selling the **Apple 3**. It was fancier than the Apple 2+ but too expensive (it listed for $4995, plus a monitor and hard drive) and couldn't run some of the Apple 2+ software. Few people bought it.

When the IBM PC came out and consumers realized the PC was better and cheaper than the Apple 3, interest in the Apple 3 vanished. Apple gave up trying to sell the Apple 3 but incorporated the Apple 3's best features into later, cheaper Apples: the Apple 2e and the Apple 2GS.

Lisa

Back in 1963, when Steve & Steve were kids in elementary school, Doug Engelbart invented the world's first computer mouse. He was at the Stanford Research Institute. During the 1970's, researchers at **Xerox's Palo Alto Research Center (Xerox PARC)** used his mouse as the basis of a fancy computer system, called the **Alto**. Xerox considered the Alto too big and expensive to sell well but invited the world to see it.

In 1979, Apple employees nudged Steve Jobs to go to Xerox and see the Alto. Steve was impressed by the Alto and decided to invent a smaller, cheaper version, which he called the **Lisa**, because that was his daughter's name.

The Lisa changed the computer world forever. Before the Lisa, personal computers were awkward to use. The Lisa was the first affordable personal computer that made good use of a **mouse**, **icons** (pictures & symbols you can click with the mouse), **horizontal menus** (lists of topics that appear across the screen's top), and **pull-down menus** (which you see when you click items on the horizontal menus). Those features made the computer easier to learn — and fun! The Lisa was the first computer whose business programs were truly fun to run. Because it was so easy to learn to use, customers could start using it without reading the manuals. Everybody praised the Lisa and called it a new breakthrough in software technology.

The Lisa was "affordable" but just by the rich: it cost nearly $10,000. For the Lisa, Apple invented special business programs that were fun and easy to use; but the Lisa could *not* run Apple 2 programs, since the Lisa had a completely different CPU.

Independent programmers had difficulty developing their *own* programs for the Lisa, since Apple didn't supply enough programming tools: Apple never invented a Lisa version of Basic, delayed introducing a version of Pascal, and didn't make detailed manuals available to the average programmer. And though icons and pull-down menus are easy to use, they're difficult for programmers to invent.

Apple gradually lowered the Lisa's price.

Early Macs

In January 1984, Apple introduced the **Macintosh (Mac)**, which was a stripped-down Lisa. Like the original Lisa, the Mac uses a mouse, icons, horizontal menus, and pull-down menus. The Mac's price was low enough to make it popular.

The Mac was even more fun and easy than the Lisa! It appealed to beginners scared of computers. Advanced computerists liked it also, because it felt ultra-modern, handled graphics fast, and passed data from one program to another simply.

The Mac's original version ran too slowly, but later versions ran faster. Since the Mac was so easy to use and priced low enough, many people bought it. Lots of software was developed for it — much more than for the Lisa, so Apple eventually stopped selling the Lisa and a compromise called the **Mac XL**.

Original Mac Apple began selling the Mac for $2495. The Mac's original version included 3 parts: the mouse, the keyboard, and the system unit.

The system unit contained a 9-inch black-and-white screen, a 3½-inch floppy disk drive, and a motherboard. On the motherboard sat an 8-megahertz **68000** CPU, 2 ROM chips (containing most of the operating system and many routines for drawing graphics), rows of RAM chips, a disk controller, and 2 serial ports (for attaching a printer and a modem).

That Mac was called the **original 128K Mac** because it included 128K of RAM (plus 64K of ROM).

Then Apple invented an improvement called the **512K Mac** because it included 512K of RAM. Apple wanted to call it the "Big Mac" but feared that customers would think it a hamburger.

Mac Plus In January 1986, Apple shipped an improved Mac, the **Mac Plus**, which had a bigger RAM, bigger ROM, better disk drive (double-sided instead of single-sided), bigger keyboard (more keys), and a port that let you add a hard-disk drive more easily. Those improvements permitted hardware & software tricks that let Mac programs run faster.

Mac SE In 1987, Apple shipped an even fancier Mac, the **Mac SE**. It ran software 15% faster than the Mac Plus because it contains a cleverer ROM (256K instead of 128K) and fancier support chips. It was also more **expandable**: it let you insert extra circuitry more easily. Unfortunately, the keyboard cost extra: you could buy the **standard keyboard** (which had 81 keys) or the **extended keyboard** (which had 105 keys).

Mac 2 When Apple introduced the Mac SE, Apple also introduced a luxury model, the **Mac 2**. It contains a faster CPU chip (a 16-megahertz **68020**) and 6 slots for inserting printed-circuit cards. Instead of sticking you with a 9-inch black-and-white monitor, it let you use any kind of monitor you wish: choose big or small, black-and-white or gray-scale or color. The monitor cost extra; so did the keyboard (standard or extended) and video card (which you put into a slot and attached the monitor to).

Since the Mac 2 let you choose your own monitor, the Mac 2 was called a **modular Mac**.

Performas versus Quadras In 1990, Apple stopped selling all Macs I've mentioned so far — the 128K Mac, 512K Mac, Mac Plus, Mac SE, and Mac 2. Apple switched to Macs that are more modern.

Apple's first great modern Mac came in 1991. It was called the **Quadra**. It contained a **68040** CPU. It was called the **Quadra** because of the "4" in "68040". The **Quadra** was intended for folks smart enough to know that "quadra" is the Latin word for "4". It was intended to be sold by expert salespeople to expert customers.

In 1992, Apple invented a "simplified Quadra", called the **Performa**, for beginners. It was intended to be sold to idiotic customers who think the word "performer" should be pronounced "performa". Then customers could choose between the Performa (for beginners) and the Quadra (which was still available, for experts). Performas came in several varieties: you could choose a normal CPU (a **68030**), a faster CPU (a **68040**), or an even faster CPU (a **Power PC chip**).

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Power Macs After watching the Performa-versus-Quadra war, Apple decided on a compromise: all new Macs would include a keyboard (like a Performa), but you could typically choose your own monitor (like buying a Quadra).

In 1994, Apple began selling powerful Macs, called **Power Macs**. Each contained a fast CPU chip (called the **Power PC**), but the price didn't include a monitor.

Mac clones In 1995, Apple's executives began letting other companies make clones of Macs, in return for a licensing fee. The most successful clone maker was **Power Computing**, whose clones ran faster than Apple's originals. Clones were also made by **Radius**, **Motorola**, and **Umax**.

But in 1997, Apple had a change of heart and withdrew the licenses of all the clone makers except **Umax**. Apple restricted Umax to making just clones that are "junk" (priced under $1000).

Umax no longer bothers to make Mac clones.

iMacs

In 1998, Apple began selling simplified Macs, to help beginners use the Internet. Each simplified Mac is called an **Internet Mac (iMac)**.

Apple sold it in 4 styles. Here are the details.…

Classic iMac The **classic iMac** looked out-of-this-world!

It looked like an airplane's nose cone — or an ostrich egg from outer space. It was **translucent** — which means you could almost see through it, like trying to look through a frosted shower-stall door to see the sexy woman inside. Intriguing! Every reviewer who saw it loved it, and so did Apple's customers. I bought one myself. It was great! That nose cone included a **15-inch CRT**, pair of stereo speakers, and fax/modem. The price also included a keyboard, mouse, and software.

The translucent case was tinted in a wild color. The first iMac was in a color called **Bondi Blue** (named after Australia's Bondi beach); later iMacs were in colors called Blueberry, Strawberry, Grape, Lime, Tangerine, Indigo (blue), Graphite (black), Snow (white), Blue Dalmatian (white spots on a blue background), and Flower Power (a floral print inspired by the 1960's). Apple got lots of praise for creatively avoiding beige, and many companies imitated Apple's wild color schemes.

The eMac After inventing the classic iMac, Apple invented the **eMac**, which was an iMac with a bigger screen: **17-inch** instead of 15-inch. It was designed for schools; "eMac" means "educational Mac". It was originally sold just to schools, but Apple later let *everybody* buy it. It came in just one color: white.

New iMac Next came the **new iMac**, which looked totally different: even more out-of-this-world!

It was a **white hemisphere** (so it looks like a mound of mashed potatoes), with an arm coming out of its top. At the arm's end, instead of a hand, you saw an **LCD** thin-screen monitor. (The original version's screen was 15-inch; Apple later offered 17-inch and 20-inch versions also.) The monitor hovered in front of the arm and hid the arm from your view, so the monitor seemed to hover by itself mysteriously in the air, like a UFO propelled by aliens.

People who used the new iMac were said to "do the mashed potato", "play with their hovercraft", and "kiss aliens".

Since the new iMac looked so mysteriously intriguing, many IBM-clone manufacturers copied Apple's idea of using a flat-screen LCD monitor. Those companies bought so many 15-inch LCD screens from suppliers that Apple could no longer get enough supplies for itself, and suppliers raised their prices, forcing Apple to raise its prices by $100. But eventually prices came back down.

Newest iMac **Apple has stopped selling the classic iMac, the eMac, and the new iMac.** Now Apple sells instead the **newest iMac**. It resembles the new iMac but has no white hemisphere; instead, all the system-unit circuitry hides inside the LCD monitor. The first version of the newest iMac was white plastic; the current version (introduced in August 2007) is aluminum instead.

Modern Mac prices

Now Apple sells just 4 kinds of normal computers.

MacBook Back in 1991, Apple began selling a laptop called a **PowerBook**. In 1999, Apple began selling a cheaper laptop, called an **iBook**.

Apple's stopped selling the PowerBook and iBook. Instead, Apple sells a newer laptop, called the **MacBook**, which comes in 4 varieties:

The MacBook Air	includes a 13.3" screen and starts at $999.
The MacBook Pro 13"	includes a 13.3" screen and starts at $1299.
The MacBook Pro 14"	includes a 14.2" screen and starts at $1999.
The MacBook Pro 16"	includes a 16.2" screen and starts at $2499.

The iMac Apple's all-in-one computer is called the **iMac**. It includes a 24" screen an starts at $1299.

Mac mini The **Mac mini** is a system unit that's cheap (starting at just $699) because its price doesn't include a keyboard, mouse, screen, speakers, microphone, or video camera. If you already own a keyboard, mouse, and screen from an older Mac computer (or even from an IBM-compatible computer), you can attach them to the Mac mini to build your own computer system.

Mac Pro The **Mac Pro** is a system unit that acts like the Mac mini but is much faster and costs much more: it starts at $5999.

Discounts

You can buy directly from Apple by phoning **800-MY-APPLE** or using the Internet to go to **store.apple.com** or visiting Apple's stores (which are in just a few cities). You can also buy Apple's computers from chain stores (such as **Best Buy**, **Walmart**, and **Target**), local Apple dealers, and these mail-order dealers:

Dealer	Internet address	Phone number
MacMall	www.themacmall.com	800-MACMALL
Mac Connection	www.macconnection.com	603-423-2000

MacMall usually has more exciting ads, but Mac Connection usually charges less for shipping and installation. Both companies are owned by bigger companies:

MacMall is owned by PCM, which also owns PCMall and TigerDirect
Mac Connection is owned by Connection, which also owns PC Connection

I've been showing you Apple's list prices. Unlike IBM clones, whose prices drop each month, Apple's list prices stay constant for many months, then drop suddenly. But while Apple's list prices stay "constant", Apple secretly gives bigger discounts to dealers, who in turn give "deals" to customers. The deals usually involve getting $20 off, or paying full price but getting a free $50 gift card, or getting $100 off because it's an outdated model that Apple no longer sells or will replace by a better model a few weeks from now.

Service

When you buy a Mac, you get **3 months of phone support** (so you can phone Apple for free help answering questions about how to use your Mac) and a **1-year limited warranty** (which says Apple will fix the hardware if it breaks during the first year and you carry your Mac to an Apple-authorized repair center).

Most of your questions and difficulties will be during the first 3 months, when Apple's help is free. After the first 3 months, pay consultants and repair shops when necessary.

Should you buy a Mac?

When the Mac first came out, computer experts loved it and praised it for being easier than an IBM PC.

Then Microsoft invented **Windows**, which made the IBM PC resemble a Mac.

The first version of Windows was terrible, much worse than a Mac. Nobody took that version of Windows seriously. But over the years, Microsoft gradually improved Windows.

When **Windows 3.0** came out, it was good enough to be useable. Though still not as nice as a Mac, it became popular because it ran on IBM PC clones, which cost much less than Macs.

When **Windows 3.1** came out, some folks even *liked* it.

When **Windows 95** came out in 1995, the Mac became doomed. Most critics agreed that Windows 95 was *better* than a Mac. **Windows 98**, **Windows Me**, **Windows XP**, **Windows Vista**, **Windows 7**, **Windows 8**, **Windows 8.1**, **Windows 10**, and **Windows 11** were further improvements. Moreover, a computer running Windows 11 costs *less* than a Mac.

Apple faces a new problem: since practically everybody has switched to buying Windows computers instead of Macs, most programmers aren't bothering to write Mac programs anymore. So if you have a Mac, you're stuck running old programs written long ago, in versions less pleasant than new Windows versions. As a result, the Mac has actually become *harder* to use than a Windows computer!

The big exception to Mac's downfall is the graphics-art community. Years ago, before Windows became good, the Mac became the standard for folks in the graphics-arts community (such as ad agencies, newspapers, magazines, artists, and companies running printing presses). They still use Macs.

Some universities standardized on Macs because Apple Computer Inc. gave those universities a discount. When the discounts expired, many of those universities shifted to buying Windows computers instead.

iPod, iPhone, iPad

After inventing the Mac (in 1984) and the iMac (in 1998), Apple invented the **iPod** in 2001. It's a handheld box that plays music.

Then Apple invented the **iPhone**, in 2007. It became the most popular smartphone.

Then Apple invented the **iPad**, in 2010. It became the most popular tablet.

Who runs Apple?

After being founded by **Steve Wozniak** and **Steve Jobs**, Apple's leadership changed.

Steve Wozniak got in an airplane crash that hurt his head and gave him amnesia, so he left the company and enrolled in college under a fake name ("Rocky Clark"). After he graduated, he returned to Apple Computer Company quietly. Steve Jobs managed the company.

Though Apple was successful, Steve Jobs' strategies upset some computerists.

For example, Apple's ads claimed that the Apple was the first personal computer (it was *not* the first!); Apple launched a big campaign to make businessmen buy Apple Pascal (though Apple Pascal didn't help the average businessman at all); Apple prohibited its dealers from displaying games (though Apple later relented); and Apple prohibited authorized dealers from selling Apples by mail order.

Apple Computer Inc. donated computers to schools for three reasons: to be nice, get a tax write-off, and lure schools into buying Apples (to be compatible with the Apples that the schools received free). But if Apple were *really* nice, it would have lowered prices to let low-income consumers afford them. Apple sold just to the "chic", not the poor.

Steve & Steve both left Apple and went separate ways.

Apple's next head was **John Sculley**, a marketer who used to be a vice-president of Pepsi. He made Pepsi the #2 soft drink (just behind Coke) and kept Apple the #2 microcomputer company (just behind IBM).

In 1993, he had Apple invent and sell a handheld computer called the **Newton**. Instead of including a keyboard, it included a tablet you could write on with a pen. The computer tried to read handwritten words but couldn't read handwriting accurately enough. Apple's board of directors ousted him for spending too much effort on the Newton and not enough on the Mac.

Apple's next head was **Michael Spindler**, an efficient German who dropped Apple's costs and prices. But in 1995, Apple's profits plunged for 3 reasons:

Microsoft began selling Windows 95 (which let IBM clones become nearly as pleasant as Macs).

Intel dramatically dropped prices on the Pentium chips used in IBM clones.

Spindler guessed wrong about which Macs would sell well, so Apple got stuck with unsold inventory of some models, parts shortages for others.

In 1996, Apple's board of directors fired Michael and replaced him with **Gil Amelio**. To cut costs, Gil fired lots of employees. In 1997, the board fired *him* and put **Steve Jobs** back in charge. In 2011, Steve died from cancer.

Now Apple is run by **Tim Cook**, who's popular and gay. He's successful: he's made Apple become even more profitable than when Steve Jobs was in charge, though Apple's latest improvements are undramatic, boring.