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The human fax machine experiment

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Abstract
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The Human Fax Machine experiment

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This document has three parts:

- The Human Fax Machine - Reflections
- The Human Fax Machine - Instructions
- The Human Fax Machine - Documentation

The Human Fax Machine - Reflections

The Human Fax Machine draws together two sets of codes – the formality of machine instructions and the much looser codes of human group interaction. As an introduction to the computational mind-set, participants are set the task of devising some means of communicating an image from one group of people to another with simple sound signals. They may have only a wooden rattle, a container of shells or two forks that they can clang together, but they must somehow transmit the image across a small visual barrier to other members of their group so that the latter can reproduce it on butcher’s paper with marker pens.
This always proves a very challenging exercise and tends to produce all kinds of absurd and ingenious solutions. The groups are allocated some time to agree on a shared code and a set of communication protocols. Almost inevitably, however, they miss something, they fail to consider some crucial area of ambiguity or some fundamental potential for entropy and miscommunication. At times the issues revolve around a weakness in the formal code, at other times around human problems of performance, hearing, concentration and the etiquette of turn taking.

Broadly, we look for two sets of solutions: a raster-based approach that involves subdividing the image into a grid and transmitting binary information for each row and column square; and a vector-based approach that involves drawing shapes via linking together grid-based points. These neatly computational solutions do appear, but rarely in their pure logical form. Most often the code systems involve a hybrid of logical and human-perceptual, kinesthetic schemas. Rather, for instance, than insisting on simply binary audio signals, groups tend to envisage rich and complex systems, exploiting dimensions of volume, duration, timbre, etc. Unsurprisingly, the more imaginative and nuanced the set of codes, the more likely that they are to come spectacularly undone.

Failure is an essential part of the exercise, helping to clarify what distinguishes computational systems from more informal systems of information handling and transmission. Over a number of iterations, however, groups prove remarkably successful in developing systems that marry algorithmic logic to human interaction to actually transmit simple images with some reasonable level of accuracy. In the
process, they gain a sense of the mixed, semi-human and semi-machinic character of programming languages.

Overall, if the exercise works, it is not only because it draws attention to and establishes curious links between two dimensions of code, but also because it sets a genuine challenge for participants. When first set the problem, many groups go completely blank for a few minutes, unable to think of any suitable means of rendering an image as a sequence of audio signals, but this is precisely also what leads them to subsequently develop all kinds of strange and novel solutions, and, as well, to actually become interested in what could seem a merely technical problem. In this manner, the exercise frames an instrumental problem in imaginative terms and the various solutions appear as pieces of more or less successful practical magic.

The crux of the problem lies in the requirement to generate a new language which is functional (i.e., it should actually work to communicate a basic "message") and also scalable (ideally, the language which is developed could also be used to transmit a much more complex image-message). This requires not only the exercise of the metaphorical mind ("What solutions have I come across in the past that I could apply to this situation?"), but also the pragmatic mind ("My solution might work, but is it the most efficient available?").

The *Human Fax Machine* is fundamentally social: solutions emerge from what makes sense within the small group itself, and depend on the ability to work together. Code systems that students invent will thus necessarily involve poetic idiosyncrasies and
artful flourishes which effectively model the development of human culture on a small scale.
The Human Fax Machine - Instructions

Materials and Equipment

- A room—ordinary classroom size is fine.
- Some way of making a visual barrier—for example, a desk turned on its side, or a vertical partition, or a sheet hanging from the ceiling. Two or three such barriers are required.
- Large sheets of paper. These do not need to be high-quality paper.
- A variety of different coloured thick marker pens.
- A variety of simple sound-making devices.
  - E.g.:
    - A glass jar with a few coins inside
    - Two wooden spoons
    - Two river stones
    - A bunch of keys
- A range of rudimentary line drawings for sample transmission.
- Digital cameras and video cameras for documenting the process and the codes created.

Instructions

1. Break into small groups of between four and six participants.

   Each group gets one unsophisticated sound-making device (a spoon and glass, or a bell, or a jar with dried chickpeas, etc.) The group begins by developing its code system. In practice, this part of the experiment is the most difficult, and can take quite a long time. The group sits together with paper, pens, and sound-making device. Through the process of discussion, trial and error, participants develop and document a "lexicon" of sounds. What graphic marks could these sounds be used to communicate?

2. Having developed the first draft of a code system, each group now splits into two sub-teams: The “ENCODERS”, who will transmit the image-message, and the “DECODERS”, who will receive it. The group should write down the code in duplicate, so that both the ENCODERS and the DECODERS have a working copy of it.

3. The ENCODERS and the DECODERS now sit on opposite sides of a visual barrier in such a way that the two sub-teams cannot see each other. Test the system out with a graphic image—a simple line drawing. Once the teams have completed the transmission, it's time to refine the code by considering the following questions:
   - Is the code appropriate for the sound-making device provided?
   - Can it transmit diagonal lines, curves, organic shapes, etc.?
   - What doesn't work?
   - What if the ENCODERS make a mistake when transmitting?
   - What if the DECODERS make a mistake when receiving?
What if the group needs to clarify, pause, or start over?

How does the group deal with “noise” in the system?

There is no need to agonise about making it perfect. If it seems basically workable, go with the system in a provisional manner. Participants will refine the code through successive iterations.

4. Now, a challenge. The team will be allocated an image it has never seen before. THE ENCODERS will be handed the image, but the DECODERS must not see it. The ENCODERS sit on one side of the visual barrier, and the DECODERS sit on the other side. The two cannot see each other. Nobody is permitted to speak. The ENCODERS use their sound-making device to transmit the encoded image. On the other side of the partition, the DECODERS listen carefully and decipher the sound. The DECODERS now draw the image according to the established code. Once the transmission is complete, the team gets together, discusses what went wrong, improves the code system, and carries out a second transmission using a different image. This iterative improvement process continues with further refinements and progressively more complex images.

5. Reconvene with all the participants and discuss:
   - What species of code systems each group devised
   - What processes the groups explored to arrive at their systems
   - How successful the systems were at approximating the original image
   - What was learned in the process
   - What was frustrating or enjoyable about the process
The Human Fax Machine - Documentation

In what follows, a set of images and videos are selected and captioned, to give a sense of the range of solutions which were generated during various Human Fax Machine workshops between 2010 and 2012.

Several workshops were carried out at University of Wollongong, University of Tasmania, and Swinburne University, with participants ranging from undergraduate Media Arts students, to academics, to professionals in information technology.

The images are divided roughly into these sections:

The spatial set-up and performance of the activity:
- Creating the Code
- Transmitting the Code
- The set up of the room
- Documentation of the performance

Solutions generated by workshop participants:
- Text-based Systems
- Vector-based Systems
- Hybrid Approaches
- Raster-based systems
- Semantic systems

Refinements via iteration:
- Building in Redundancy
- Devising Feedback signals
- Creating Efficiency
- Experiments with Compression
- Encoding before sending
1. **Creating the Code.** Participants work together to develop their system. Consensus needs to be reached on what each sound will “mean”. This is then written down as a lexicon which makes sense only within the group.
2. **Transmitting the code.** Often one or two people will determine how to codify the image as sound, and a third will receive instructions and make the sounds – in this case by banging a metal tray with a spoon.
3. A typical classroom set up. Two tables have been up-ended to create a visual barrier. The ENCODERS sit on the left in this photo, and the DECODER sits on the right.
4. **Gameplay.** Short video showing the sonic interaction between the ENCODERS and a single DECODER. A coin rattling in a jar, and tapping on the table are the two basic sounds used by this group.
5. **Gameplay.** Short video showing the difficulty of the task of decoding and reconstituting the image. Something has clearly gone awry in the transmission of the image here (a simple line drawing of a house).
6. **Text-based systems.** Here, the group has decided to transmit images through descriptive words. Each letter of the alphabet corresponds to a certain number of “gong strikes” followed by a certain number of “hand taps”. This system has more economy of scale than a basic alphanumeric code like "A=1, Z=26", but the system’s weakness is that it still relies heavily on the accurate description of an image in words – and assumes that the DECODERS will be able to re-generate the image from the textual description.
7. **Text-based Systems.** An example of the image transmission resulting from the code system developed in the previous slide. Here you can see how much detail the text needs to go into for a relatively simplistic image transmission. This system would begin to fall down if the image being transmitted had abstract elements.
8. **Vector-based systems.** Here the group has developed a “clock face” approach – ie, each of the numbers 1-12 represent a particular angle for the direction through which a line will travel. The distance of the line segment is determined in advance. Thus 3 “taps” followed by 4 “claps” would mean travelling in the direction of “3 o’clock” for a distance of 4 units. To be versatile, this plotting system would need to have the capacity to instruct the DECODER to move his/her marker pen to a new position on the grid.
9. **Vector-based systems.** The basic components of this vector system are: direction of line; beginning position of the line segment (within a pre-determined grid); and type of line (eg curved, straight etc).
10. “Shape”-based systems. A variation on the vector approach. This group proposed that images are composed of basic constituent shapes (circle, square, triangle) as well as line segments. The limitations of this particular system are writ large by the group on their code-lexicon page.
11. **Raster-based systems.** Accurate only down to the level of “resolution” chosen for the underlying grid. Participants produce multiple copies of this grid in advance as a kind of “software”. This method produces a pixelated approximation of the original image. Can be time consuming and mechanical, since information relating to each and every pixel position needs to be transmitted. Transmission duration could be shortened by devising a method of “compression” to communicate several blank pixels in a row.
12. “Point plotting” method. This is a hybrid of the raster and vector systems, but with compression built into it, since only critical points on the grid are transmitted. The weakness of this system is that it relies on the DECODERS to join the dots – leaving room for error, especially with more complex or abstract images.
13. **Hybrid systems.** This complex approach is a vector system with a semantic “enhancement”. Its lexicon is based on words in a predicted hierarchy. For instance, words like “person” and “building” and “animal” have their very own codes. This approach seems a bit like the game of charades – and like that game, success would depend on good rapport and shared cultural references between the ENCODERS and DECODERS.
14. **Redundancy.** The mechanical nature of the raster-based system means that three group members can put themselves to the task of DECODING the image simultaneously, thus reducing the risk of a catastrophic transmission dropout if one participant’s attention drifts off momentarily.
15. **Feedback systems.** This group has recognised the need for a signal to be sent from the DECODERS to the ENCODERS requesting the repetition of a sound, or a pause in the sending of the image.
16. **Efficiencies.** Here the ENCODERS have produced a working “score” that they will use to produce the sonic transmission. This separates the process of encoding from the action of soundmaking, thus increasing the speed of transmission and reducing the chance of error.
17. **Artefacts.** Another score – this approach to transmission produces some interesting byproducts. The marks on this page are effectively an image displayed in its underlying codified form.
18. **Efficiencies.** Encoding the score before transmitting. This vector-based system is ill-equipped to deal with curved lines. The ENCODERS break the image into straight line segments which their system can accommodate, then they discard the original image. An approximated image will be transmitted this way.
19. **Refinements**. Here, a group using the raster method completes the DECODING process by tracing the pixellated result onto another layer of paper, thus returning the image to a line drawing.