What is the centralised mindset, and how might informatics free us from it?

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Abstract. A decentralised approach to systems analysis can be very profitable. This report shows how informatics can help us avoid the centralised mindset and how this is important for human-computer interaction.

1 Introduction

The world is full of things that humans do not understand. We have often found that when we do invent new concepts we have had to starting looking at something in a different way. Informatics helps us look at systems in a new way allowing us to unlock their hidden inner structures.

This report describes how we can look at systems in a centralised and decentralised ways. Informatics helps us look at complex decentralised systems. As informatics is mainly computer based, it is important to understand how informatics systems themselves can be centralised or decentralised.

2 Centralisation versus Decentralisation

The OED defines Centralisation as '1. The action of centralizing or fact of being centralised; gathering to a centre. 2. esp. The concentration of administrative power in the hands of a central authority, to which all inferior departments, local branches, etc. are directly responsible.' The benefits of centralisation are immediately obvious: When performing a task, a group of people that move together in a coordinated fashion will almost always outperform a group of people that are uncoordinated. It is easy to see how centralisation increases this coordination. Armies and governments have used a centralised model for generations for this very purpose.

A Decentralised system in contrast is one where there is less or no concentration of centralised control. One might assume that this might lead to less coordinated group performance. There are examples in nature of decentralised systems where impressive coordination is seen. Ants (Resnick[1] p60) do not have a centralised controller yet are able to forage successfully for food, build complex nests, and coordinate defensive attacks on predators. Individual ants, including the queen, have no comprehension of the group strategy they interact with their surroundings according to simple rules.

Both decentralised and centralised systems are present in nature. Most systems are decentralised; weather patterns are formed out of squillions of individual air molecules which behave in simple ways. Ecologies are formed out of sometimes 100s to 1000s of different species which interact with each other, in a decentralised fashion, to form a stable environment.

The only creatures in nature that form more centralised structures are those that have a concept of a system. Chimpanzees form centralised societies where an alpha male will lead a tribe of chimpanzees. Humans also organise themselves into groups with central leaders. The ability to mentally construct a system as an abstraction from its separate parts which is important here. Chimpanzees have a concept of themselves[6] this is essentially a centralised concept. They can see a centralised controller (the 'self') within their own system. Hence they are able to form social systems with centralised controllers[7].

This ability to conceptualise systems is a key part of centralisation. The moment we describe any decentralised system as a 'system', we are in effect centralising it. The system has behaviour as a whole and we may want to change or predict that behaviour. How we may change or predict the behaviour of a system is important or useful information. We may take a centralised or a decentralised approach to solving this problem.

3 The Centralised Mindset

The centralised approach (or the 'centralised mindset') is to look at a system's behaviour and try and map it onto a centralised hierarchical model (e.g. an army style control pyramid). Take a flock of birds migrating south for the winter, the birds flock together in an impressive organised fashion dancing patterns in the sky. Resnick states that 'Traditional theories of bird flocking were based on the idea of a "leader" bird at the front of the flock.' [1] All the other birds were taking their cue from the leading bird, hence generating a central hierarchy. However, it has been shown that a much better model is of birds following simple rules reacting to the movements of nearby birds[5].

The decentralised model of birds following simple rules forming a 'self-organizing' system has been shown to be a much better model than the centralised approach. There is some centralised feedback working on this system. The birds' gene makeup includes code that promotes this behaviour. The birds flock because there are clear advantages to their species in migrating as a group and the flocking dance is the way evolution has evolved for creation of flocks (making them very visible to other birds). What the model lacks is a centrally linked deterministic causal chain.

This defines the Centralised Mindset: viewing systems as best modelled with a centralised hierarchy (often causally linked) with a central controller. This is why Catholics have the pope: the pope is a human link in the causal chain directing God's will to the humans (apologies to any Catholic readers for this gross generalisation of your faith). This mindset is ingrained in the way we think.

Complexity theory helps us understand how non-centralised relationships in systems can lead to ordered behaviour as whole. In the ant example, no one ant's actions determine the behaviour of the model as a whole, there is no direct causal link between the systems behaviour and its parts. This makes the system much harder to understand. Making the initial leap to seeing things in a causal fashion is fairly hard, but unlearning it and looking deeper is even harder. Computer modelling (and informatics) helps us look at how we might understand decentralised systems and how changes to a building block of a decentralised system might affect the behaviour of the system.

In real life, no system is totally decentralised. Looking back at the ant system, the ants as micro systems themselves within the whole ant system are treated centrally i.e. their function is what is interesting, not their structure. Both ants and birds effectively have a centralised controller through their genetic makeup but this system is less centralised due to the lack of central hierarchy. Decentralisation is an amount: systems can be more or less decentralised (or, vice versa, centralised).

4 Decentralisation

Decentralisation is useful in many cases. Decentralised systems adapt in very sophisticated ways and lack the Achilles heal that centralised systems can have. No one unit in a decentralised system has any more control or relevance than any other. In modern warfare, taking out the centralised control structure has proved an effective strategy (see the Gulf War). Guerrilla warfare proved very effective in the Vietnam War however, due to its decentralised approach. Similarly decentralised network approaches prove to be more resilient to break down as they can better adapt to localised failures.

Randomness in decentralised systems helps to create a flexible, creative, and rich structure. The fact that ants move in random ways means that they explore an environment far more effectively than if they followed a set pattern. Positive feedback allows the ants to build trails to food sources that lead other ants there, the other ants build more trails which lead even more ants and so on. If the ants did not have a random factor built in then they might settle for a poor food source a long way away rather than a richer one closer by.

5 Using Informatics to understand decentralised systems

Decentralised systems are difficult to understand. They are complex and generally non-linear. Randomised behaviour is common and there is little way of predicting how a system will develop by manually following the paths of the constituent objects. Systems need to be treated with a more 'biological' approach, observing their overall behaviour as opposed to observing their detailed structure. Informatics allows us to model the behaviour of large complex decentralised systems so we can understand them and develop decentralised systems of our own.

Resnick shows in his book Termites and Turtles[1] how we can model the behaviour of ants using his Starlogo program. He develops a system, or simulation, where individual virtual ants move in random ways until they find food or a pheromone path leading to food. When they find food they return to the nest laying a pheromone path back to the food (with diminishing pheromone as they get further from the food). With one food source, the virtual ants move out in random ways until they find the food, then they will start to lay a pheromone path to the food. Other virtual ants find the path and follow it to the food and soon there is a strong conveyor belt of virtual ants going to the food and bringing it back to the nest. Since the virtual ants move randomly before they find a path, some still explore the environment.

With multiple food sources, the virtual ants show what could be seen as intelligent behaviour. They locate the closest food source first and deplete that, then they move onto the second closest food source and so on. This behaviour is optimal. It doesnt matter how many times one runs the simulation, the system will still exhibit similar behaviour. This is useful in showing how one could use virtual ants to explore a virtual environment such as, for example, a network.

6 Informatics systems

The example of ants above is an example of an Informatics System. The system shows informatics producing information, not hard scientific fact. Human beings are generally happy to act on information as long as they can trust its source. Modern science is moving towards an 'if it works, run with it' approach, so information is becoming harder currency. Information must be presented to humans in a way they can understand.

The most complex computer network is the Internet. It is decentralised in many different ways. On a physical level, each individual computer exists on a similar level to the other computers. There is no hierarchy between computers. Any computer can communicate to any other on the network.

More interestingly, information is also decentralised. The Hypertext Mark-up Language (HTML) was designed so that any piece of information in one place on the Internet can link to another piece of information somewhere else. There is no centralised organisational structure, however some centralised approaches have developed. The Yahoo directory acts as a sort of centralised information repository, but it only covers a tiny subset of the amount of information out there (is this a problem with its centralised design?).

One of the main concerns about how the Internet and computers will affect our lives is that they are not human orientated enough. Winograd & Flores[4] talk about how humans perform tasks in unstructured ways. If one thinks about a human interacting with a computer as a system in itself, then the events and objects within that system can either follow a centralised pattern or a decentralised pattern.

Norman argues that the centralisation of tools in computers makes them more unusable because they are less related to the job in hand. By centralisation he

means that collecting software packages or tools together on the same computer, sharing the same interface, is causing a centralisation of software. Much in the same way that centralising tools onto a penknife makes each tool less usable, he argues that centralising software onto a computer makes it all less usable than it could be.

Heidegger's philosophy of thrownness is important to this idea of using tools. He distinguishes between objects *present-at-hand* and objects *ready-to-hand*. Objects *ready-to-hand* do not exist (on a conscious level), they are taken for granted. We are consciously aware of objects *present-at-hand*, we are able to study them and rationalise about them. As outlined above, centralised objects in a system are part of a centralised (often causally linked) hierarchical model. A centralised object is harder to view as an object *ready-to-hand* because it has many (hierarchical) interactions outside it it may actually be a centralised object outside the current *ready-to-hand* network. Decentralised objects are simpler and more easily *ready-to-hand*.

Winograd and Flores[4] use word-processors as an example. A proficient person typing at a word-processor will think of words and then they will appear on the screen. 'There is a network of equipment that includes [the person's] arms and hands, a keyboard, and many complex devices that mediate between [the person's mind] and a screen.' (p37). The 'network of equipment' is *ready-to-hand*. What is important is that there can be breakdowns where for example a key on the keyboard gets stuck (or the infamous caps-lock key gets accidentally pressed) and part of the network becomes suddenly *present-at-hand*.

An example of two decentralised objects that we could use for 'word-processing' is a pen and paper. As long as the pen doesnt break and the paper doesnt run out, we wont run into any centralised hierarchy issues. The pen is a pen and the paper is some paper and there is nothing more complicated than that. Neither have any reliance on anything else.

This concept of *readiness-to-hand* is key for computer design. Norman[3] feels the same: he feels that computers have become too complex, users are presented with copious menu items that [they] will have to search through for the function they want. This complexity leaves lots of room for Heidegger style breakdowns. Norman looks at computer functionality explaining that 'I dont want to use a computer. I dont want to do word processing. I want to write a letter, or find out what the weather will be, or pay a bill, or play a game.' p75. He rather naively suggests that we should buy separate appliances to do all these things (forgetting that most people are not fond of clutter). He rather amusingly comes up with the idea of a shopping list appliance (p266) a pen and paper are sometimes a fantastically superior solution compared to any technological appliance yet invented. The difference in usability (for the basic functions of storing peoples numbers and addresses and calendar appointments) between a Filofax and a Palm Pilot is staggering.

Norman suggests in his chapter 'Human-Centered Development'[3] that we should concentrate more on what a human is actually trying to achieve when using the software rather than trying to give a product as much functionality as

possible. We must try and make the computer as un-intrusive (or invisible) as possible while the user is completing their task. This leads back to Heideggers ideas of objects or tools being *ready-to-hand*.

7 Distributed Informatics

In 'On the Internet'[2], Dreyfus uses anecdotal evidence to try to show that the Internet prohibits telepresence. Telepresence is the question whether our actual being might actually be transmittable through the Internet into a virtual world, or someone elses world. He argues that technology can either get in the way, or miss out too much of the background information. He is looking computers to be un-intrusive (or *ready-to-hand*) when people use them for communication so that people have more of a feeling of actually being with each other.

Dreyfus points out that Internet communication devices (such as face to face and voice to voice) are somehow missing something that we get in reality background information is missing. Surveys have shown that people find these environments unimmersive. This is a misleading argument. Deaf people miss much of the background environmental information. Blind people also miss out on large amounts of background environmental information. Both groups still manage to somehow fill in the gaps. Communication can and does occur through Internet chat devices: MSN messenger, ICQ, AOL, etc. People are learning to fill in the gaps that Dreyfus claims are missing using emoticons (the famous smiley :o), look at it sideways, indicates happiness or irony). Many children are growing up learning to communicate with these technologies and many now use them in a mphready-to-hand fashion. When someone types a message to someone they know, it is not dissimilar an experience to actually being in a room with that person and talking to them. The whole Internet, the two computers, etc becomes invisible and one mind talks directly, using language, to another.

Maybe there is an argument that the Internet disables us in a fashion removing some of the vitality that real person-to-person communication can entail. But, telepresence is happening on the Internet. Dreyfus tries to force a model of communication on the Internet that is based on our physical way of communicating - without actually trying to understand how communication really works. By looking at visually and audibly impaired people and now Internet chat communication, we can see there are different modes and levels of communication.

8 Conclusion

Resnick's research into decentralisation has shown us a new way of conceptualising systems. Informatics is important for helping us apply his concepts. Information is the new hard currency of the world and informatics helps us extract information from complex systems such as decentralised systems. Decentralised systems are inherently more complex than centralised systems as they lack a centralised hierarchy (which tends to make centralised systems easier to comprehend due to the simplification provided).

Human-computer interaction can be viewed as a system and while centralisation may help make a human-computer system easier to comprehend, it can be shown that decentralised systems are less intrusive when actually being used due to the simpler nature of their constituent parts.

References

1. Resnick, M. (1997). Turtles, Termites, and Traffic Jams. MIT Press, Cambridge, MA.
2. Dreyfus, H. (2001). On The Internet. Routledge, London.
3. Norman, D. A. (1998). The Invisible Computer. MIT Press, Cambridge, MA.
4. Winograd, T. & Flores, F. (1987). Understanding Computers and Cognition. Addison-Wesley, Reading, MA.
5. Heppner, F. & Grenander, U. (1990). A Stochastic Nonlinear Model for Coordinated Bird Flocks. In Krasner S. (Ed.), The Ubiquity of Chaos. AAAS Pubs, Washington, DC.
6. Parker, S., Mitchell, R. & Boccia M. (1994). Self-Awareness in Animals and Humans, Cambridge University Press.
7. De Waal, F. (1989) Chimpanzee politics : power and sex among apes, John Hopkins University Press, Baltimore