Maverick* Research: Augmented Reality — Stuck Between Virtual and Physical Worlds, and Stressed Out

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Initiatives: Technology Innovation

> We must be digitally literate to function in the virtual world. But that will be increasingly insufficient to function. As augmented reality becomes mainstream, people must learn to mediate between the virtual and physical worlds in order to navigate the augmented world in comfort and with skill.

Overview

Specific Maverick Caution

This Maverick* research breaks new ground related to augmented reality (AR). Common wisdom is that we need to be "digitally literate" to function in the virtual world. We must know how to operate a smartphone and a computer, understand the basics of the internet and cloud, be smart with social media, and even be able to overcome digital barriers to get any type of customer service. Not being digitally literate can cause people significant stress, and for some, it is increasingly hard to function within the virtual world.

But here, we argue that we need to consider another type of stress even more. Perhaps a more fundamental type of stress. This stress is created when people get caught *in-between* the digital world and the physical world, where some systems and people haven't yet adapted.

Maverick Findings

- Augmented reality is often a little bit "off"; it doesn't overlay the physical world perfectly. This means people must constantly mediate between the virtual and physical worlds. This causes cognitive dissonance and leads to stress.
- Engineers often think "inside out," with the rules and specifications leading over reality, instead of taking the real world as the main reality.

Maverick Recommendations

- People must increasingly mediate and translate between different worlds by building skills for that.
- Developers should use insights from psychology — particularly around cognitive dissonance — to minimize the issues following from people mediating between the virtual and physical worlds. Do this by taking the real world as the starting point, not the virtual layer, and by making sure AR systems learn from users' behaviors.

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Analysis

Consider this example, a true story from one of the authors of this research:

I was alone in the car in a different country, and it was nighttime. The voice assistant of the navigation software on my smartphone told me to take the next left. It was programmed to tell me 30 meters or 100 feet before the actual street, but in this case there was a tiny alley to the left, 10 meters after my location. As I drove slowly, I took that left turn instead of the correct street, and had a hard time maneuvering out again. There was a tiny difference between the workings of the software and physical reality. It is my job as the driver to translate the instructions of the virtual world into the physical action of taking the correct street to the left. And I needed to mediate the differences between the virtual and physical worlds.

With augmented reality, where a virtual world overlays a physical world (see Note 1 for a definition), we will see more examples of gaps between the virtual and the physical, leading to significant stress and discomfort for people.

Systems have had their own reality for a long time. Consider the following example:

Your family receives a letter from a service you subscribe to, sharing their sympathy at your passing away, and the membership, with all its perks, being discontinued. You call up to confirm you are still alive. The customer service representative at first doesn't even believe you: "I am sorry, our system clearly states that you are deceased." It turns out to be hard, if not impossible, to reinstate the service and all the perks that come with the many years of history you've had. And it's all up to you to get it fixed. There is no process, no functionality in the system. After many hours on the phone and sending evidence you are still alive, you get a new membership. The perks are gone, because of a gap between "administrative reality" and "real reality" **(the moment the term "real reality" is needed to describe our world, it is a clear sign that something has gone fundamentally wrong).**

We are seeing this phenomenon of people getting caught up in augmented reality already. When Pokémon GO came out, there were numerous examples where people entered other people's gardens and even restricted natural parks to catch the Pokémon spotted there. [1]

A Fundamental Exploration Into How People Relate to Technology

Studying the digital society is a study of interaction with some kind of technology involved. Don Ihde, an American philosopher of science and technology, identified four fundamental relationships between people, technology and the world (see What Can We Learn From Don Ihde?):

- In *embodiment relationships*, we use technology as an extension of ourselves to communicate. We use glasses to see better, or jump on a Zoom call to talk to people on the other side of the world.
- In *hermeneutic relationships*, technology describes to humans what the world looks like. Think for instance of an MRI scan, or a radar screen.
- In *alterity relationships*, technology interfaces with a part of the world. Think of an ATM with a user interface that allows us to draw cash. Or think of a thermostat that we operate to increase the temperature in the house.
- In *background relations*, technology sets the context for a human action or interaction, like the sound of a doorbell prompting action.

Those four relationships can also be expressed in more formulaic terms:

- Embodiment relations: (human - technology) → world
- Hermeneutic relations: human → (technology - world)

- Alterity relations: human → technology (world)
- Background relations: human (technology/world)

In all four categories, technologies mediate between people and the rest of the world. “Mediation” means conveying and reconciling between two parties.

Here we introduce a new, fifth, relationship that we should master. It is *human beings* that must mediate between the virtual and physical worlds, or between virtual worlds.

Technology ← Human → World

Consider the example of the navigation system. There was a tiny difference between the workings of the software and physical reality. It is the driver’s job to translate the instructions of the virtual world into the physical action of taking the street to the left.

When interacting with augmented reality, there is the AR interface, which in itself is a reality. And it interacts with the physical reality it represents. Picture an AR overlay over a machine you are trying to fix. Your perception of your hand interacting with the physical machine can be distorted by what you are watching in the AR overlay. In some ways it is similar to when you try to straighten the back of your hair with the aid of two mirrors and end up reaching in the wrong direction. In the case of this kind of AR, dissonance is experienced as you look back and forth between the interface and physical reality — while also experiencing proprioceptive sensations directly related to the movement of your hand.

These examples so far are all about creating an unintentional gap between the virtual and physical worlds. However, within AR we will also see many intentional gaps. Imagine public spaces, like buildings or roads, that lack maintenance, while the virtual layer masks this. We already see the psychological effects on teenagers confronted with highly touched up instagram posts that offer a distorted view of reality.

You are the mediator between the virtual world and the physical world, which can cause stress.

This idea of people mediating between the virtual and physical worlds is a fundamental insight. German philosopher Martin Heidegger introduced the concept of *dasein* ("being there") as a way of describing how people relate to the physical world around them. "Being there" is a very appropriate translation. One is always "there" — world-bound, submerged, entangled, engaged. We have a certain natural behavior in the world as we are so familiar with it, and — being part of it — interact with it to a large extent with skill and in comfort.

Functioning solely in the physical world is no longer an option, as the virtual world has become an unavoidable reality to get many things done. We need digital literacy to shape our *digital dasein* (see Digital Connectivism: Appendix).

We've always had a mental model of the world that guides us in interpreting what we observe, and provides us with guidance on actions and with information based on which we make predictions. We use that same mental model to navigate the virtual world. Sometimes our mental model is wrong, and so we learn. We experience, refine and update our mental model continuously.

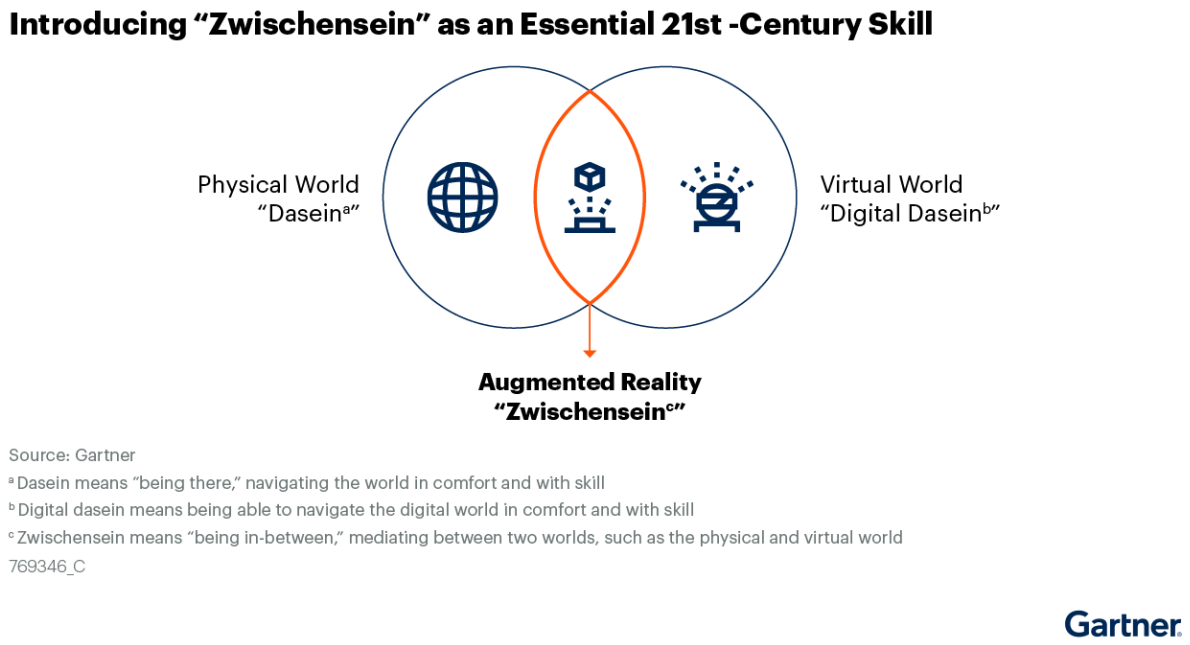
But now, let's consider augmented reality, which overlays a model on top of the physical world. This affects how our mental model needs to operate. It needs to reconcile, or mediate, two realities: the augmented part, and the physical part. This is a new process that at the very least requires more effort and likely leads to frustration, stress, disappointment and even anxiety. Most often, this is the result of that mediation process becoming too complicated, or having to go too fast.

This is where we introduce the concept of *zwischensein*, or being in-between (see Figure 1). How well are we able to resolve conflict between and inside digital overlays and the physical world?

The essence of the idea is not new. Children of immigrants often know all too well how difficult it is to navigate between the world of "home" and the world "outside," such as the street, school or work. They mediate between those worlds all the time. Employees in companies often do the same as well, feeling they have to mediate between the world at home and the world at work, leading to stress and anxiety when these worlds ask for conflicting behaviors.

> Zwischensein, or being in-between, is the 21st-century skill we need to master that we haven't identified sufficiently yet.

Figure 1: Introducing "Zwischensein" as an Essential 21st-Century Skill



Source: Gartner
[a] Dasein means "being there," navigating the world in comfort and with skill
[b] Digital dasein means being able to navigate the digital world in comfort and with skill
[c] Zwischensein means "being in-between," mediating between two worlds, such as the physical and virtual world
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We know how to navigate the physical world, and we build digital literacy skills to navigate the virtual world. But what if those two worlds overlap and conflict in augmented reality?

The objects in the virtual world are symbols. These can be anything — traffic signs, or coins to win in a game, or virtual characters to chase and catch. These symbols overlay the real world: the roads that require those traffic signs, the places the virtual characters and coins are placed, and all other aspects of reality. Augmented reality mixes these virtual symbols and physical objects together. This leads to interesting design possibilities, but also new challenges of how we navigate this augmented world.

In that sense, augmented reality is more confusing than virtual reality. Augmented reality is intended to be a blend of the virtual and physical worlds, while VR intends to present an immersive and completely new reality, separate from physical reality. Augmented reality poses more stress and navigational problems than virtual reality or other human-machine interfaces. Moreover, these problems are exacerbated when a user is engaged in more than one AR platform. For example, the use of smartglasses may provide more detail in satellite navigation instructions (e.g., by showing an actual route overlaying the road). Meanwhile, the user could also be engaged in another type of overlay that allows location-based advertising, where AR highlights a store with a personal discount that is on the route. To visit the store could mean abandoning the indicated route briefly. These are seemingly minor conflicts, though the reader can undoubtedly imagine how far this may soon go with metaverse engagements of different platforms simultaneously, or even sequentially (i.e., switching from one overlay to another and back, while remaining in the same physical reality).

AR Designers Should Design to Eliminate Cognitive Dissonance

Conflicts between the augmented layer and physical reality can be extremely disorienting to the human being caught in the middle. There is a gap between what they experience as real, through the augmented layer, and what others accept as real (consensus reality), in the physical world. When the two worlds conflict, the challenge for us is to choose which reality to follow.

As a solo actor in zwischensein, we may not trust our own perception of the physical world. We may very well anticipate that the augmented reality overlay has already been built based on a consensus reality, which is seen as more real. We may thereby conclude that our individual perception of the physical world must be flawed, and that we must reject our own perceptions. And then we act based on that — perhaps to our own detriment. This is at the crux of why navigating zwischensein is a source of stress.

Another way to look at the stress within this “in-between” experience is through the lens of cognitive dissonance. Cognitive dissonance is “the perception of contradictory information. Relevant items of information include a person’s actions, feelings, ideas, beliefs, values, **and things in the environment.** Cognitive dissonance is typically experienced as psychological stress when persons participate in an action that goes against one or more of those things.” [2]

Most of the psychological research on how to address cognitive dissonance focuses on what the person suffering from it can do. However, in the case of zwischensein, this is missing the point, as it is caused by external factors.

Here we suggest *avoiding* cognitive dissonance, in two ways:

1. Engineers should take the real world as the starting point, not their virtual world.

2. Augmented reality systems should learn from people's behaviors.

Take the Real World as the Starting Point

Engineers sometimes have the tendency to put their model and the workings of the application at the center. Many of us have witnessed payment machines aborting a transaction, stating "debit card problem," though the debit card worked perfectly well a few minutes before elsewhere. The debit card isn't the problem, the machine reading is.

In these cases, in the mind of the engineer, the model, its rules and assumptions are right and apply to the real world. The assumption is that the virtual model drives action in the physical world. So, the simulation drives reality. The engineering assumption of their virtual model being correct is the main problem that needs to be solved.

There is always a difference between virtual and physical reality, and physical reality should be in the lead. Forcing a model to drive behavior within that reality *always* leads to unexpected and unintended outcomes.

> **"The map is not the territory" is a phrase coined by the Polish-American philosopher and engineer Alfred Korzybski. He used it to convey the fact that people often confuse models of reality with reality itself. According to Korzybski, models stand to represent things, but they are not identical to those things.**

We need a clear design principle for augmented reality. *Make sure that reality is always in the lead, and that the virtual world adapts to the physical world.* Assume when there is discrepancy between the virtual and physical worlds that the physical world is probably right. Assume that there is insufficient data and accept blind spots, which should not be seen as dysfunctional (that would be the engineer's trap).

Use clues from the real world. Let's take the case of navigation software. First, collecting street information is not enough. At the same time, there should be sensors that pick up a picture of a roadblock because of roadworks, and factor that in as well. Observation trumps model. And navigation systems should feed us with more human contextual information: take the next street to the left, at the traffic light, by the light poles; show an augmented arrow path on the actual route; or even "follow that red car."

Learn From People's Behaviors

Another way is to incorporate into augmented reality interfaces the ability to report when the augmented reality version contrasts with what is perceived in physical reality.

It's so easy to think of feedback as "user error" and label this as a learning opportunity for the user. But that would be confirming the engineer's mindset that the virtual system is leading and any deviations from it must be wrong. Instead, the engineer mindset should be that whenever there is a deviation in user behavior from what was expected through the virtual layer, the virtual layer needs adapting. Therefore, augmented reality systems should learn continuously.

People should be empowered to contest it and share input to a new consensus derived from their own passage through zwischensein. Even better if their changes, along with the input of others, allow for automated updates to the interface and experience.

It starts by recognizing the variable amount of time it takes different people to adapt. Solutions should have built-in features to observe when and where humans tend to "make mistakes" per the original design. These are likely moments in the designed AR experience where the processing and reconciling of contradictory information is needed. Prioritize review, correction and enhancement of features through the lens of this reality and perception gap.

In Conclusion

We believe that the idea of "zwischensein" is a fundamental insight in the digital world, and uncovers an important source of cognitive dissonance, leading to stress. We also believe that the recommendations that follow from this, making sure AR systems learn and that engineers should put the real world before the virtual world in their thinking, are fairly obvious. But the fact that they are obvious doesn't mean these recommendations are followed. We can all see examples of the opposite around us all the time — the rules of the system are the starting point, not reality. We believe this is a main reason for the cognitive dissonance caused.

When AR systems are better designed, cognitive dissonance decreases. And over time, we learn how to deal with mediating between technology and the real world. Zwischensein, the state of people being in-between technology and the world, becomes less of an issue. Essentially, we go back to a more comfortable state of dasein, “being there,” navigating the augmented world in comfort and with skill. Until the next source of technology innovation creates the next phase of zwischensein …

Evidence

[1] Pokémon Woe: My Front Garden Has Become a Hot Spot for Monsters, Financial Times; Dutch Authorities Take Pokémon Go Creators to Court Over Protected Beaches, TIME.

[2] Cognitive Dissonance, Wikipedia.

Note 1: Augmented Reality

Augmented reality (AR) is the real-time use of information in the form of text, graphics, audio and other virtual enhancements integrated with real-world objects. It is this “real world” element that differentiates AR from virtual reality.

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