THE AUTOMATED HOME OF THE 21ST CENTURY

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The purpose of this article is to help unify thoughts on adopting best practices for home automation. This article also analyzes why fully automated homes are not yet commonplace and what steps are necessary for consumers to feel comfortable making this transition in their lifestyles. This article calls for business to incorporate a standardized system of communication among not only their product offerings, but among other manufacturers' products within the marketplace. It also calls for businesses to focus on their design schemes, ease of use, and potential for integration so that consumers will want to adopt these new automation technologies.

Keywords: Home automation, Domotics, Smart home, Internet of Things, Internet enabled appliances, Remote control

INTRODUCTION

As children, we did not think in terms of limitations. We did not see impossibilities, and we questioned everything we did not understand. Each new generation has an amazing advantage over its predecessors because it does not yet comprehend its limitations. This poses an interesting thought experiment with regard to the development of technology. We bridge gaps as each generation continues to push the bounds of reason and understanding. We create new constructs for us to live with. We develop new ways to better our existence. With this potential for continued growth, are we really where we thought we would be when the first computer was built so many years ago? Does the home of the 21st century truly look like we imagined it would so many years ago? These are interesting questions that this article will address.

Many new technologies are created everyday which bring us closer to living in a truly automated home. Even with this being the case, there still seems to be something holding us back. With businesses releasing new internal methods of having their own products communicate with each other, markets could be limited to a particular brand or manufacturer by design. This is great for individual manufacturers, but is not great for users. As will be seen, businesses need to focus on encouraging open communication standards and channels of information from all manufacturers to be able to make the fully automated home of the 21st century truly come into fruition.

With any technological advancement there is always some form of concern on the basis of complexity and usability. The concern people have over these two issues can be easily understood as humans are creatures of habit and do not like change. We also do not enjoy having to depend on things that are complex to use or are hard to understand on a functional basis. We like designs that are simple. We like designs that are based off of concepts that we can understand based on prior experience. This means that as long as change occurs at a pace the user perceives to be noninvasive to their normal habits, then the user will be more accepting of nominal changes to the technology they use. When designing a product that pushes the bounds of what consumers are willing to use, there are two main categories of challenges that need to be considered: technological limitations and design limitations.

TECHNOLOGICAL LIMITATIONS AND THEIR SOLUTIONS

Technological limitations separate themselves from design limitations on the basis that technological limitations are easier to isolate and problem solve. Technological limitations are usually solved over time with the advancements of new technology. There is also a logical progression to the expansion upon technological limitations. Often technological limitations lead to the discovery of other technological limitations that need to be solved. For example, until computers were able to handle the large computations that deal with graphical data all pictures were captured on film that was processed by hand. Once the benefit was discovered for processing graphics and pictures completely digitally rather than on film larger hard-drives were needed to store the processed information. Furthermore, it was not until internet bandwidth speeds were high enough to support video formats that consumers were able see the benefit of an all-digital media structure. So, what are some of the technological limitations we are facing now that are preventing the 21st century home from becoming a reality?

Currently the largest area of growth is centered on innovations that make the home more energy efficient. At this point as we move into the digital age more devices are introduced increasing the power the average home consumes. This creates a technological limitation for businesses to face. According to Paetz, et al. (2012), businesses must create a backend that is able to support their user's needs. Businesses need to be able to meet the demand of their market by making "significant investments". They need to know how and when their consumers are going to use their product. If businesses could create data mines to gather information about their customers' usage patterns then their infrastructure could precisely meet the needs of their consumers. This is particularly true for the energy industry. Where power grids have to be loaded to meet the potential demand created by consumers. If power grids could "conserve energy and/or shift electricity consumption from peak to off-peak periods" (Energate, 2011), then energy consumption could be better regulated and distributed.

A way to see this put in practice can be seen in the market today using smart meters. Smart meters track the energy usage of homes and report this information to the energy companies. "Some of these measures have been addressed in European and national policies. On a European level, new conditions for private households have been enforced in the directive 2006/32/EC, which requires Member States to introduce, among others things, some kind of instrument or meter that provides feedback to private households on energy consumption and information about energy efficiency. (Paetz, et al., 2012) If we take that a step further and connect smart appliances using the "Network of Things" (Zigbee, 2018) with the power grid through these smart meters, then the power companies would be able to communicate the opportune times for the consumers to run their appliances. For the 21st century homes to become more energy efficient, "consumers will have to make changes to their everyday behavior and routines" (Fischer, C., 2007). Because of this energy companies need to find methods to influence their consumers to change their habits.

Companies need to create a product line that communicates to other products within that company's ecosystem. Doing otherwise would be harmful to the end goal of creating an automated home. Creating a "Network of Things" in which all devices can share information equally no matter the manufacturer would give consumers the freedom to purchase the best product for their needs. The wireless standard that is being used to build this network is Zigbee, created by the Zigbee Alliance. The purpose of this

standard according to its creators is to "let product manufacturers help their customers create their own Internet of Things and mobile to mobile wireless sensor networks to gain greater control of, and even improve, everyday activities." (Zigbee, 2018)

If manufacturers were to use these network technologies created by the Zigbee Alliance then it would not matter who the product manufacturer was. All products would be able to communicate and share information equally. Companies need to focus on standardized processes of communication instead of creating their own limited system for internal use only. Incorporating Zigbee's technologies would still maintain the overarching goal of having the usage information available for all kinds of internal mining purposes. However, by using these technologies, partnerships between corporations would be more easily formed allowing for more connections between products within the ecosystem of the consumer.

One way that Energy companies could help influence their customers to choose these opportune off-peak times is through the use of tariffs. If implemented correctly, tariffs would change the energy rate structure from a sheer energy over time rating (kilowatt per hour) to energy over time multiplied by some load rating. "This directive has been transformed into national law also in Germany (§40 Energy Act) and prescribes that energy suppliers have to offer some kind of electricity tariff that motivates private consumers to conserve energy and/or shift their electricity consumption from peak to off-peak periods." (Paetz, et al., 2012) If a consumer was able to know that postponing his current activity would significantly decrease the cost of that activity, then that would effectively encourage consumers to modify their schedule of energy usage.

To accomplish this several things would have to happen. First, channels would have to be set up so that the information was legally gathered and the consumer would have to reap some benefit for turning over the rights to their data. Second, the information would have to be securely gathered, processed, and stored in such a way as to not create a harmful environment for the consumer it was gathered from. Third, policies and regulations would have to be created so that an equal balance of rights was created between the company using the data and the consumer it came from. Once these things were done customers would feel much more comfortable using a device which handed over their personal information to a corporation for processing.

DESIGN LIMITATIONS AND THEIR SOLUTIONS

One of the biggest debates today in product design centers on skeuomorphic design (Worstall, 2018). This design concept puts the focus of the design on aesthetic elements that link the customer back to something they are familiar with. In excess this can cause the design focus to move away from feature improvements and focus solely on the aesthetics of the design. In the case of an automated home, consumers are most relaxed when they are at home. They have a set pattern of things they do on a daily basis. As we have seen if consumers notice a harmful shift in this pattern caused by a new product then they are less likely to support the product within the market.

Another design limitation can be caused by a company's product life cycle release schedule. If the technology behind the product evolves too quickly or if the company releases a product too soon then it can severely hurt the future adoption rate of a product. All consumers view the products they buy as an investment. If the customer feels that they will waste money investing in a product then they will wait until a purchase within the market is less risky. This creates a cause and effect relationship between customers not buying a product because of market instability and producers not developing the markets further because customers are not buying into the product ecosystem. This is because consumers prefer simplicity over functionality (Bloch and Wagner, 2003).

The largest issue that needs to be considered to bring these new technologies to market is the simplicity of design (Bloch and Wagner, 2003). The consumer needs to be able to integrate the technology into the system that they are currently using without strain or technological backlash. The system needs to be built stable enough so that the consumer does not need to worry about upkeep. (Bergman, 2000) Creating devices to replace existing products and effectively bringing them into the

modern era without sacrificing the relationship consumers have with a product is a fine line to walk. A great example of this design process can be seen in the release of the Nest thermostat (Nest, 2018).

Nest designed a thermostat, that although more digital than most, looks and acts like a normal thermostat. However, the device programs itself automatically based on the consumers use. This saves each consumer the max possible amount on heating and cooling energy usage. Through background processes it also keeps its own software up-to-date with software updates pushed over the air. Because of this simplicity of design the consumer does not have to change their habits to use the device. The problem according to Nest is that "89% of programmable thermostats waste energy—about $173 a year, on average. They're so complicated that most people don't bother to program them." (Nest, 2018). The device bases its schedule of performance around the consumers use and gently nudges the consumer to be more conservative through making known to the user when and how much there system is being used. This simple design of having everything running in the background is great for consumers. Consumers need to be able to have a minimal technological understanding and yet still be able to use the product. The products design needs to be derived from devices the consumer is already familiar with and understands.

Another example can be seen in the "Philips Hue". The "Philips Hue" is a LED light bulb designed to replace the standard incandescent. Many light bulbs types have tried to replace the standard incandescent over the years, the most recent being the compact florescent. The key difference with the Hue made by Philips is that it saves the consumer more energy usage per kilowatt-hour than any other bulb. Up to 80% less energy usage per bulbs when compared to typical 600 Lumen 50 watt incandescent bulbs (Introducing Philips Hue, 2018). It is also able to change colors and brightness levels remotely over a wireless connection. On top of all the added automated features, because the bulb is a LED type bulb the lifespan of the bulb is 15years (Apple Store, 2018). One design reason why the technology in the LED bulb is better than the comparable compact florescent is that LED bulbs have no harmful chemical or materials in them. This creates another benefit to consumers since there is no harm done to the environment through their use.

POSSIBLE FUTURE EXPECTATIONS

It is safe to say that one day the home will be more automated than it is now. "However, complete solutions which also include home automation have not been offered on the market up to now" (Fischer, 2007). Home automation systems are still expensive and are thus used solely by the wealthy and social elite. (Staub and Senn, 2003). As with every passing year more products are released which unlocks this capability for the consumer. With all the possible types of technology available, and all the advancements we have made within technology, it is only a matter of time before everything in our homes is connected and controlled though an automated system.

As we have seen the main thing that is holding this process back is standardization. To create a standardized system we must first ask ourselves what that system will look like. You must start by looking at the tasks you do each day and filter off the ones that potentially can be managed by an automated system. As systems become smarter through the use of artificial intelligence more tasks that previously could not be added to the list will be able to be taken over by our automation systems.

To go through this process start with the first thing that you do every morning. You wake up. Even the process of waking up is becoming more automated. It is quite common now to be able to set multiple alarms on an alarm clock. This in itself is an automated process, since it allows us to set different alarms for different mornings for different reasons. Say for example your weekend schedule is different from your weekday schedule. But what happens when things cause your schedule to change such as holidays, weather, or traffic? These problems could be eliminated through a deeper integration of automation into the process.

Now, say we connect your alarm clock to the "Network of Things". What happens? What benefit could we glean? If all these systems were able to communicate with each other to share information then with enough information the system would now take control of itself without having to disturb the user for confirmation. For example by being tied into your home alarm system the alarm knows what time you

normally leave every morning. Thus it is able to calculate how long you need from the time you wake up until the time you are out the door. It also knows what time you set the coffee machine for and how long it takes to make thanks to information from your coffee maker. It also knows the condition of the roads you take to get to your office thanks to the GPS in your car, which knows you normal route to work. Combine all this information and a system could accurately predict what time you need to wake up by so that you are not late for work and set the coffee maker to give you enough time to still enjoy that first cup before you leave for work.

Continuing the same process, what's next on the list, laundry or perhaps the dishes? With both of these, once connected to the "Network of Things", they will be able to determine with information gathered from the "Smart Meter" as well as anything else currently running on the "Network of Things" when is the most opportune time for them to run. Your Air-conditioner could connect much this same way. Whole neighborhoods could stagger their usage by coordinating their schedules with each other through a "Smart Grid".

Another implementation could be through receiving textual information from the automated system in the form of an update/alert on your mobile device (Botterweck, et al., 2009). If this system were implemented, on your way home from work you could get a message on your phone asking whether or not some item should be reordered because your current stock is running low. Or perhaps it is more convenient to purchase the item on your way home and thus it displays the nearest locations on your current route home. The entire system can now be seen as multiple devices working together to make repeated tasks the user does more convenient (Botterweck, 2007).

CONCLUSIONS

The 21st century home is certainly not quite like we imagined it would be so many years ago. The thoughts and ideas of the past gave us seemingly impossible goals to tackle, but today many of these goals are on the verge of becoming a common reality. We must continue to look at these goals much as children do. Not as strictly impossible things that our limitations will never allow us to understand, but simply as questions that we do not currently have the understanding needed to fully solve. Our paradigms must change. Our habits must change. We must not limit ourselves only to a betterment of standard processes, but we must further the advancement of technology to help us reinvent our lifestyles and habits.

The two best ways for businesses to encourage change is to make the product as simple and easy to use as possible and change the way consumers interact with their products. If these practices are taken advantage of by businesses then we will see our homes move even more swiftly into the 21st century.

This being stated, businesses need to focus on practices which put the information in the hands of consumers in order for consumers to feel that they are in control of their usage. If businesses promote the usage of their consumers by building a backend support system then the entirety of the ecosystem will flourish. Data mining is essential to building out the most supportive backend system. To best support consumers, standards need to be created in the automation process for devices to communicate together.

As mentioned, the best way to accomplish this is through the "Network of Things". Done correctly, homes will be able to not only notify the consumer that their pantry is almost empty, but also reorder of items that the consumer normally purchases. Appliances will be able to run themselves at off-peak times by communicating with each other and the power grid. This allows multiple homes to a-synchronize their services creating a better distributed load on the power grid. This will not only save the consumer money on their electricity bill, but also allow power companies to regulate the load on their grid more effectively. Expanding the Enterprise Resource Planning concept into the home will move the home further into the 21st century.

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