Digital Thinking

Seeing the world with digital eyes

https://alandix.com/academic/talks/DigitalThinking-CHIGreece-2021/

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Digital technology is ubiquitous and has transformed many aspects of domestic and business life. At a personal level there is an 'app for everything', in commerce banks are shifting online and even the heat and oil of the factory floor is being transformed by industry 4.0. In some cases, the changes are incremental, simply making existing process more efficient, or allowing online access to previous face-to-face services. However, there are also more radical changes. Some of these are within the methods of digital production from the perpetual beta of Web 2.0 and A-B testing of user interfaces to agile software development. Other changes are enabled by digital technology, such as more flexible industrial processes due to digital fabrication and applications of AI in medicine. There is a distinctly digital eye that allows us to think differently about the world, for example greater levels of personalisation in consumer products, or more dynamic sensor-rich industrial processes. Sometimes these innovations happen by accident, but we can explicitly adopt this viewpoint to prompt more radical design practice. In this talk I will draw out some of the facets and design heuristics of this new mode of digital thinking.

CCS CONCEPTS • Human-centered computing~Human computer interaction (HCI)~HCI theory, concepts and models

Additional Keywords and Phrases: digital thinking, deep digitality, design thinking, innovation, digital economy

1 WHAT IS DIGITAL THINKING?

The first motorcars were called 'horseless carriages' and steered by tillers as if they were a boat. In the early days of cinematography, the genre had to discover new ways of telling stories, that were not simply a poor imitation of the theatre. When we adopt new technology, it is easy to be trapped in the ways of the past, not recognizing the innovative potential allowing old things to be done in new ways, and perhaps revealing vistas that were previously unimaginable.

I have previously argued that the same is true of digital technology, especially when we look at large scale systems such as manufacturing, education, and health. Often digital systems act like sticking plaster for problems, or make small aspects more efficient, but still adopt the large-scale patterns laid down by physical technology. I have used the term 'deep digitality' for when we reset our conceptual focus and asking what the world would be like if digital technology predated the industrial revolution, or even the Medicis [5,7]. Explorations of Deep Digitality have used various case studies, some developed over the past few years, some dating back longer [6]. Oddly, some of the potential scenarios are quite light on the use of digital technology itself. It is more that the exposure to digital technology, from dot-com to app-culture, changes the way one thinks about the world.

It is clear that there is some form of 'digital thinking'. I write this with care as there has been a plethora of ways of 'thinking' (management thinking, systems thinking [2,11], computational thinking [13], design thinking [1,12]), which already overlap to varying degrees; there is a danger of creating hype rather than substance. In addition, I have written myself about quantitative–qualitative reasoning [9], which is about the informal ways we think about formal and numerical phenomena. However, the modes of 'digital thinking' certainly seems distinct from 'computational thinking', and while intersecting closely with 'design thinking', 'digital thinking' has a different foci and perspective.

However, there is a gap between identifying that there is a distinct mode of thinking and tying it down to something that can be used in a more controlled and deliberate fashion. In the following we'll try to tease out some of the elements of digital thinking, but in the spirit of a working document. The various facets will be demonstrated with examples and case studies, some old, some recent, some real and existing, some potential. Some of these patterns of thought are ones that are inspired by the digital world, but could be applied almost without digital technology. However, others are more closely tied to the potential unleashed by the nexus of vastly reduced costs of computation, near pervasive global communication, and the growth of digital fabrication.

We will consider digital thinking under two high-level headings:

- ***human*** – How existing human processes and systems might radically change or new ones emerge. This is often about identifying how our existing institutions have been shaped by the physical limitations of communication, production and transport.
- ***engineering*** – How we design physical systems differently, given the nature of digital technology. This often about trading engineering precision for computational power.

The latter is more about ways to solve problems that make more effective use of digital technology. Whereas the former, and more radical, is about reformulating what fundamental problems we tackle in the first place. The latter makes things work better, the former changes what those things are. Under each heading, we will look at a number of heuristics, some will be familiar, others less so.

2 HUMAN ASPECTS OF DIGITAL THINKING – FINDING BETTER PROBLEMS

Individual vs. uniform mass production (long-tail thinking) – While traditional crafts were bespoke, the industrial revolution and mass-production techniques led to the creation of large numbers of identical products. In contrast, websites and mobile apps are often heavily personalised. Digital technology can help make physical products like this, for example a small distillery in West Wales (inthewelshwind.co.uk) enables other small businesses to create unique hyperlocal botanical blends for their own branded gins [8]. Industry 4.0 techniques including flexible manufacturing and digital fabrication create the potential for 21st century industry digital artisans.

Distributed vs. centralized – Physical transport and economies of scale have led to heavily centralised logistics. However, global communication allows local–to–local connections, such as the Freecycle Network (freecycle.org).

Open monitored processes – In industry, education and even research, we often adopt inflexible processes. In contrast, combinations of sensing technology and rapid computation can allow processes that are more open-ended, monitoring progress, tracking gaps, problems or even inconsistencies rather than forbidding them. For example, working with musicolgists, we have been seeking ways to make digital archives work more incrementally as material is available rather than waiting for the final authoritative dataset and using rich provenance to combine community-sourced and scholarly material [3,4].

Deconstructing knowledge, behaviour and experience – Just-in-time knowledge and remote collaboration can break down traditional professional barriers, for example, enabling paramedics to perform medical tasks in the field.

Physical–digital ecologies – In a traditional workshop there would be a specialised tool for each task, in contrast 20th century user interfaces were about the single device doing everything. Point-to-point and cloud communication means we can now thing about rich ecologies where different devices and technologies interact, for example combining physical books and digital devices [10].

3 ENGINEERING ASPECTS OF DIGITAL THINKING – SOLVING PROBLEMS BETTER

These human aspects of digital thinking generate new challenges for digital technology. Happily, digital thinking offers ways to address these, in part plain old cybernetics, in part more radical. These include: ***commoditising complexity*** – for example Firefly (lucidina.com) puts a computer behind every LED in display lighting turning light into digital media; ***control vs. measurement*** – to some extent this dates back to the universal governor, but cheap and/or accurate sensing allows tight feedback control, for example, self-balancing in a Segway; ***accuracy vs. computation*** – for example Firefly lights do not need to be accurately positioned, instead computer vision techniques work out where they are and alter rendering to suit the actual positions; ***best vs. good enough*** – for example many noSQL databases used for web applications relax the strict ACID consistency conditions of traditional databases in order to achieve responsiveness; ***defuse sensing and opportunistic data*** – instead of designing precise and optimal sensors or tests for specific purposes, we may make use of commonly available sensors, such as on mobile phones, and combine large volumes of imperfect data in order, for example, to detect rare or slow progressing diseases.

4 SUMMARY

This is work in progress. I don't have all the answers! I'd love to hear about your experiences as you look at the world with digital eyes. For more about digital thinking as it continues to develop, see: https://digitalthinking.wales/

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