TOOLBOX

Evolution & revolution in human factors

This year's Human Factors NL Annual Congress has the strapline Evolution, revolution! It's a thought-provoking theme that begs the obvious questions:
- What has changed in human factors?
- Which of these changes are evolutionary and which are revolutionary?
- What changes do we foresee in the future, and how should we respond to them?

Dan Jenkins

The world has changed

Human factors has been around as an identifiable profession for about 70 years – the oldest human factors society (now called the Chartered Institute of Ergonomics and Human Factors; CIEHF) was founded in the UK in 1949. Looking back across those 70 years, the world has changed in many ways. There have been clear, objective, reductions in child mortality, plane crashes (as a percentage of passenger miles flown), child labour, and malnutrition. Meanwhile, clear objective improvements in women with the right to vote, literacy rates, harvest yields, child cancer survival rates, girls in school, and access to clean drinking water (see Rosling, 2019 for more on this). The reasons behind these changes are complex and nuanced, but almost all are a result of changes at a technical and intentional, often political, level.

More recently, the introduction of the internet and the proliferation of connected device has completely revolutionised almost every aspect of our lives. For many of us, the way that we work, move around, shop, and even socialise has changed dramatically in the last twenty-five years. What's more, it is safe to say that we are only partway through this 'connected revolution'. Advances in communication technologies and microprocessors are making it possible to connect more 'things' – allowing for further changes in the way we live our lives, the way we manage our families health, and how we interact with each other.

What's changed in human factors?

Given the change in the wider world, one would naturally expect a clear change in a discipline that aims to study it. But in what ways has the discipline of human factors changed?

Our understanding has grown substantially in the last 70 years, there is a long list of journals dedicated to human factors that have amassed thousands of articles describing thousands of experiments and studies. These papers describe many hundreds of new methods, some of which have made the challenging transition to the world practitioners and design.

On the design side, human factors (HF) has changed considerably. Alongside, new tools and techniques, human factors now takes seat at the decision-making table in many industries. Either due to a recognition of its role in improving the commercial success of products, or as a result of regulators understanding the important role it can play in improving safety and efficiency.

These notable changes in HF are, in part, a result of it being a relatively new profession, but more recently they have been driven by changes in the world. As a result of connectivity, interactions have become more complicated often necessitating the need for more a structured study. Taking the example of vehicle control. Fifty years ago, when the driver pressed the brake pedal, they were typically applying direct pressure onto the brake pads of the wheels. Today, we have introduced a range of increasingly intelligent, often distributed, digital decision makers. These digital decision makers help decide how much pressure to apply, to which wheels, when to apply it and when not. The introduction of these digital decision makers, or 'actors', moves us away from a simple manmachine dialog to a more complex group discussion. As such, it is often important to consider larger system boundaries, distributed teams, different allocations of work between humans and more commonly also considering machines (i.e. automation) as a critical part of the decisionmaking process.

Evolution or revolution?

The fact that both the world and human factors have changed is unquestionable, the slightly harder question is whether this change is evolutionary or revolutionary – as there are clear examples of both types. Drawing from our own human factors' toolkit, and the work of

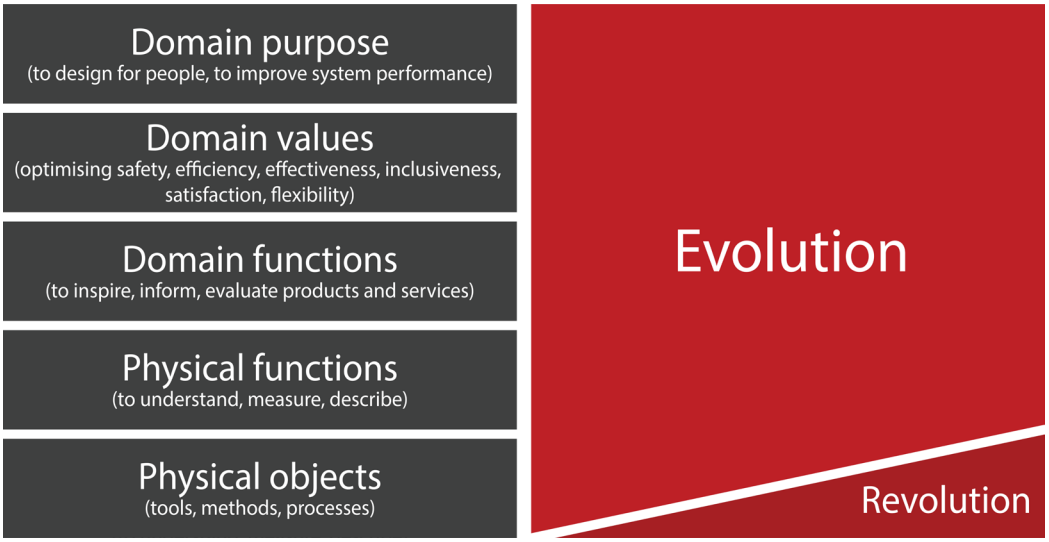

Figure 1. Abstraction hierarchy of human factors practitioners (Rasmussen et al., 1994).

Jens Rasmussen, we can see different types of change at different levels of abstraction (see Rasmussen's Abstraction Hierarchy; Figure 1). At the highest level (Domain purpose), it is possible to argue that much remains the same. Our purpose, or 'reason for being', remains much the same as it was 70 years ago – to improve system performance, and ultimately to design for people. Henry Dreyfuss clearly articulated this back in 1955 in the front cover to his seminal text (Figure 2).

Similarly, at the next level down, the abstraction hierarchy, the domain values level, little has changed. We continue measure things like safety, comfort, satisfaction, efficiency, plus items such as efficacy, inclusiveness, and flexibility (see Figure 3). As part of the design process, we routinely start by thinking about how things are done today, and how they could be done in the future.

At the base of the hierarchy, there is also much consistency. Our core methods and approaches basically remain founded on a small number of data collection approaches – we talk to people, we observe them, we describe what we expect them to do, and we record what they actually do in practice. The outer ring in Figure 3, provides concrete examples of this, such as measuring the time taken by sub tasks, recording deviations from set procedures (sometime captures in SOPs), and measuring operator satisfaction.

While there is much in common, the tools we use and the methods we apply today are often quite different. It is in this area that we see elements of revolution. What has changed in more recent time is both the quality of data and speed of the data collection – revolutionising the way that we work. While previously we were limited to asking people what they thought, or doing our best to observe them, now we can use tools like eyetracking to record exactly what they are looking at, objects that they fixate on, and how they scan complex interfaces – creating a whole new level of insights.

Advances in prototyping have also made it much faster and easier to create things (objects, environments, digital experiences), allowing us to explore interactions and their impact on system performance. The idea of prototyping is, of course, not new, however, new techniques make it possible to iterate faster. Today, we can create highly detailed physical objects in a few hours (often overnight); create and use high-resolution 3D CAD models to assess things like the fit to the human body; apply computer models to predict fatigue rates; explore visibility from cabs while conducting complex tasks. The speed and fidelity of these assessments and investigations mean that they can be conducted without causing delays to the critical path of the design project, allowing the HF team to provide rich insights in a timely fashion to influence the design.

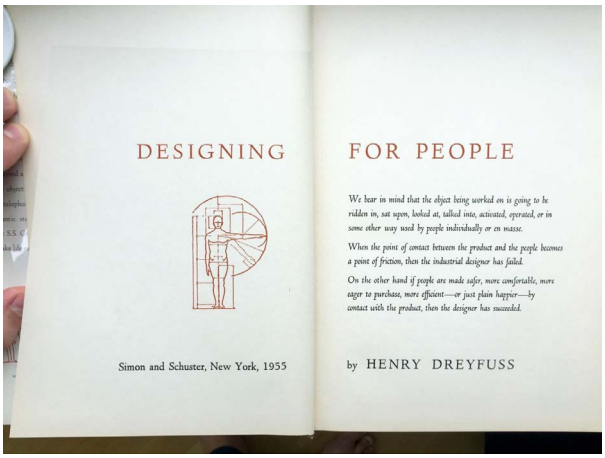

Figure 2. The introduction page to Henry Dreyfuss' book – Designing for people (1955). "When the point of contact between the product and the people becomes a point of friction, then the industrial designer has failed. On the other hand, if people are made safer, more comfortable, more eager to purchase, more efficient – or just plain happier – by contact with the product, the designer has succeeded."

The other clear change lies in the collection of large data sets. Previously, it was an arduous task to understand group behaviours as much of the data had to be collated manually. Now, it is possible to tap into existing data sets, using mathematical social networks analysis tools to explore how system elements are interacting. While we were previously limited to specific data collection exercises (expensive and time consuming experiments), we now are able to collect data throughout the life of a product. Apps, physical objects, and buildings can capture and communicate how they are being used. As well as responding in real-time, this data can be used to optimise future iterations of the design and often be upgraded in service.

From a design perspective, more information about the way that products are used is incredibly valuable as it allows us to make informed decisions throughout the design process. However, it is also important to question the impact that these new systems have on end users. From a user perspective, it can be quite scary if we pause and reflect on how much information is really being collected and to what ends. There is something incredibly Orwellian about the idea of devices that may, or may not, be listening into the conversations that we invite into our living rooms. The devices that we queue up to buy, that track our movements and report them back to large multinational corporations.

As human factors professionals, it's important for us to pause occasionally and truly consider our 'Domain purpose'. Particularly as busy practitioners, it can be all too easy to become fixated on the lower levels of Figure 3. To embrace the exciting opportunities of new technologies, without really questioning their explicit impact on the higher levels. The good news is that, as human factor professionals, we are incredibly well placed to inform these discussions. We have the tool kits, the process and the understanding to ensure we take steps forward with a transparent view of the value of new technology, but also some of the risks.

The future

It's a very dangerous thing to write down predictions of the future, but here goes!

I see little change in the higher levels of abstraction. I believe that we will continue to design for improved system performance (efficiency, safety, inclusiveness, satisfaction, flexibility and effectiveness). Likewise, we will continue to strive to inspire, inform and evaluate new products, systems and services. And, to do this, we will continue to seek to understand, measure and describe 'work as done' and 'work as imagined'.

I believe the revolution will continue to happen at the base of the hierarchy in the tools techniques and processes that we adopt. I see us continuing to borrow from parallel fields, at an individual level there are exciting new possibilities for more objective

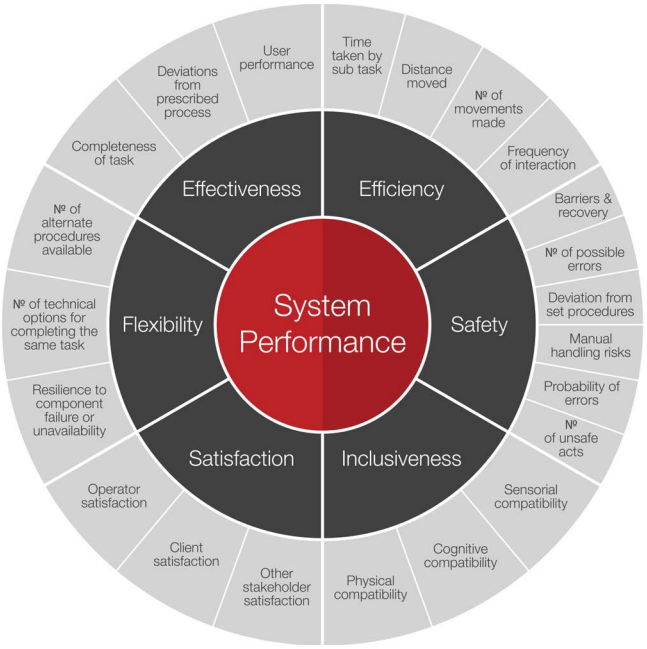

Figure 3. Factors to consider when assessing system performance.

measurements of what people are thinking, how they are responding to what they see, hear, feel, smell, and taste at a physiological and neurological level. While at more of a systems level, we are just scratching the surface of what can be done to understand how groups of individuals interact and influence one another. To do this, I see us embracing more of the systems thinking tools that already are in our toolkit, and I see these migrating across from academia to practice. As we shift to a world of artificial intelligence, we will see greater distribution of tasks between humans and machines, and a greater need to measure and understand performance at a system level – ensuring that the systems that we develop have real value at the higher levels of the abstraction hierarchy, not just the lower ones.

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