<u>Communications 1</u>

<u>Materials:</u>
Learning Resources two-color counters, set of 400.
1" grid printed on yellow cardstock

<u>Handout</u>
Redundancy

<u>Resources</u>:
What is a Parity Bit? https://www.tutorialspoint.com/what-is-a-parity-bit
Parity Magic Trick https://www.csfieldguide.org.nz/en/chapters/coding-error-control/the-parity-magic-trick/

1. <u>What is communication</u>?: show Source, Channel & Receiver using diagram

2. <u>Human channels</u>: compare the five senses; create chart collectively showing characteristics of each and examples of the use of each one for communication between people.

| Channel | Advantages | Disadvantages | Examples |
|---|---|---|---|
| Sight | Operates at a distance; very high information capacity; all humans can produce images, and most can receive them; images persist over time, unless there is motion | Receiver's gaze must be directed at sender; nothing can be blocking "line of sight"; ambient light is required | Writing, drawing, graphic images, gestures, facial expressions, photos, films, computer screens |
| Sound | Operates at a distance; high information capacity; orientation of the receiver's head is not important; most people can produce and receive sounds | Sounds do not persist after being generated; it is hard to distinguish among simultaneous sounds; noise can interfere with messages; human voice has limited range | Speech, tone of voice, emphasis, nonverbal utterances, radios, alarms, bells and sirens |
| Touch | Interpreted as strong expression of feeling; high sensitivity of human body | Requires close proximity; culture prohibits some forms of physical contact | Taps, pats, punches, kicks, pinches, kisses, handshakes |
| Smell | Persists over time; conveys strong meanings | Low information capacity; requires fairly close proximity; humans cannot produce smells at will (with a few unpleasant exceptions) | Perfume, flowers, deodorant, smell added to natural gas to warn of gas leak |
| Taste | Association with food | Low information capacity; requires close physical proximity; risk of poisoning | Gourmet foods and beverages |

3. Communication between people & machines (Alexa, keyboard, printer) or between machines (voice phone, internet, text); Add encoder and decoder to diagram

4. <u>Errors in everyday communication:</u>

a) Example of Woody Allen as bank robber:
https://www.youtube.com/watch?v=4VdMdboymT8

b) Classroom Examples; <u>F is for Effort</u> by Richard Benson

c) "A woman without her man is nothing."

5. <u>Signals vs. Noise</u>:

   a) Examples from relationships, classroom, school culture; Create T chart showing signal & noise in each case

       b) Activity:

       i) form groups of 3 consisting of source, channel, receiver;
       ii) Source writes a one-sentence message;
       iii) channel rewrites, changing one word;
       iv) receiver tries to determine original meaning

6. <u>Redundancy</u>:

   a) comparing abacuses

   b) Giving credit card info, phone #'s, URLs, addresses;

   How much of a postal address, email address, web address or phone # is necessary? Some kinds of messages have no redundancy, so any error is fatal; while others have enough redundancy to preserve the message

| **Without redundancy** | **With redundancy** |
|---|---|
| My cell # is 646 305 0000 | My cell # is 646 305 0000 – that's 646 305 0000 |
| My card # is 4147 0997 8753 0000 | Card #: 4147 0997 8753 0000 Expiration: 11/24 CVV: 145 |
| My name is Gary | My name is Gary – G A R Y -- George Alice Roger Yvonne |
| My zip code is 10033 | I live in New York, NY 10033. |
| Go to www.citytechnology.org | Google City Technology or go to www.citytechnology.org |

   c) Using words to replace letters: G as in George, A is in …

   d) Activity: groups of 3 as before

       i) Source writes a one-sentence message;
       ii) channel rewrites, deleting every vowel
       iii) receiver tries to decode

7. <u>Introduction to Parity</u>, the simplest form of error detection. Suppose you want to send someone your birthdate in binary, using a combination of five 0's and 1's. These five numbers, which could each be 0 or 1, are called <u>bits</u>. To guard against errors, you add a redundant sixth bit at the end, called a parity bit. The parity bit is used to detect one error among the six bits. To calculate the parity bit, count the number of 1's among the five-bit

message. If the count is odd, make the parity bit a 1. If the count is even, make the parity bit a 0. For example, if your message was 01010, your parity bit at the end would be 0, giving 010100, because the number of 1's was 2, and even number. If you wanted to send 11100, the total number of 1's is 3, an odd number, so the parity bit is 1, giving 111001.

Group (of 3) Activity: Source: Add a parity bit to your birthdate. Channel: change one bit (or not) Receiver: Use the parity test to determine whether or not a bit was changed.

8. Parity Magic Trick. The instructor plays a game with a student volunteer. On the blackboard or whiteboard, the student draws a 5 x 5 array of counters in two colors. The instructor adds a $6^{th}$ row and $6^{th}$ column of parity bits, to force the number of each color in each row and column to have even parity. The instructor then looks the other way while the student changes one of the counters inside the array from one color to the other. The instructor then uses row and column parity to identify which counter were reversed.

Group Activity: Using parity to detect an error. Students work in groups of 4, in the roles of source, channel, and receiver. Each group receives 35 two-color counters. The source lays out 25 counters in a 5 x 5 array, with some counters yellow-side-up, and others red-side-up. The detective places 10 additional counters, one per row and one per column, to try to detect the location of any counter that was changed. The channel turns one of the counters upside down, changing its color. The recorder keeps a record of each game, including the original placement of the counters, the additional row and column, the counter that was changed, and the success of the detective in identifying the flipped counter. Periodically, the four students can change roles.

For use at home; Demonstrate a variation in this activity using pennies rather than counters.


BREAK BETWEEN SESSIONS

9. Universal Product Code (UPC).

These are found on most products and used to identify the product by scanning the code.

Mystery: At the checkout counter, the cashier scans a barcode. Sometimes the cashier tries again, because the "scan did not take". How does the scanner "know" when a scan is bad?

Solution: The Universal Product Code (UPC) consists of the bar code and 12 numbers below it, including the two smaller ones at the right and left. The bar combinations represent these numbers. I have two boxes of Breton crackers from Dare Foods. One holds Multigrain Crackers, and the other is for the Reduced Fat and Salt variety. These have the following barcode numbers:

0 55653 63010 4   Multigrain Breton Crackers

0 55653 63210 8   Vinta 8 Grains and Seeds Crackers

The 0 55653 at the left of each code is the manufacturer's code, representing Dare Foods.

The 63010 and 63210 following the first code are product codes, representing Breton Multigrain Crackers and Vinta Crackers, respectively.

The 4 and 8, at the extreme right, are check digits, which are used to detect errors in scanning or manual data entry at the checkout counter.

Let's look first at how numbers are represented by the bars. Here is the barcode from Breton Multigrain Crackers:



Each number is represented by seven strips, each of which could be white or black. A white stripe reads as binary 0, while a black stripe represents binary 1. The codes are different on the left and right sides. The longer pairs of stripes at the left, right and center are called "guard bars," which tell the scanner when to start, stop and switch from left to right. The code for each number, on the right and the left, are shown in the translation table on p. 3.
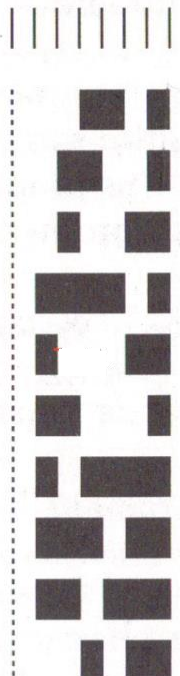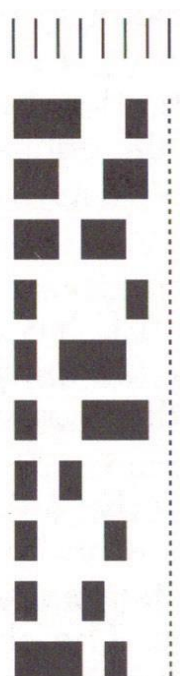
Group Activity:

a) Starting with the two 5's near the left of the sample barcode, try to find the same patterns on the left side of the table, in the row labeled 5.

b) Look at the binary code column son the left and right. What patterns do you notice?

c) Is there parity in each column? If so, what kind – even or odd?

d) How many black and white stripes does each column have?

e) How are the left and right columns related?

Class discussion:

a) What are some different kinds of redundancy built into UPC bar codes?

b) Some scanners require that the bar code be swiped across the window, while others have a larger window that can scan the entire code at once. In either case, the direction doesn't seem to matter. The code can be scanned from right to left, right to left, right-side-up or upside-down. For example, the sample code above could have been read forward as 0 55653 63010 4. How would it read backwards?

c) How can the scanner tell the difference?

2. Translating from bars to numbers

The table below shows how a decimal and a binary number corresponds to each pattern of bars.

| Left side | | Binary code | Right side | | Binary Code |
|---|---|---|---|---|---|
| 0 | | 0001101 | 0 | | 1110010 |
| 1 | | 0011001 | 1 | | 1100110 |
| 2 | | 0010011 | 2 | | 1101100 |
| 3 | | 0111101 | 3 | | 1000010 |
| 4 | | 0100011 | 4 | | 1011100 |
| 5 | | 0110001 | 5 | | 1001110 |
| 6 | | 0101111 | 6 | | 1010000 |
| 7 | | 0111011 | 7 | | 1000100 |
| 8 | | 0110111 | 8 | | 1001000 |
| 9 | | 0001011 | 9 | | 1110100 |

Translation Table

Group activity: Using the translation table and a magnifier, show how the bar patterns translate into the numbers on a sample UPC code.

Homework Assignment:

Identify all the redundancy strategies built into the UPC bar codes.

BREAK BETWEEN SESSIONS

3. Check digit

Another form of redundancy is built into the check digit at the very right. In the sample barcode, the check digit is the 4 at the right end.

Here is how the 4 is calculated from the preceding 11 numbers 0 55653 63010. Pick every other number starting with the 0 at the left end. There are six numbers to add. Below these, make a separate sum of the remaining five numbers, which are in between the first row of six. Add these five numbers separately:

$0 + 5 + 5 + 6 + 0 + 0 = 16$

$5 + 6 + 3 + 3 + 1 \quad = 18$

Next multiply the first sum by 3, and then add the second sum as is:

16 x 3 = 48          48 + 18 = 66

Then subtract this number from 180, which is the largest sum you can get from the 11 numbers. In our case we get 180 – 66 = 114. The last digit is 4, which is the check digit. The scanner automatically makes this calculation, and if it gets the wrong result, it gives an error signal.

<u>Activity</u>: Calculate the check digit for Reduced Fat and Salt crackers. The first 11 digits of the bar code are 0 55653 67060.  See if your result agrees with the bar code's check digit of 5.

<u>Independent Activity</u>: Find a product with a 12-digit UPC barcode, cover the check digit, and try to predict it. Using the calculation outlined above. See if you can get it!

<u>Group Activity</u>:

Check to see if the check digit can catch the following errors:

| One-digit errors: | | |
|---|---|---|
| Correct: | 5-02003-91562-**1** | 5-02003-**9**1562-1 |
| Incorrect: | 5-02003-91562-**7** | 5-02003-**0**1562-1 |

| Transposition errors: | | | |
|---|---|---|---|
| Correct: | 5-02003-**91**562**-**1 | **5-0**2003-91562-1 | 2-90014-301**61**-7 | 4-**72**011-10391-7 |
| Incorrect: | 5-02003-**19**562-1 | **0-5**2003-91562-1 | 2-90014-301**16**-7 | 4-**27**011-10391-7 |

What patterns can you find that determine whether an error will be caught or not?