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Concept models for design practice

Modelos conceptuales para la práctica del diseño

Modelos conceituais para a prática de design

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Abstract

Concept models are common guides to living, and some more specialized ones, which have been developed and validated in other fields have been adopted by designers for use in their work. In particular, concept models serve as templates for decision-making and action, and valid concept models make decision-making and action faster, more efficient, and more successful. It is not necessary that the concept models be complete to be useful, but it is necessary that the elements they do contain are relevant to the activity at hand, and that the model itself is a sufficiently accurate representation to be predictive. However, the field of design, like many other inventive disciplines (e.g. architecture, landscape architecture, urban planning, engineering, computer science) has not traditionally concerned itself with the development and validation of concept models beyond those that are applicable within the confines of a single project. In this paper, we argue that the time has come for the inventive disciplines to increasingly produce their own concept models to benefit practitioners in many different kinds of projects, both within the inventive disciplines and beyond, into disciplines where knowledge production is sequential (as in much of science) or aggregative (as in much of the humanities).

Key words: design theory, design research, design practice, concept models.

Resumen

Los modelos conceptuales son guías para la vida. Algunos han sido desarrollados y validados en otros campos, y adoptados por los diseñadores para su uso. Los modelos conceptuales sirven para tomar decisiones y actuar, y aquellos validados, hacen que la toma de decisiones y la acción sean más rápidas, eficientes y exitosas. No es necesario que los modelos conceptuales estén completos para ser útiles, pero sí que los elementos que contienen sean relevantes para la actividad a desarrollar y que el modelo sea una representación lo suficientemente precisa para ser predictiva. Sin embargo, el diseño, al igual que muchas otras disciplinas inventivas (la arquitectura, la arquitectura del paisaje, la planificación urbana, la ingeniería, la informática) no se ha ocupado tradicionalmente del desarrollo y la validación de modelos conceptuales más allá de los aplicables a un proyecto único. En este artículo, argumentamos que ha llegado el momento de que las disciplinas inventivas produzcan cada vez más sus propios modelos conceptuales para beneficiar a sus profesionales en diferentes tipos de proyectos, al igual que en otras disciplinas donde la producción del conocimiento es secuencial (gran parte de las ciencias exactas) o agregativa (como en muchas de las humanidades).

Palabras clave: teoría del diseño, investigación del diseño, práctica del diseño, modelos conceptuales.

Resumo

Los modelos conceptuales son guías para a vida. Alguns foram desenvolvidos e validados em outros campos e adotados pelos designers para o uso. Os modelos conceituais para as decisões e atualizações, e esses validados, fazem com que tomem decisões e ações, são bem-sucedidas, eficientes e exitosas. Não é necessário que os modelos conceituados sejam completos para ser úteis, mas é o que é um componente para o desenvolvimento de uma atividade e um modelo e um modelo de referência. Sin embargo, o design, al igual que muitas outras disciplinas inventivas, a arquitetura da paisagem, a planejamento urbana, a ingeniería, a informática) não se ha ocupado tradicionalmente de desenvolvimento e a validade de modelos conceituais mais longe de aplicadores um único projeto único. En este artículo, argumentamos que ha llegado o momento de que as disciplinas inventivas produzam cada vez mais modelos de modelos para conceituais para beneficiários em diferentes tipos de projetos, além de em outras disciplinas onde a produção do conhecimento é secuencial (gran parte de las ciencias exactas) o agregativa (como em muchas das humanidades).

Palavras-chave: teoria do design, pesquisa de design, prática de design, modelos conceituais.

Introduction

For several decades, design has been moving ahead in the academy, defining itself as its own discipline, and recognizing that it may often need to use distinct forms of knowledge production (Gray and Malins, 2004; Dyrssen, 2010). These methods are typically characterized as research through design or research by design (Frayling, 1993; Zimmerman, Stolterman and Forlizzi, 2010; Gaver, 2012), where the research outcomes are achieved using design approaches such as prototyping. These decades of work have brought design research to the point where it is now ready to focus on the development of its own concept models for use in design practice. As suggested by Forlizzi, Stolterman and Zimmerman (2009), this has already been happening in some places.

That said, design practice has relied for most of its history on concept models[1] that have been transferred and adapted from other disciplines. There are concept models, for instance, about perception. The designer asks: "do I need to complete an outline of the object in this drawing, or will people understand a partial outline?" "They will get it", said the Gestalt theorists (Koffka, 1935). "According to our model of how this works, people can complete outlines in their minds". So, designers read the principles coming out of the Berlin school of experimental psychology in the 1920's, and ever since they have been confident about providing partial outlines. For example, looking at the cover of *Time* magazine throughout its history, there is a time where the title is always entirely visible, and a moment after which it is often partially obscured (Figure 1).

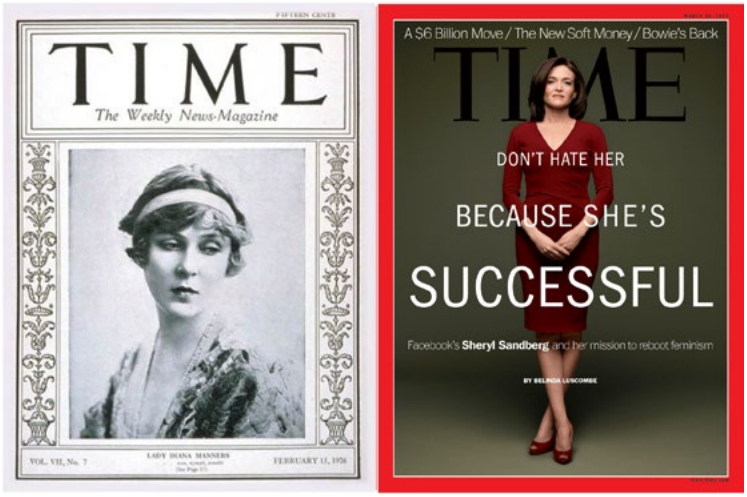

Figure 1. The covers of *Time* magazines in 1926 and 2013.

[1] We use the phrase "operational predictive concept models", instead of the word "theory", because we are writing primarily for practicing designers, for many of whom "theory" has become a hissing and a byword.

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ºThe designer asks: "can people figure out what they are supposed to do with this object, or do I need to provide elaborate instructions?" "It depends", say the ecological psychologists. "If it is well designed, they should be able to get it. That's something people are good at doing. Try not to confuse them with signals that say pull when they actually have to push". So, designers read Gibson (1979), or more likely Norman (1990), and some of our electronics, for example, became easier to use.

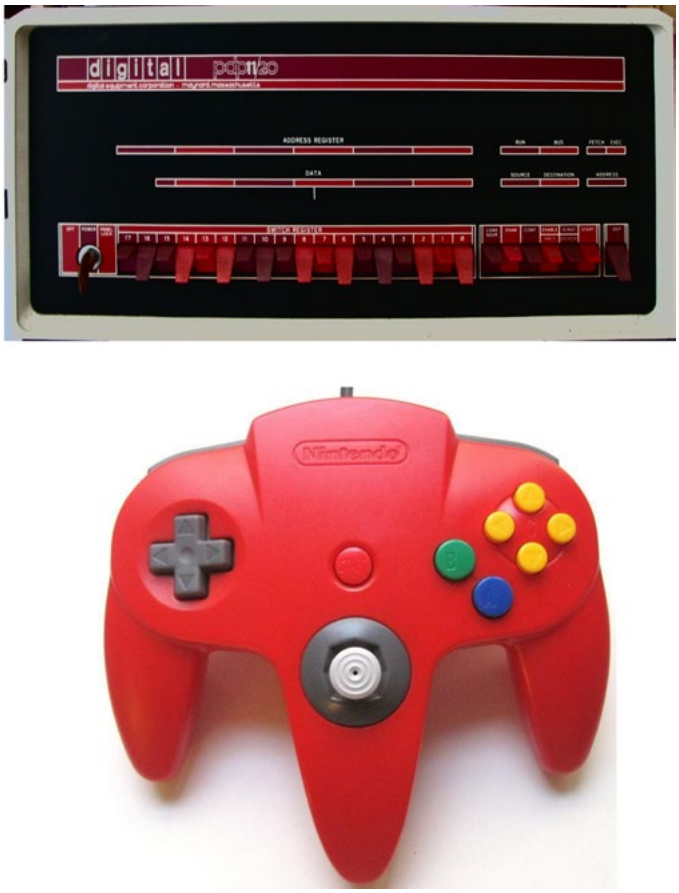

Figure 2. Computer interfaces in the 1950's and 1990's.

There are concept models about communication. "Can we just transmit messages at people and they will understand?" asks the designer. "Well, our model of this process says that is how it works if we are talking about electronic equipment" say Shannon and Weaver (1949). So, we read their report, skipped the part about electronic equipment, or rather assumed it was not a necessity, and went on to produce a bombardment of useless messages every year for many decades. We had misapplied the model by ignoring one of its salient aspect, that people are not telephones.

Which is one of the main problems with adapting a concept model from another discipline: there is a translation step from a model intended for one purpose to a model intended for another, and sometimes too much gets lost in the process. As an example, take the Heisenberg Uncertainty Principle from physics. It says that we cannot know the speed of a subatomic particle and its position at the same time, since we use a photon to get the answer, and at that scale, the photon changes the position of the subatomic particle if we measure the speed, or changes the speed if we measure the position. Elementary!

However, people who do not identify as physicists subsequently decided that the Uncertainty Principle could be applied to the macro scale, where a single photon is not being used to identify anything. At that scale, the principle is metaphorical rather than literal, with the result that it can be applied to everything from what's for dinner to whether or not there is global warming. People confusing the metaphor with the reality will say things like: "you can't know anything for certain. Scientists admit that themselves". In metaphorically applying Heisenberg's Uncertainty Principle outside the realm of subatomic particles, too much was lost in a translation that never should have been attempted in the first place. A possibly more useful metaphorical insight from the principle is that the same tool (in this case the photon) cannot necessarily be expected to perform two functions (measuring location and speed) at the same time.

Another problem with concept models borrowed from elsewhere is that, even if we understand the salient parts, and are working in an appropriate domain, they may not actually be fit for purpose. They were, after all, developed for other reasons than to be used by designers, so even if designers can properly understand them, the attempt to use them might be problematic. Take, for example, a genre of fiction known as the hero's journey. In simple form, a protagonist (the hero) has a goal, and to achieve that goal must travel and overcome obstacles. It is a mental model of human action that has served well in the computer gaming industry, and there have also been attempts to use it for design projects.

However, most human activity is not heroic, but mundane, so scaffolding a design project using this perfectly valid model of a particular fictional genre is often not helpful. For example, think of the many retail experiences where the customer is expected to navigate the physical space in a relatively linear manner. As proof of this underlying assumption, it is only necessary to look at the empty reverse side of free-standing signage by walking in reverse order, perhaps by entering, for instance, through the exit door.

In fact, there are sufficiently many alternative genres and ways of using them that thinking of the user experience as a linear journey of any kind might actually introduce confusion. As Northrop Frye (1957) identified, human actions in many cases can best be understood as cycles that recur indefinitely, with each iteration of the cycle superimposed on the others. The cycle of planting and harvest is an example of this kind of activity.

Is a particular instance of human behavior most appropriately represented as a comedy, tragedy, romance, adventure, thriller, horror, picaresque, or some combination? Maybe it is a fairy tale, which itself has numerous sub-genres, including success through friendship, strength, cleverness, and guile. Maybe it is a Cinderella story, which has strong elements of undeserved suffering and incredible luck.

The utility of concept models

Much of our lives involve the application of concept models. I have, for instance, a concept model of my office, that I can use to help someone else find books or to suggest which drawer to look in for pens. I am not even hopelessly lost when I go into someone else's office, because there is a good chance that the model I have for my own office will generalize to some extent. Once I see a desk and a chair and some books, I can be fairly confident that I am in an office, and everything that I know about offices can be brought to bear.

In many cases, models can be used to produce methods, or sequences of steps to accomplish a task. If I am on the phone and guiding someone through my office, I might communicate just the relevant parts of my concept model of the room. I could say, for instance, that the person should first walk to the desk, then circle around behind it, and open the top center drawer, at which point the selection of pens will be visible.

It is also possible that I do not really need a model or a method, but instead upon entering a strange office there are a limited number of affordances that I can recognize to help me find books or pens. I can work from direct perception of what is likely: the books will be on bookshelves. I can be reasonably sure that the pens will not be jammed point-first into the bulletin board. The downloading to the environment of the intelligence of the person who uses the office (Hollan, Hutchins and Kirsh, 2000) might communicate sufficiently to me as well, so, if I am lucky, the books will be organized in some way I can discern and use to help me find the book I am looking for.

A classic example of the usefulness of a model from the user perspective is an experiment about driving. Guiard (1983) set up an experimental apparatus where a joystick slid back and forth along the underside of a table. Participants were to use the joystick to steer a virtual car on the screen in front of them. However, the motion was counter-intuitive, since moving the joystick left turned the car right, and vice versa. These participants made many errors. In the next group, using exactly the same device, Guiard told the participants that the task was to steer the car, but that they should think of the joystick as being glued to the bottom of the steering wheel. Virtually no errors were made, even though all that changed was the concept model of the users.

There are various ways to critique this relatively clear result, for example, by suggesting that the experiment was not realistic enough or that the participants may have varied in terms of their driving or joystick expertise. There were also only two concept models: sliding stick or steering wheel. However, in the cases of more abstract concepts, there is potentially a wide range of possible valid concept models, and it is more difficult to directly observe what is likely. In fact, for many of the most useful concept models, it is not obvious at all that a pattern even exists, until someone has sufficiently studied the topic to begin to make sense of a wealth of individual observations and propose a general pattern. For many important domains, there are also multiple concept models, where different researchers using the same evidence have come to different conclusions. This is particularly true in the humanities, where the goal is to produce as many valid models as possible for the same object of study.

Producing concept models

It is not difficult to create a concept model. People do it all the time, whenever they have a thought about how something works (Dubberly, 2009). Some concept models are *ad hoc*, only useful for a minute. An example might be the model that forms about the likely behaviors of other drivers while we are driving. Others might last a lifetime.

For instance, a child might encounter a friendly dog. Based on that introductory experience, the child begins to form a preliminary concept of how dogs work, perhaps that "dogs like me". After seeing other people with dogs, that model might be generalized to something like "dogs are suitable companions for people". Since that concept of dogs is also widely endorsed by others, there may be no necessity for revisiting it as time goes on.

On the other hand, the growing child might have another experience, in the form of an encounter with another dog that is not friendly. The child has learned that not all dogs behave in a friendly way. This learning may have implications for the concept model. One option is to revise the existing model to say something like most dogs are friendly and suitable companions, but there are exceptions: perhaps under a new branching between good dogs and bad dogs. The other option is to discard the existing model in favor of a new one, perhaps that dogs are not really suitable companions for people at all, but may be suitable for other purposes, such as working as farm animals.

We can also learn concept models as part of our education. For instance, we might have a model, probably as inaccurate as not, of what the solar system looks like, or of what is permitted or not in polite society. A large part of learning involves memorizing the concept models that our society believes are important for its citizens to have.

With that in mind, if we want to share our concept models so that other people can take advantage of them, it is useful to choose what we want to model so that it is likely to be of interest and use, and to produce them based on some existing or growing body of knowledge. That way, there is less that needs to be done to revise them when subsequent evidence becomes available, and it is less difficult to convince others that they are working correctly.

One strategy for carrying out this kind of work is described by Glaser and Strauss (1967), in the constant comparison version of grounded theory. They suggest that once the first piece of evidence is in, the scholars should start developing a concept model. Then based on that initial guess, new evidence can be obtained that pertains directly to specific aspects of the model, allowing the researcher to abandon, revise, or extend it. The pro-

cess of obtaining new data in order to examine the emerging model is repeated until the researchers believe the model is robust enough that it is worthwhile moving it over into the testing or validation phase. The danger to be avoided is that the model can become too fixed too early in the process. One way of reducing that risk is to ask, at every stage of collecting evidence, a question such as "where do you think is the greatest chance of my misunderstanding some important feature of what we are discussing?"

Although Glaser and Strauss (1967) provide a strategy for the efficient construction of models based on a growing body of evidence, there are innumerable other ways to go about the process. At some level, it might be said that all scholarly activity is intended to produce and validate concept models.

Validating concept models

The basic process for checking out a concept model is to see to what extent its predictions pan out. For instance, if I have a concept model that says I can control objects with my mind, then I should be able to use my mind and nothing else to move objects around me. If I cannot, then I must question the validity of the model. On the other hand, if I have a concept model that says some people some of the time can move objects with their minds, then I do not have any predictions that I can easily validate. All I can try to do is search the world for the right people under the right conditions, or else try to establish who the right people might be and then set up the conditions, or vice versa. If my model could help me predict the correct conditions and people, it would definitely be more useful, but as it stands, it is not a very robust model.

Then, of course, the question arises about the kinds of evidence and argument that are necessary to convince not just me, but also other experts in the field. Evidence and argument for validity in the sciences, social sciences, and humanities all differ, and there is no reason why the inventive disciplines, including design, cannot establish their own criteria just as these other areas have.

As most researchers are already aware, in the sciences and many of the social sciences, the goal is most often to disprove the null hypothesis, which means that for any prediction the concept model makes, it is statistically highly unlikely that the prediction would come about by random chance. Different areas set the bar for statistically highly unlikely at different levels, but less than 5% is usually the highest anyone will go. For matters of convenience, exact numbers are usually not reported, but instead the study will say what bar their results fall beneath (e.g. $p < .05$ or $p < .01$ or $p < .005$ and so on).

For the humanities and the remaining social sciences, the goals are somewhat different. The purpose of research in the humanities is to take an object of study and enrich it by looking at it from a new, valid perspective: what is often referred to as an interpretive lens. In this case, validity is determined through evidence of a documentary kind, combined with a compelling argument.

For example, a literary scholar might be interested in the private letters and poems of the eighteenth-century poet and adventurer Lady Mary Wortley Montague. Although she never published in her lifetime, there is a good extant collection of her writing (Figure 3).

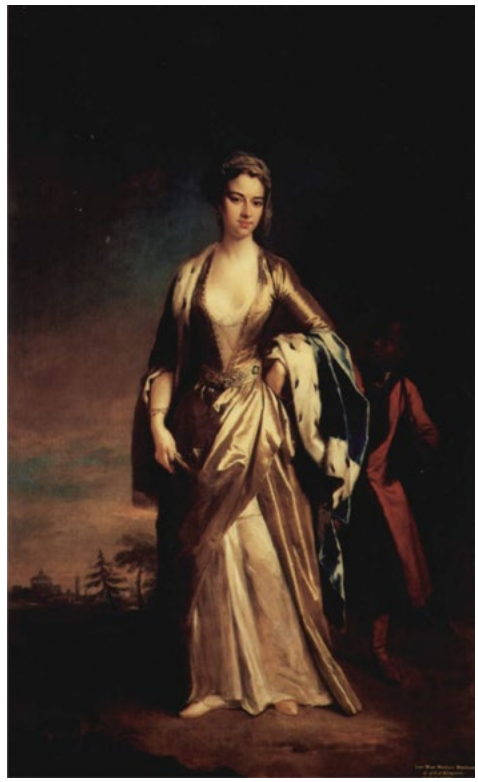

Figure 3. Lady Mary Wortley Montague

Since she traveled widely, a post-colonial scholar may read the material looking for patterns of colonial thinking. Another, interested in body theory, might spend time on the work Lady Mary did in bringing the practice of smallpox inoculation to the western world. In that case, the body of evidence might be expanded to include historical accounts of inoculation. A third, bringing a feminist lens to bear, could be more interested in the biographical details of a woman from society who left her wealthy British husband to enjoy life and lovers on the continent. In this case, the letters to her female friends and scandalized conservative daughter might be supplemented by other biographical accounts from the time.

For the inventive disciplines, including design, the situation is different again. As has often been said (Zimmerman, Forlizzi and Evenson, 2007; Gaver, 2012; van de Weijer, van Cleempoel and Heynen, 2014), these fields are interested primarily in possible futures, rather than in getting a better understanding of the present and the past. This is in large part the reason why design has historically made use of so many research methods and concept models from other disciplines. Since their focus is on the present or past, and it is necessary to understand both in order to think about possible futures, why not adopt their models, their methods, or better yet, their findings, so that the actual project can get started. It makes perfect sense.

However, whenever design looks to understanding the future, the research methods and the evidence they collect about the present or past need to be reconsidered. Some of the predictions that can be made with models of the past and present naturally deal with the future. For example, Herbert Simon (1996) suggested that people do not make decisions by logically optimizing benefits, but instead, by "satisficying", or choosing an option that is sufficient. That model of human decision-making predicts not only past and current behavior, but also a future one. On the other hand, there are models that only make predictions for the past or present. An example or this is a model that explains and perhaps justifies some contemporary phenomenon, such as a model of human life that says women have a kind of natural inferiority to men, making it unreasonable for women to vote.

What is more useful for design are models that can help with decision-making during the design process. For instance, there is a concept of universal or inclusive design that says it is better when possible to create one design that accommodates a wider range of human ability than to create several designs that are specialized in order to serve specific subsets of people. One of the arguments in favor of this approach is economic, since the companies that make and sell products can sell to a wider range of people with no additional, specialized products. Another argument is that ability is not a fixed attribute, so that for practical purposes, someone with their hands full can be thought of as someone who has no hands.

From a design perspective, these kinds of concept models can be validated through the creation of prototypes, whether of objects, processes, experiences, systems, and so on. One way to use these prototypes is to expose them to study participants who can pretend that they are in the future using the prototypes.

Another approach is to compare the prototype to an existing product, service, system or whatever it might be, in order to understand if and how the prototype is an improvement. The problem with this technique is that it only works if there is a function-to-function comparison. Otherwise, it often involves a category error, since the prototype is an improvement precisely because it contains new features that were never present in the existing version (Ruecker, Radzikowska and Sinclair, 2011).

There is also the possibility that the prototype itself is a form of new knowledge (Galey and Ruecker, 2010), and that with sufficient understanding of the context leading up to the prototype, it is possible to evaluate it as though it were an academic argument. This is particularly likely in the case of prototypes intended for provocation or experiment, since they are more likely than production prototypes are to embody an idea that is contestable, defensible, and substantive (Booth, Colomb and Williams, 2008).

Concept models for designers

Given that design researchers know how to produce and validate new concept models, what then are the models that are particularly important for designers to have, that they do not already have in adequate form from other disciplines? The first ones that come to mind are models for abstract concepts that influence choices designers need to make in practice. For example, we have spent the past couple of years working on a predictive operational model of the concept of opinion. Designers have an interest in influencing opinion, whether for something as mundane as product choice or something as profound as national policies on education.

Following the constant comparison process of grounded theory, our project is currently building its third theory. It has proceeded through a series of prototypes intended to prime people who are entering cultural events (Ruecker, Roberts-Smith and Radzikowska, 2017). Our initial observation was that an opinion was probably not first and foremost an idea, since ideas can often be changed with evidence and argument. This led us to the theory that an opinion might be a kind of possession. That is, someone might own an opinion like they own a pet, putting time, money, and other resources into it. Some people have only a single pet, while other people have several.

However, on further observation and thought, the ownership model of opinion did not seem to sufficiently account for the social nature of opinions. We saw that, although we had designed environments for solitary reflection, in fact the people who participated in our study tended to want instead to interact with their friends and even strangers who were outside the confines of the private space. Our second theory was therefore that opinions might be something that people invest in, a kind of shared commodity that acts as a focus for building communities. "…building communities (Roberts-Smith, Ruecker, Zehr, and INKE, 2016).

The problem with this model is that it does not seem to sufficiently accommodate the role that specific opinions play within a larger system of beliefs. That is, for many people, the value of an opinion is that, rather than being itself a fixed object, it serves instead as a token that can be used in various ways. Our current model of opinion is, therefore, that opinions are a kind of money that people can print themselves, then use along with other resources in patterns of investment.

If this model is accurate, one approach to working with opinions would therefore be to approach them using strategies for dealing with investments. We might, for example, study the extent to which a particular person can accept risk or is risk-averse. We

might consider what the returns on investment might be, and whether the expectation is that an opinion will provide returns in the short or long term. Finally, we may be able to modify or strengthen opinions by modifying or strengthening the overall pattern of investments that fall outside opinion, and see if opinion will follow. For example, someone might have an opinion that expensive furniture is an unnecessary luxury, then commit to a relationship with a person who owns expensive furniture. The investment in the relationship might be such that the opinion about furniture begins to change, perhaps even to the extent that a growing interest in expensive furniture becomes a means of strengthening the larger commitment.

In another project, just getting underway, we are interested in modeling what it means for someone to hold multiple simultaneous interpretations. We believe interpretation is different from opinion, partly because it relies on evidence and argument, while opinion does not require either of those. The ability to hold multiple interpretations in mind while withholding opinion is arguably one of the core skills taught by the humanities, and its deprecation in society is arguably one of the conditions that has led to a less tolerant world. For designers interested in social good, understanding what makes some people capable of holding multiple simultaneous valid interpretations could lead to design solutions that begin to come to terms with dangerously inflexible patterns of thought and behavior.

We are convinced that a predictive concept model of opinion and another of interpretation could be valuable to designers. However, there are a cluster of related concepts that we have not even started to explore. These include belief, position or stance, attitude, judgment, posture, feeling (in the cognitive sense), and thought. Although it is not essential to map out these various concepts in order for one of them to be useful to design practice, the more we have, the greater their predictive value will be.

Conclusions

Design practice has made good operational use of many predictive concept models originating in other disciplines, from experimental psychology to Newtonian physics to behavioral economics. New models are being developed by other disciplines on a regular basis, and designers are adept at watching for these developments and discovering ways that the insights they represent can be put to use. Less commonly, in fact, infrequently, are new predictive concept models being developed by design researchers, whose interest in knowledge about possible futures could mean that their results could be more directly of use by design practitioners. But with good luck and hard work, that situation may be changing.

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