

# Cracking the Code



## Student Worksheet: What's Next?

Engineers are currently working on improvements to the barcode system. For example, Electrical Engineers at the University of Pittsburgh and Oregon State University have been working together to develop a new product ID system called the "Peni-Tag" (Product Emitting Number Identification Tag). These would be embedded in all products, perhaps in place of labels in clothing, and if the design is successful, would eliminate the need for barcodes.



When engineers work in teams to solve a problem they usually look at the problems that are associated with a current product or way of doing something.

### You are the Engineering Team!

Your challenge is to work as a team to identify problems associated with the current barcode system and propose a new product or system to improve the current system.

### State the Problems:

1. Identify three shortcomings of the current barcode system (for example, sometimes the barcode is scratched and the computer can't pick it up, or sometimes the check-out person has to run it across two or three times before the computer picks it up).
2. As a team, develop on paper a new product or system that would solve these problems and also add new benefits to embedded information (for example, an entire product manual could be embedded in a chip that could tell a futuristic washing machine what temperature to set the water to safely wash a load of similar shirts).
3. Present your ideas to the class in three forms:
  - describe how your product works, technically, in words.
  - draw an illustration of either your final product, or a situation where it is being used.
  - write an advertisement for the new product stating its top three features.

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## Student Worksheet: Checking the Code

Most product UPC codes have twelve digits. The first six numbers define the manufacturer or vendor of the product. Every product that the vendor sells will have the same first six numbers. The next five digits are specific to the product itself. And, the last number is a special digit called the "check digit" that is a double check to make sure that the UPC for the code



is correct. This "check digit" has a mathematical formula it follows to confirm that the product is accurately checked. Here's how it works, using the UPC code for Heinz 57 Ketchup Tomato (14 oz). The code is 013000001243.

Step One: Add the digits in the odd positions together:

$$0 + 3 + 0 + 0 + 1 + 4 = 8$$

Step Two: Multiply the answer in Step One by 3:

$$8 \times 3 = 24$$

Step Three: Add the digits in the even positions (except for the 12th digit):

$$1 + 0 + 0 + 0 + 2 = 3$$

Step Four: Add the answer from Step Three to the answer from Step Two:

$$3 + 24 = 27$$

Step Five: Add the check digit (in this case 3) to the answer from Step Four (27):

$$3 + 27 = 30$$

Step Six: This check digit must be a multiple of ten to be accurate, and the first digit of the answer (a multiple of ten) is used at the check digit.

Each time that a UPC is read by a barcode scanner, this calculation is automatically performed. If the check digit is different than the one that is calculated, then the computer knows that there is something wrong with the UPC.

### Your Turn:

Compute the formulas for four different barcodes and see if your calculations result in a "check digit" that is a multiple of ten.




## Student Worksheet:

Read the following press release and answer the following questions regarding the impact that bar coding technology and software engineering has had on society:

### HHS Announces New Requirements for Barcodes on Drugs and Blood to Reduce Risk of Medication Errors



HHS Secretary Tommy G. Thompson has announced that the Food and Drug Administration is issuing a final rule requiring barcodes on the labels of thousands of human drugs and biological products. The measure will help protect patients from preventable medication errors and reduce the cost of health care and represents a major step forward in the department's efforts to harness information technology to promote higher quality care.

"Barcodes can help doctors, nurses and hospitals make sure that they give their patients the right drugs at the appropriate dosage," Secretary Thompson said. "By giving health care providers a way to check medications and dosages quickly, we create an opportunity to reduce the risks of medication errors that can seriously harm patients."

"We're encouraging widespread use of technologies that can help health care providers avoid hundreds of thousands of medication errors," FDA Commissioner Mark B. McClellan, M.D., Ph.D., said. "Bar coding systems have proved their dependability and effectiveness by ensuring the accuracy of a myriad of actions in commerce and industry. We're now advancing the adoption of these systems in settings where they can help save lives."

The FDA rule calls for the inclusion of linear barcodes -- such as are used on millions of packages of consumer goods -- on most prescription drugs and on certain over-the-counter drugs that are commonly used in hospitals and dispensed pursuant to an order. Each barcode for a drug will have to contain, at a minimum, the drug's National Drug Code number. This information will be encoded within the barcode on the label of the product. Companies also may include information about lot number and product expiration dates.

In addition, the rule requires the use of machine-readable information on container labels of blood and blood components intended for transfusion. These labels, which are already used by most blood establishments, contain FDA-approved, machine-readable symbols identifying the collecting facility, the lot number relating to the donor, the product code and the donor's blood group and type.

The barcode rule is designed to support and encourage widespread adoption of advanced information systems that, in some hospitals, have reduced medication error rates by as much as 85 percent. In these institutions, patients are provided with identification bracelets that bear a barcode, which identifies the patient. The health care professional then scans the patient's barcode and scans the drug's barcode. The information system then compares the patient's drug regimen information to the drug to verify that the right patient is getting the right drug, at the right time, and at the right dose and route of administration. In a study conducted at a Veterans Affairs Medical Center employing such a barcode scanning system, 5.7 million doses of medication were administered to patients with no medication errors.

FDA estimates that the barcode rule, when fully implemented, will help prevent nearly 500,000 adverse events and transfusion errors over 20 years. The economic benefit of reducing health care costs, reducing patient pain and suffering, and reducing lost work time due to adverse events is estimated to be \$93 billion over the same period.

FDA first proposed barcode requirements in March 2003. Comments from hospitals, health care professionals, trade and professional associations and others showed widespread support for the approach to improving patient safety and promoting higher quality care.

The final rule applies to most drug manufacturers, repackers, relabelers, private label distributors and blood establishments. New medications covered by the rule will have to include barcodes within 60 days of their approval; most previously approved medicines and all blood and blood products will have to comply with the new requirements within two years.

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### Questions:

1. How do you think technology, and the introduction of barcodes have impacted the day to day life of check-out personnel at grocery stores? What's easier? What's harder?
2. Barcodes on medicine bottles or tubes help alert people to side effects and guidelines for taking their medication. How do you think this impacts society?
3. What ethical considerations would engineers discuss about barcoding blood donations?
4. What computer errors could negatively impact society through the barcode system? Give examples?
4. How could a computer or software engineer help prevent errors in the barcode system?
5. What other applications can you think of where engineers could develop equipment to embed important information? More ethical implications?