

Design Ecosystems and The Design of Everyday Life

Introduction of a Conceptual Framework of Design Ecosystems

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Abstract: The design of everyday life can be studied by considering that it consists of practices that take place in a context that can be understood as a design ecosystem – a system of artifacts, resources, connections, flows and dependencies, organized by the owner's practices. This paper elaborates these concepts and discusses also the concepts designs, design toolkit, design platform, design space, and personal digital ecosystem. I also present and highlight the importance of making a distinction between social and individual practices.

Key words: *design ecosystem, practices, designs, design toolkit, design platform, design space, personal digital ecosystem, design of everyday life, individual practices*

1. Introduction

Design as a field tends to perceive the world through design projects – anchoring the point of view to something that is being designed, such as a product. In the industrial system, a product is designed to appeal to and to fit into the lives of as many people as possible [17]. The focus is on the product, and the numerous users and their needs must be in various ways approximated in some way into a manageable set of requirements that can guide the design. However, the reality is that in the end, when that product finally reaches its users, every one of them is a different individual and has a life that is always unique, and thus potentially poses a unique set of circumstances to the product. This makes little difference to the success of traditional material industrial products, but it is very significant for the usability and usefulness of digital products, because they are often intimately connected to their environment and need to be customized according to the users' preferences and practices. Because of that, it would be important for design to transfer its point of view from the single product observed as it leaves the factory to the user's whole environment where the product will eventually operate.

From an individual's point of view, a single product is just a component in a very large system of artifacts in her life that are connected by her activities, or *practices* [26, 28–31]. An artifact is mobilized by the user to perform some functions, as part of a practice, and often in connection or collaboration with some other artifacts. For example, there may be a flow of material or information between the artifacts. The function of one artifact may be dependent on a service provided by another one, and in turn support the function of another one, and so on. For an individual, the most important qualities of the artifact relate to how well it performs in its role, how smoothly and reliably it contributes to the performance of everyday life practices, and adapts to the idiosyncratic arrangements and preferences of its owner. The artifact is one within a multitude, a component in a system, performing a role that likely requires it to satisfy various dependencies and to support and serve others. If it succeeds in these, it will solidify its position as a building block that is relied upon, and if it fails, it must be fixed or replaced in order for the owner to be able to continue performing those practices.

To study this system around an individual that supports her everyday life practices, I suggest that *design ecosystem* is a useful concept that can be used as an *instrument of inquiry*. The *personal design ecosystem* consists of various *designs* and is in itself a complex, emergent design. It includes artifacts, such as products;

infrastructures, such as buildings and networks; connections and dependencies between components; flows of material and information; resources, such as materials, information, food reserves, bank accounts, or databases of media, emails, addresses; and as the elements that organize the ecosystem: the individual's practices. As the ecosystem concept is an instrument of inquiry, the boundaries of and the criteria for inclusion in the ecosystem are not in any way absolute, they depend on the knowledge interest and hence the definition of the person who invokes the inquiry.

The need for a more holistic and ecological approach to the study of artifact constellations and related design concerns has been proposed by other authors. For example Nardi and O'Day define an "information ecology" as "a system of people, practices, values, and technologies in a particular local environment. In information ecologies, the spotlight is not on technology, but on human activities that are served by technology" [19]. Tungare et al. have studied "personal information ecosystems" and "the evolution of personal information management practices" [35, 36]. Also Stolterman's research group has studied such personal ecologies or ecosystems and in their latest article call them "device landscapes" [14, 21, 27, 34]. The approach I propose here is compatible with these approaches, but has its own logic and foundation, and as such does not directly build on them. Hence I will first present my own concepts and then discuss the relationship of my approach with these others. I have also presented a complementary discussion of these concepts in another paper [15].

As explained above, the design ecosystem becomes especially interesting as a consequence of the digitalization of everyday life, and I will discuss this in the last part of the text. However, I will begin the exploration of design ecosystems with a non-digital example, and I will also use this example to highlight the role and nature of practices as the key element that organizes the designs in our life and environment. Other concepts I will discuss with this example are designs, design toolkit, design platform, and design space.

2. Practices in the kitchen

As noted above, the design ecosystem is a concept that can be adapted to the study of many phenomena, by adjusting the boundaries and the criteria of inclusion. For example, if we want to study activities that relate to cooking and try to understand the artifacts that play a role in this, we can define the ecosystem of interest as the "kitchen design ecosystem" or the "design ecosystem of cooking".

I want to use kitchen and cooking as an example, because it is a very familiar environment with familiar activities and artifacts for everyone, in spite of many cultural differences. Cooking and culinary culture is also a very fertile context for highlighting the great diversity and idiosyncrasy in everyday life, and the meaning and significance of personal preferences [3, 25, 31]. Each of us knows that almost no two people have the same culinary preferences, and at least I have never met anyone who would have the same as I do.

As a result of the significance of personal preferences, no two kitchens (that are not just left unused) are furnished, equipped and resourced in the same way. When a building with many apartments is constructed, the kitchens may originally be similar, but as soon as the future inhabitants of the apartment begin to turn it into a home for themselves, they start to customize the kitchens in various ways – furnishing it with furniture and equipment that they prefer, by equipping it with dishes, pots, pans, utensils, appliances, tools and various kinds of reserves of foodstuffs that they need for their own cooking.

In Finland, most apartments, when sold or rented to new inhabitants, contain a kitchen equipped with a fairly standard set of basic equipment related to cooking (in addition to the standard infrastructure that every room in the apartment also has, such as electricity, lights, heating etc.), things such as running water, faucet, sink, and sewer; stove; fridge, maybe a freezer; and closets and drawers. This basic equipment in effect turns the room into a

kitchen, and is expected by the inhabitants to be provided together with the apartment. Normally, people also expect that the kitchen is not customized much further than this by the previous owner, because they want to exercise their own preferences and bring their own additional artifacts into the kitchen to make it their own and appropriate for their own kitchen practices. Quite often it also happens that, in order to get a kitchen that fully meets their preferences, they actually renovate also the basic furniture and equipment of the kitchen. [31]

While the equipment that people furnish their kitchen with forms a unique combination compared to the kitchens of others, many of the components in the kitchen are also found in the other ones. The differences may be subtle, based on differences in taste, or more substantial, related to some special form of cooking. Generally however, the equipment is selected from the consumer market from a selection of goods that is supplied by the global industry, and while the particular combination of such commodities is unique, the same products are used in many other kitchens around the world, as components in some other unique combination.

However, what really is unique in every individual's cooking are the cooking practices. If two people are given the same equipment and raw materials and asked to prepare some food, for example a hamburger, they will most certainly prepare it differently and produce a different kind of result. Most of us probably have the experience of enjoying a certain kind of dish prepared by different cooks, with a different outcome. In fact, it is extremely difficult for someone to prepare a dish exactly like someone else, without making a great effort in observing and imitating the actual cooking process of that person. We are very familiar with the idea that there are common dishes that share the same basic design (such as "a hamburger"), but we also expect that they will be prepared to some degree differently by each cook, and we often exchange recommendations on where to find the best tasting implementations of each particular dish.

Within the kitchen ecosystem, it is also easy to realize the significance of the practices as the essence of what the kitchen with all its artifacts is expected to support. While a stove, a frying pan or a fork may be beautiful objects, the main role of artifacts like these is to support cooking practices. For example, if I decide to prepare fried eggs for lunch, I need all the abovementioned artifacts, as well as eggs, a spatula, oil, salt, a plate and a knife. If one of these is missing, I may try to substitute it with something else (e.g. oil with butter), or decide to change my menu and make something different.

While these are the most immediate artifacts and materials I need, they are connected to other designs. For example, the stove is electric, so it needs electricity that is delivered to me by the electric company through their network. The eggs and oil I get from a store and store them in my fridge (eggs) and on my table (oil), where they are in reserve until needed for cooking. The fridge depends on electricity, like the stove. To be able to buy electricity and the raw materials, I need money which I get from my salary.

All in all, to be able to perform the practice that is in my focus here, to prepare eggs for lunch, I need to have a number of artifacts and materials in place and to be able to make them collaborate according to a pattern I know. I take the frying pan, place it on the stove, turn the heat on, pour some oil in the pan, take the eggs out of the fridge, break them onto the pan, and begin frying them. And so on. The successful performance of this practice requires that the artifacts perform their parts in the practice. The pan must be ready to receive the oil and the eggs, it must tolerate the heat and transfer it to the oil and the eggs, it must not stick into the food, and it must release the food when it is ready, and be easy to clean afterwards. The stove, the pan and the spatula, as well as the other components in this practice, must collaborate according to the way I want to use them. If they do not, I will probably replace them with something else that functions better according to my expectations and needs.

We are used to thinking about objects such as the frying pan as isolated entities, but as this example suggests, most artifacts are in fact connected to many others, when they become part of some practice. And when we begin

to think about it, and follow the situations where an artifact is used for something, it most likely always happens in the context of some kind of practice that does involve other components, and where the success of the artifact depends on its ability to be compatible or collaborate with other artifacts, to support us to achieve our goal with our practice.

The “eggs for lunch” example presents a very cursory description of a very simple cooking practice. Cooking is an interesting area for the study of practices because there are vast resources of various kinds of descriptions of cooking. For example, there are many cookbooks that give recipes that explain the practices how to cook various dishes. People make notes of their own cooking, and parents write recipes and notes regarding cooking in order to pass on their specific family tradition to their offspring. There are many cooking programs on television, and a great number of cooking blogs on the internet. People exchange stories about their own cooking, and of the cooking of others. This is clearly a very popular area of everyday culture.

Many scholars writing about design and/or evolution have suggested that it is important to realize that design is a basic human activity, that in fact, the ability of the human species to design intentionally and to accumulate design within a culture that can be transferred to future generations, is the most significant factor that makes our species different from others. In the words of Victor Papanek:

”All men are designers. All that we do, almost all the time, is design, for design is basic to all human activity. The planning and patterning of any act toward a desired, foreseeable end constitutes the design process. Any attempt to separate design, to make it a thing-by-itself, works counter to the fact that design is the primary underlying matrix of life. Design is composing an epic poem, executing a mural, painting a masterpiece, writing a concerto. But design is also cleaning and reorganizing a desk drawer, pulling an impacted tooth, baking an apple pie, choosing sides for a backlot baseball game, and educating a child.” [24]

Several others [4, 17, 20] speak in a similar tone, highlighting the universality and ubiquity of intentional design as a fundamental human phenomenon. The other point worth noting is that the examples of design given by these writers do not always include the making of a physical, material artifact as the result of design. While it tends to be easiest for us to recognize design from material artifacts, there are also many immaterial designs, such as plans, social systems, rituals, songs and so on.

Design literature (e.g. those mentioned above) discusses design mostly as a phenomenon and as an intentional activity, but there are very few attempts to define what is *a design*. Often it appears to be implicitly just assumed that designs are outcomes of design activities. However, there is a common understanding that design also can be used to refer to the set of characteristics that define the structure and functionality of something, regardless of whether it was created by an intentional design activity. For example, things that result from biological or cultural evolution are often discussed as designs (e.g. [5, 6, 11, 13, 32, 33]). My position is that things that exhibit a design can be considered to have a design, regardless of what kind of process created that design. In many cases we have only the resulting designs available for study, with few reliable means to confirm the details of the processes that created them. Due to the elusiveness of the topic, I am not able to present a proper definition of what is a design, but generally a design defines structure or form, and properties and functionality. A design can exist in the form of some description, without being implemented as an artifact; also something can exist and embody and manifest its design without there existing a separate description of the design anywhere. The same design may be implemented in many artifacts through some process of copying or reproduction. (For further discussion of what designs are and what are designs, see [15].)

Following this idea of design, also practices can be considered to be *designs*. The way I prepare my fried eggs is a design that I *reproduce* every time I perform the practice, more or less the same way. I have developed that practice over time, and because that design is so familiar to me, I can prepare the eggs without much *additional design effort*, unless there is something exceptional in the circumstances. The cooking related practices extend beyond the simple production of an artifact, some specific dish: we cook meals composed of many dishes, we plan them, we invite friends, prepare for it by furnishing our kitchen and stocking our reserves, and so on.

The design of a dish is not the same as the design of the practice of making a meal. When I design my lunch (of fried eggs), I do not start from scratch; I employ my *design toolkit* – for example my repertoire of recipes and the tools provided by my kitchen and typically make and adjust the plan as I cook. It is a very lightweight design task, because most of the components in the final design already exist, thanks to the toolkit I have accumulated over the years of my life. However, if I do not know how to fry eggs, or I lack something in the kitchen (e.g. there is no frying pan, or no electricity), I must design some new solution, or learn it from someone else or some resource, like the net or a book.

In the case of a more elaborate practice, for example a dinner party, the immaterial dimensions of the design effort and result become more evident: who should be invited and how, when should it take place, should there be some other program besides the meal, what should the meal contain, how to orchestrate the preparation of the dishes, how to make the guests feel welcome and relaxed, and so on. The artifacts, the meal, will play an important role, but the whole event and the process of making it happen are a complex design that I need to take charge of, but which will also get significant design input from my guests.

The dinner party is also a good example of the significance of being able to influence the design of that event at a very detailed level. When cooking just for myself, I may be willing to accept less than delicious results, but in the case of the dinner party bad outcomes will make me unhappy and embarrassed, and I will do my best to secure beforehand that I can not fail, and I expect my artifacts in my design ecosystem to perform reliably and flawlessly to support me to achieve my goal. In general, people tend to pay attention differently to different kinds of things in life – that is part of what makes us individual and unique. However, most people have many areas of life where they are very particular about the design of their activities and where the details are of utmost importance.

Another aspect of practices as designs that can be explored through the dinner party example is the difference between a *social practice* [29, 30] and what I call an *individual practice*. “A dinner party” is a social practice – a well known and understood design for a certain type of event, within a certain cultural sphere. Most people in my environment will understand quite well what it means if I invite them to join me for a dinner in my home. However, when I host a dinner, I will design my own implementation of it, an individual version of that generic social practice. This I always need to do, because my own context is different compared to a generic idea of a dinner. An individual performance of a social practice must always be adapted to the personal context and circumstances of the individual in question, as well as to the time and space and social context where it is located. This means that even though there may exist a generic design for a social practice, the performance of an individual practice always requires some extent of adaptation and thus design.

This interplay between the generic designs – e.g. of social practices and of artifacts employed in them – and the particular designs – my own unique, individual and contextual adaptation and modification of the generic design – is a central characteristic of everyday life. We expect that a dinner party will be enjoyable because it is partly similar to other dinner parties, so that we know to some extent what to expect, but importantly also different and unique, so that it will not be boring. The generic designs are part of our everyday life design toolkit that we

acquire from our social environment and from the market, in order to organize and design our own life activities in a way that we want.

The kitchen is a special facility in my home, specifically designed and furnished as a generic environment to support many different cooking activities. The artifacts are chosen to accommodate the variety of foods and cooking methods that I foresee myself using, and of course, my apartment was already furnished with many basic components that are common for cooking in Finland, before I moved in. The pots and pans support the cooking of many kinds of dishes, and I have selected them to accommodate the normal variety of my personal cooking. The stove is a generic tool for heating any of my pots and pans that are meant for heating, and the fridge is a generic tool for storing any food that needs to be kept cool. With all these and other features, the kitchen functions as a *design platform* for cooking: it is an environment where various design activities can take place and where various new designs can be created easily. It provides services that are generally needed for cooking, such as frozen, cool and room temperature storage, ways to clean, cut and mix raw materials, heating, and so on. When I want to prepare a roast in the oven, I only need to acquire the meat and fresh herbs, as my kitchen already contains all the other ingredients and equipment for making it, and I have all the necessary knowledge and a generic design of the practice in my cooking repertoire.

The kitchen is an example of a design platform that I have largely composed myself. There are also design platforms that are designed by some other actor or vendor, that exist for the purpose of supporting further design activities with their services. Examples of such platforms are the monetary system; electricity grid; water and sewage system; public transport; schools and universities; the market; a mall; and so on. A building with its management functions can be thought of as a platform for living. When I buy or rent an apartment, I do not have to concern myself personally with the cleaning and management of the building, as the company that owns the building will take care of these on my behalf. I can concentrate on the design of my personal life and leave the common concerns of the building to the management company. (More about platforms: [8])

The final concept that I want to introduce still in the kitchen is the *design space* [2]. My kitchen, my resources (time, money, materials, available sources for materials and information, network of friends) and my abilities create and delimit a space of opportunities for design. When I consider making a meal tonight, I have to consider what I have in storage, what I might want to consider buying, whether the stores are still open, what I know how to cook, what I could learn to cook using my cookbooks, the internet and my friends' advice, what equipment I have available, what I can imagine, and the resulting options that may come to my mind and I can realistically consider to make, all together form my design space in that particular situation. My design space considering a dinner party will be probably very different, as there will be different considerations in terms of time, effort, desired qualities and so on. If I am travelling in a foreign city and staying at a hotel, my design space for cooking is probably extremely limited – maybe the room has only a water heater, which rules out most kinds of cooking. However, I may have a very broad and interesting design space for planning a delicious dinner experience, if I am ready to include restaurants in my design toolkit in that situation. The design space is thus a dynamically changing space that contracts and expands depending on the applicable constraints and the resources, capabilities and components that are available at any particular moment in my design toolkit.

3. Digitalization and digital technology

My kitchen design ecosystem is mostly based on non-digital technology. However, most other areas of my everyday life practices have, during only a couple of decades, become increasingly permeated by digital technology, in a transformation – a *digitalization* process of society – that continues in an accelerating pace [16].

In the sphere of everyday life, people acquire new digital devices and software that they use to take care of a growing share of functions within their practices. While the first digital device that entered homes was probably the digital clock, it is the personal computer that really began the transformation of everyday life practices, because it was the first programmable, truly multifunctional digital device that entered the home. After the time of the first personal computers, we have witnessed the transformation of almost all kinds of mechanical and electronic devices to be based on digital electronics. For example, our telephones, cameras, media devices, temperature meters and scales are now increasingly digital.

The essential special characteristic of digital technology is that as at its core is always a programmable computer, it is flexible in its functionality – it can in theory be programmed to do anything that can be described as a program. A digital device thus always contains two essential, complementary elements: 1) the *hardware*, that consists of the computer that runs the programs, and its peripheral circuits that provide it with means for input and output of information, such as network connections and user interfaces; and 2) the *software*, the complex set of interacting programs that control what the computer does. Because of this programmability, the computer is a *metamedium*, as famously suggested by Alan Kay in 1977 [9], that can function like any other medium if programmed appropriately. This metamedium nature of the computer has enabled it to become the new core technology utilized in all areas of life, and to replace the earlier analog electronics, for example in all kinds of media and communication devices. When one type of technology can be used for a great variety of design configurations, the flexible solution can become enormously competitive through economies of scale and replace the earlier diverse static solutions. Thus, over the past couple of decades, most electronic devices quickly turned into digitally powered ones, housing a computer inside even when they may have maintained the same plain outward appearance.

When devices become digital metamedia, that creates a new potential: they can now support new functionality and flexibility in the form of further programmability. Thus a mobile phone has evolved from just a telephone into a multifunctional smart phone, a design platform that can be modified by installing new software applications into it. Televisions are in the process of becoming smart, by supporting the installation of new functionality as software components. And so on.

The proliferation of digital devices have thus created a significant novel design environment for humankind. A new software application can be designed, copied and distributed to millions of people in hours or days, without using and wasting any material resources. This lowers the costs of design, production and distribution and speeds up the cycle of *design evolution* significantly.

With new applications, I can turn my computer or smart phone into a calendar, an address book, an email device, a book reader and so on. When I start to use a digital calendar, I do not necessarily need a physical calendar any more. When my music becomes digital and is stored in my computer or music player's hard disk, I do not need to use my CDs and the CD player any more. In this way, the digital devices and their fast evolving software solutions take over increasing responsibilities of supporting my everyday life practices, and tend to replace and render obsolete the earlier material artifacts that performed the same function.

As these digital solutions all use digital information formats, it is technically possible for them to interact and exchange information, if they are programmed to do so. In fact, many applications are designed to work together. For example, in my mobile phone, when I want to make a call to a friend, I select my friend's name from my address book and make a call by pressing the call button, and the activity is taken over by the telephone application. When I receive an email from a friend about an event that includes a link to a Google Map, I can touch the link in the email and I will be transferred to the map. It is thus one of the important benefits of software

that various software components and applications can be designed to work together. This means that every software application does not need to incorporate all of the functions that it needs to perform its services, if it is possible to get those services from some other software instead. In reality, all digital devices run many software applications that have many dependencies and information flows between them, and these devices are thus complex *digital design ecosystems* on their own.

The most important software in any digital device is its *operating system*. The operating system governs the whole device and provides many basic services to all other software on the device. Any other software on the device is thus completely dependent on the operating system's support. If, for some reason, the operating system refuses its support or is incompatible with the other software, that other dependent software will not be able to perform its services or in the worst case, will not run at all. This highlights the *dualistic character* of the digital environment: while it is inherently *flexible* in the sense that its functionality can be changed by simply modifying the software, it is at the same time completely *rigid* in the sense that software must follow very strict grammar rules and constraints set by the operating environment. The flexibility can only be implemented within the boundaries of these rules and constraints. If the rules are not followed, for example when the software contains a bug or its binary code becomes corrupt through some data storage error, or if the rules in the environment are changed, the software will not function any more.

This total dependency gives the operating systems and their makers and designers a very unique position of power and control in the digital design ecosystems.

4. The personal digital ecosystem

I define the personal digital ecosystem as a design ecosystem that consists of the digital devices, software systems and digital data that a person uses or interacts with within her practices, as well as some other, non-digital elements that are integral for its functions and phenomena. It may contain things such as computers, mobile phones, digital televisions, network routers, cables, hard disks, printers, memory sticks, CD and DVD discs, screens, mice, remote controls, various software, data and external services. And like in the case of the kitchen, these are organized into a working configuration by the individual's practices.

Much like the kitchen that is preconfigured when I move in, also digital devices are typically preconfigured to some extent when they enter my life, most often equipped with an operating system and some basic standard software applications.

However, as digital devices are themselves already complex design ecosystems with a lot of built-in flexibility, when I begin to use them, I most often need to configure them and adapt them to my particular circumstances. Increasingly, these devices are expected to be customized to be administered by one person who has the ability to control all of the device's functions. This is a trend that relates to the increasing number of internal and external services that we use that require some kind of user account that is tied to the customer's identity. In the configuration process, the new device is tied to my internet connections, communication accounts, other devices in the network, and other local circumstances. As soon as I start to use it, I install my own data such as information about my social network, and my communication and media preferences. After I have used it for a while, the system accumulates data from and through my practices; documents, logs, messages, and media.

Hence, when I start to actually use a device and its services, it becomes quickly adapted and connected to my ecosystem and thus its design changes from a generic one to a particular, idiosyncratic one (a process also called *domestication*, see [12], [23]). The same pattern applies not only to devices, but also to every new service and software application that I begin to use. The configurations that are continuously adjusted and customized to

match the evolution of my practices and the accumulated digital data grow to become essential *resources* for my life and practices.

One big difference between the kitchen ecosystem and the digital ecosystem is the especially powerful role of the operating systems as the fundamental design platforms that everything else depends on the digital devices. The most popular end-user operating systems (Windows, OS X, iOS, Android) are under the exclusive control of their makers, and thus they implement designs and policies that these corporations define. For me, this means that the platforms are configured and operated according to some policies that I can not change, even if I would like to. Thus, my freedom to define and design my own ecosystem is more restricted than in the kitchen. For example, in some situations I can not decide which software applications I may use for certain functions, as the operating system owner will make those decisions for me (e.g. in conjunction with the iOS 6 upgrade, Apple removed the Maps application made by Google from their customers' phones and replaced it with their own Apple Maps application).

However, like in the case of the kitchen, my digital ecosystem is most importantly organized by my practices. The devices and the software in them are for all practical purposes dead unless I take them up and employ them in some of my practices. A device sitting idle on the shelf, or an app that I never start, do not have any significant effects or consequences for my life. For example, I use my phone, my email, or text messages because I need to communicate with some people. But these needs are usually connected to more complex practices that employ also other software and services. For example, I may plan to arrange an event for a group of friends to go to the theatre together. This plan is a project that may require me to use several different components to realize: Facebook, email, Google Maps, the website of the theatre, the ticket agency, and a Doodle Poll (a web based service for selecting a date between a group of people), for example. These components do not provide any kind of coordinated event organization service to me; instead they each provide a service that I need to mobilize towards that end as a part of a composition, by employing them and operating them with skill and a design intention. I thus design ad hoc an individual practice that is adapted to my idiosyncratic need, context and circumstances, using these existing artifacts as my design toolkit.

One important area of contemporary digital practices are various media related practices. In my home, I have several shelves of non-digital media, such as LP records, CDs, cassette tapes, videotapes, slides and books. They testify that various media, both commercial and self produced have over the years had great significance for me. Lately, a very large share of all new media that I create, receive and use has turned into a digital format, and it is manipulated, stored and viewed exclusively with digital devices. This is an area of the digital ecosystem that is being transformed especially fast. Both my practices and the equipment (devices, software, services) I use change significantly every year, through many small and large, often unpredictable, mostly externally determined events. These changes are not always easy to manage, because the products provided by the industry do not usually take into account the whole of my ecosystem. It is not easy to manage the collections of media that result from many different media systems that do not share any common media and metadata management, archival, cataloguing or backup features. It is a real and serious concern that due to such difficulties, many families risk losing some of their important digital memories.

5. Discussion

How does the digital design ecosystem differ from the kitchen ecosystem, and why is it useful to think about the digital environment as an ecosystem? The key differences are:

- 1) the designs in the digital ecosystem are tied to other components in their ecosystem more strongly (the function of a component depends on the function of another one) and deeply (the dependent functions are essential for the general functionality of the components)
- 2) the evolution of the digital ecosystem is extremely fast due to both internal and external changes, and because of the strong and deep dependencies, changes in one component often create strong pressures for other components to change as well
- 3) the digital platforms are being employed in very comprehensive and integrative ways to all kinds of practices, which means that their effects, benefits as well as risks and problems are more totalitarian than those of the non-digital ones
- 4) personal digital ecosystems evolve into very idiosyncratic designs, which makes it impossible to manage and solve their design issues successfully with external generic designs; as they grow, and their design complexity grows, they demand increasingly local design efforts – which are increasingly carried out by the owners themselves

It is useful to consider the digital environment as an ecosystem because:

- 1) because of such high degree of ecosystemic integration, it is essential to understand the wider ecosystem to achieve a general understanding of the ways how people use digital technology in everyday life
- 2) when designing digital products that will end up as components in the diverse personal digital ecosystems, it is important to foresee the ecosystemic connections, as well as the evolution of the ecosystem, and design to support them
- 3) for the owners of digital ecosystems, it is useful to become aware of the nature of the digital ecosystem, and to understand the risks and dependencies it creates, and the design, maintenance and management requirements that it creates for the owner
- 4) for the society, it is important to realize that the everyday life of the citizens is fast becoming digital, and turning their ability to live their everyday life according to their preferences quickly highly dependent on the software and service evolution that is controlled by a handful of large corporations

Compared to the other ideas regarding digital environments by other authors mentioned in the introduction, the design ecosystem idea is in my view a useful foundation because it is on a higher abstraction level and thus more generic and applicable in the same form to all kinds of ecosystems – for example natural ecosystems [22] and business ecosystems [1, 18].

Compared to the term “ecology” [19] or “landscape” [34], I believe that the evolutionary history of the concept [10] and the earlier meanings and uses of the term “ecosystem” fit the use that is being discussed here best, and it thus carries along most support through analogy, especially when with the design ecosystem concept I have established a “common ancestor concept” for such various, more specific, types of ecosystems.

In the field of ecology, the term “ecology” itself is not used to describe an *environment* in the same fashion as it is used in the ICT literature (e.g. “the library as an ecology” [19]); instead, there the term refers to the *study* or the *set of knowledge* about something within its environment (e.g. “the ecology of a bacteria” [7]). However, in other areas where ecological thinking has been developed (e.g. ICT, human ecology, organizational ecology, media ecology, etc.), the term “ecology” often refers to an environment with all its entities, which is described as an ecology of a certain kind. This usage justifies such use of that word also in the current context, but I propose that here “ecology” should be used to refer to the generic nature of the environment when great specificity or analysis

of the dependencies between the entities belonging to it is not required, whereas “ecosystem” should refer to particular, specific, situated and real systems with some boundaries, criteria of inclusion/exclusion, connections and dependencies. For example, “the contemporary digital ecology” could refer to a totality of digital entities, while “my digital ecosystem” would refer specifically to those components that I have in my use, configured in specific ways and mobilized through my practices.

Also, while the approach, concerns and insights of Stolterman, Jung, Ryan, and Siegel [34] are by and large very compatible and close to mine, there are some important differences. They have chosen to focus on interactive devices as the basic units of analysis, while I talk about digital designs. They ground their decision on the finding that people generally consider their devices as the “things” they use, even though the devices may host and take care of many different software systems and functionalities. I agree with the relevance of this finding, but it also seems to be so that as the complexity of the whole ecosystem grows, there are more breakdowns and other circumstances that require people to acquire clearer understanding of the inner complexity of their systems, as they have to act as the system managers and maintain the continuity of their practices across multiple cycles of upgrades and device and software changes. People seem to be already quite knowledgeable of various software components and applications they need to purchase, install, upgrade, backup and transfer between devices, as well as pay attention to files, databases, messages, address books and so on. Also, many of the actions, problems and concerns take place within one device, in interactions between software components, or between only very specific components in different devices; and finally, the evolution of the software environment within any device may be so rapid that the device changes its functionality – for the good or the bad – very fundamentally over a short period of time. Thus, it appears to me that an ecosystemic approach needs to be able to dig deeper into the nested design ecosystems also within the devices, which my focus on designs as opposed to devices allows.

To conclude, I reiterate that the owner’s practices should be considered as the main organizing structures that establish order and connections within personal digital ecosystems. The artifacts are employed in practices and have in each practice a limited role based on what contribution they can make. I believe that it would be important for designers to realize that 1) *practices are the central field where everyday life design takes place daily*, with the various *digital tools forming their design toolkit*, and that 2) *their designs should aim to become trusted and persistent building blocks within the personal digital ecosystem*.

In order to succeed, designers should therefore strive to design for 1) *ecosystemic awareness, competence and sustainability* – so that their designs contribute to the *functionality and sustainability of the whole ecosystem*, through *desirable performance* instead of hostile takeover and lock-in; as well as 2) *designability* – so that their design supports *further design and reliable adaptations by the owner*.

5. References

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