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ON TECHNOLOGY AS MATERIAL IN DESIGN

> And what is the purpose of writing music? One is, of course, not dealing with purposes but dealing with sounds.[1]
>
> John Cage *Silence*

In many ways, design has been moving away from the physical object[2]. Emerging approaches to design such as interaction, experience and service design, often utilising new technologies with almost 'immaterial' properties, seem to point to a situation where the material 'thing' as we used to know it is replaced by communication, information, systems and infrastructures.

From another perspective, however, the importance of the things themselves is being re-discovered[3], and perhaps these new 'immaterial' technologies play a role in this. A central reason for this shift is that though technical objects are often characterised by their practical functionality[4], their everyday lives seem a bit more complicated than these official functions might suggest. Thus, the predominant focus on practical functionality in the design of technical objects need to reconsidered and above all complemented.

As we turn to these things, we do not only have to re-locate the functions of technical objects within a rich context of use; to understand the presence of technical objects, we also need to consider the materials that builds them. In what follows, I will present some ideas on how the properties of technologies (such as information technology) seem to influence the way we think about the design of technical objects. Further, I will try to challenge the instrumental perspective on technology by considering it to be design material, asking question about it as such: what its expressions as material, its form elements?

TECHNICAL THINGS

At the centre of our understanding of the technical object, we find the notion of functions. Describing the technological object as having a dual nature, Kroes writes:

> On the one hand, they are physical objects or processes, with a specific structure (set of properties), the behaviour of which is governed by the (causal) laws of physics. On the other hand, an essential aspect of any technical object is its function; think away from a technical object its function and what is left is just some kind of physical object. It is by virtue of its practical function that an object is a technical object.[5]

We might ask to what extent this notion of practical functionality that we refer to when we say, for instance, 'dish washers', 'printers' and 'word-processors', captures what it means to design, use and live with such things.

Although technological devices might be designed to exist in the periphery of our attention, they still influence how we engage in the practices we use them in[6]. To use Borgmann's example of the hearth versus central heating[7]: the practical functionality we refer to when calling something a 'heater' tell us little about how the device mediates and influences how we engage in the practice of heating our house, yet its design brings significant changes to what that practice will be like. Akrich makes a related remark:

> For some time sociologists of technology have argued that when technologists define the characteristics of their objects, they necessarily make hypothesis about the entities that make up the world into which the object is to be inserted. Designers thus define actors with specific tastes, competences, motives, aspirations, political prejudices, and the rest, … A large part of the work of innovators is that of "inscribing" this vision of (or prediction about) the world in the technical content of the new object.[8]

In practice, it seems that although a given design carries with it some notion of what using it will/should be like, what actually happens as people starting using it is a partly open question. For sure, much actual use closely resembles the ideas about the use that governed the design of the thing. There are, however, other scenarios to consider. For instance, it might be that the model of use that the design prescribes does not match the users intentions and desires but works in the opposite direction. Jones argues:

> But there is a hidden cost, a severe one, which has only recently become evident. It is that of inflexibility, over-specialization, the realization that this 'plastic world' of homogenized, cost-reduced products is increasingly unalterable, un-repairable, and imposes upon us (from its stabilization of the larger scale of functions) a life, an obligatory way of *using* what is made, that is felt as coercive, not satisfying, with decreasing outlets for individuality. The lesson is obvious, though how to apply it is not: do not stabilize functions.[9]

The use proposed by a design need, however, not be accepted at all. Akrich again: "To be sure, it may be that no actors will come forward to play the roles envisaged by the designer. Or users may define quite different roles of their own"[10]. Use can be a creative practice where people find their own interpretations of objects and what it means to use them. Analysing de Certeau, Blauvelt remarks that: "consumption is not merely empty, or passive, as many critics claim, but can contain elements of user resistance – nonconformist, adaptive, appropriative, or otherwise transgressive tactics – that become creative acts of their own fashioning"[11].

How ‘users’ relate to the intended functionality of a thing seems to create a span of interpretations and approaches ranging from more or less accepting the suggested way of using the thing, to coming up with entirely new interpretations. Thus, there seems to be a continuum of ways in which users relate to the practical functions we use to characterise the technical object[12]. Whether we come to the conclusion that the models of use that the object embodies provoke creative re-interpretation and re-appropriation, or whether the optimisation of functions creates frustrating constraints, it is clear there is much to the use of technical objects that is not captured by a reference to its practical functionality.

Turning back to what it means to design technology, these expanding views on what using technical objects is like, have some implications for how we think about designing them. Clearly, if we think that the design of such things is primarily about implementing practical functions, our focus being on how to properly specify and evaluate those functions, these perspectives seem to urge us to reconsider the importance not only of ‘what’ a thing does, but also ‘how’. Promoting design with focus on the capacity to engage, Verbeek & Kockelkoren argues that:

> This could be done by healing the split between machinery and commodity, thus creating a revaluation of the machinery of products. Product machinery should be freed from its withdrawal and be visible, accessible and understandable again. … Functionalism would indeed, focus on the functioning of products but, in doing so, it does not pay attention to the *involvement* of people in this functioning, but mainly the *result* of it. Functionalism, therefore, does not result in focal things, but in devices that procure commodities.”[13]

With respect to ‘how’ we implement functions, however, we also need to recall the other part of Kroes description of the technical object: that it is also a physical thing[14]. Maybe it is because so many new technologies appear as being almost ‘immaterial’, or because influential ideas like “form follows function” moved our attention from the form of things to their functionality, or because our understanding of the technical object so heavily relies on its practical functionality that we almost seem to have forgotten that technical things also are physical things with properties as such. But if it is the things themselves we are interested in, the materials we use to craft them might need some attention as well.

Traditionally, materials have a central role in design, in our understanding of form, and of what it means to craft an object[15]. Not only are many design disciplines defined, even named, in relation to certain materials – the emergence and continuous development of new materials have also played a central role in the evolution of design as they challenge existing notions of form, expressions, aesthetics and what sorts of objects in general can be created. However strong the emphasis on functions may be in modernist design, it is hard to imagine this movement without its characteristic materials, such as reinforced concrete, steel, glass and plywood.

Even though we now might be turning towards the immaterial, matter still matters. “Any immaterial civilization will be heavily materialized because its immaterial products are necessarily linked to the mechanical infrastructure that generates, stabilizes, and governs them.”, Moles argues[16]. In his work on the electronic object, Dunne comments: “The electronic object is an object on the threshold of materiality. Although ‘dematerialisation’ has become a common expression in the

relation to electronic technology, it is difficult to define in relation to the tangle of logic, matter and electrons that is the electronic object. ... But the physical can never be completely dismissed."[17] Promoting the need to question aspects of the shift towards the immaterial, Fry argues that: "the aim of rematerialisation is a taking back of control over one's interaction with the world. Skills are not merely functional, utilitarian practices but … they are sensory and informational engagements with the matter of one's immediate environment." [18]

Perhaps, the coming of less tangible 'materials' such as information technology represents another major change of the relation between the designer and her materials, like the introduction of mechanical production did. But maybe there is something to be learned about the presence of technical objects by reconsidering the materials that build them. For instance, is the strong focus on practical functionality only a matter of a deliberate perspective, or is it something that is emphasised by characteristics of certain technologies, like the properties of a certain kind of wood shape what objects we can carve out of it? Before presenting some ideas of what thinking about technology as design material could be like, I will present some examples of how our interest and focus seem to be drawn to the practical functionality of technical objects as we try to design them.

INESCAPABLE FUNCTIONS

> Is that the meaning of the post-modern; the shift, in so many fields of life, from the planned and predictable, the multiplied ideal, the impersonal, to the empiric, the memory, the present thought? To the product not as means but as presence, as thing-in-itself?
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> Software. The word, like others coming from computing and the new technologies, implies a far more than accidental change from the rigid to the gentle, the mechanical to the automatic, the imposed to the adaptive. But can we rise to it? [19]
>
> John Chris Jones *Softecnica*

Although hopes have been raised that new flexible technologies would support more adaptive and open designs, it seems there is more to the fixation of functions than deliberate intentions. A certain focus on the practical functions of technical objects seem to come not only from our basic understanding of this kind of things, but also from the situation we find ourselves in as we try to design them.

Unknown Objects

When designing a traditional object, such as a table or a pair of shoes, the object is to a certain extent known beforehand, i.e., there already exist familiar categories of such objects to look to and there are traditions embedded within practices of design and use of such things that we can relate to. To design 'new' things of this kind

partly means reinterpreting what is known, expanding on existing ideas about what can be expected, perhaps even challenging current understandings of the object category[20].

When introducing new kinds of objects, such as new technologies, there is not as much in terms of traditions, expectations and interpretations to lean on and react against. In fact, such a framework must often be developed along with the object itself [21]. This places the designer in a rather difficult position, since not only the object but also all aspects of its eventual use needs to be envisioned. Methods such as probing into possible use scenarios and user expectations become a way to get to know the object to be designed and help us build the framework needed for understanding the design problem, i.e., that characterising practical function the object will be designed around.

Here, our need for a 'practical function' to govern the design easily transfers into a concern for how the thing will be used. A main problem, however, is that while we can determine the design of a thing, we can only *predict* its use. And this is where we risk fixating its functions and to some extent also ways of using it – confusing the two different tasks, that of designing the object with that of predicting its use, we try to determine its use the way we determine its design. In practice, this confusion might lead to a focus on the capacities, needs and desires of people as a basis for design on one side, and the technology itself on the other. In the extreme case, design therefore risks becoming a question of how to package a given technology in a way that makes sense to a specified user group.

Of course, projecting what it will mean to use an object is something that is, to various extents, always present in design. However, when introducing not only new objects, but new object categories, these questions become central. Further, whereas it can be argued that the design of things such as the table, the chairs, or the dinnerware at a dinner party will shape the social interactions taking place (especially if significantly deviating from what we have come to expect from such objects [22]), such changes are subtle compared to the rather dramatic effects of new communication technologies on how we relate to one another.

Seductive Surfaces

When working with traditional materials, there used to be a more or less direct correspondence between the complexity of the object and its surface. Maeda writes:

> Prior to the development of modern technology, artefacts produced by humans obeyed an intuitive relationship between size and complexity. A small object corresponded to a simple function, whereas a larger object was associated with a proportionally more complex function. This simple relationship arouse from the macroscopic nature of technology at the time and is significant because it extended two sacred promises, one to the user and one to the industrial designer. The first is that the user would be able to construct a priori impressions of an object before actually using it, that is, literally *sizing up* the nature of the object at first glance. The second is that industrial designers would have a suitable amount of visual and tactile design space. … in which to express that functionality.[23]

With miniaturisation and new materials, this has changed. There is no longer any perceivable correspondence between the complexity of the object and its surface. Manzini writes:

> In the past, all that man produced (that is all the transformations he brought to natural substrates) belonged to his order of magnitude and was within his sensorial sphere. This made it easy to understand the components and functioning of all artificial objects… Throughout its development, technoscience brought its manipulative capacity, the level of its controlling possibilities; to dimensional scales different from those of our direct experience. Thus the artificial products it produces do not show structures or "mechanisms" sensitively connected to effects. In current practice, at the dimensional scale of our senses, functions seem to emerge mysteriously from inexpressive and dumb materials and components.
>
> This is true for those who experience this artificial environment as well as for those who are to design and manufacture it.[24]

This development implies a significant change of the way we think about both 'objects' and 'materials', and it might even be an important reason for the shift towards an interest in 'services' and 'experiences' instead (cf. also Jones' notion of 'intangible design'[25]).

This 'new' discrepancy between inner complexity and surface is problematic when taken in combination with the notion that a design should express the intended use of the object. With respect to design as in part being a clear statement of intended use that the user can understand and immediately relate to, this reduction in the space available for expression and explanation forces us to make decisions about what to bring forth and what to hide away. As we deal with the question of what to explain and express, we base our decisions on the notions of use that guide the design process. The surface, then, becomes a kind of interface supporting predetermined modes of communication. But we soon approach a situation where we seem to be trying to achieve the impossible, namely, to properly express the inner workings of the object while at the same time hiding its complexity.

Especially when design becomes 'packaging' – i.e. when the basic technology itself already exists and the task is to design the more or less interactive box it will reside in – it is often technological workings that need to be expressed and explained through the design. Since the surface does not suffice, the real complexity will be hidden and something else will be presented be it through metaphors or something else. And again, we will have a hard time not working on basis of intended functionality as any decision of what to present and support, and what complexity to hide away, will be based on what functions we have in mind. But when the user leaves the domain of intended use, or when something does not work they way expected, the surface the device presents to the user makes little sense. To be able re-appropriate and re-interpret such things, the 'user' would have create a 'new' surface that better suits her needs and intentions – at least this could be one way of looking at what it means to be 'hacking' technical objects.[26]

Time

With miniaturisation, there comes a need for working with time as a design variable. Maeda continues (cf. also quote above):

> The contemporary solution to the reduction in design volume has been to compensate for physical space with virtual space… Hence, although we might consider an object restricted in a spatial sense, its dynamic surfaces allow the object to transcend those restrictions through expression along the never-ending dimension of time [27]

At first, it may seem as if working with a temporal dimension could free us from the problem of deciding what to express with the surface of things since, in theory, it would enable us to sequence everything over time. While there are systems and devices with endless menu-systems that seemingly do try to implement this idea, working with time introduces new design problems, and to realise that these are at least as complex as the spatial ones we need only look at music, film or drama[28].

With respect to interpreting and understanding a design in use, temporal elements present the difficulty of how to shape things that will only show when the object is being used in one way or another. Whether a result of user input, the result of more autonomous processes, or both, the appearance of the object changes over time and so we cannot simply take a quick look at the thing to see what it is — to understand it, we need to experience it over time. Much work has been done on how to overcome this, for example interfaces that continuously display all or most of their functions to the user, but the basic problem remains, especially if we aim to design something that takes advantage of dynamic properties and that adapts or develops over time.

The importance of temporal form ties notions of use even closer to the design, as we turn to investigating use and users in order to learn about the expressions of the thing over time, or to design it to fit the activities of users[29]. In other words, we might try to base the temporal composition of the design on observed or envisioned behaviours. And again, we risk confusing the activity of designing the object with determining how it should be used, this time not only as functions but also in terms of more specific predefined behaviours and patterns of use.

TECHNOLOGY AS DESIGN MATERIAL

It seems that notions of practical functionality becomes central to technology design not only because of our general understanding of technical objects *per se*, but also because of aspects of the situation we find ourselves in as we try to develop new applications. Turning towards the materials we use to build them, however, we get a slightly different perspective.

When working with a design material, we find ourselves within a framework that does not necessarily depend on ‘functions’ in the rationalistic sense, but where questions of form, expressions and aesthetics provide a basis for exploring possibilities and characteristics of the materials at hand. For instance, to understand what it means to design things using clay, wood or textiles, we would make things using the materials in questions just to better understand how they work, what functions and expressions they afford. This is not, however, to say that this knowledge differs from our understanding of technology in that it is tacit or experiential[30], but simply that it does not seem to rely on the specific acts of use to which the final object might, or might not, relate to in the end

Working with form and materials rather than the function of objects is not just an educational process – for instance, a textile designer may work with a material without having to know exactly what purposes it eventually might be used for since this is left open for whoever decides to use it. Although the textile designer might have ideas about tablecloths, curtains or clothes, what he or she actually designs is the fabric itself. Not only textile designers, but people in general have an understanding of textiles as material and a way of talking about them in terms of basic expressions such as texture, smoothness, thickness, and colour without having to relate to the functionality of any final object.

This is, of course, a highly simplified account of what is really going on, but it nevertheless points to a significant difference between how we relate to, say, textiles versus computational technology as building blocks of everyday things. The issue here is not so much whether we let the practical function of the final design govern the design process or not, but if we *have* to let it do so. Here, it seems like the working with established design materials depends on a greater span of perspectives ranging from issues of specific practical functions to general questions of how given materials are used to craft certain expressions. Or in other words, that the presence of the thing is being considered from a richer set of perspectives compared to the narrow focus on practical functionality we seem to have when creating technical objects.

Clearly, the materiality of technologies differs from that of traditional design materials. Perhaps we cannot physically shape computational things with our hands the way we shape wood, glass or concrete. But, as discussed above, this is not only a question of the properties of matter, perceivable or not, but of what frame of reference we use, and what questions we ask as we engage in design[31]. And so we might ask, what happens if we try to think of 'technology' in terms of 'form' and 'material'?

Material Expressions

Let us start by asking if the reason we do not perceive the expressions of technology as material is because there are none or because they are hidden beneath a surface of increasing technological perfection? While we talk about, say, textiles in terms of material expressions, what could be said about the material expressions of electricity? Taking as an example a rather simple object such as a lamp, it is quite obvious that electricity, although perhaps in itself invisible, has a strong presence in the object. But while we might talk about the lampshade in terms of design expression, the presence of the electrical parts is often reduced to questions of on and off, their operation preferably described in terms of Watts. We seem to hide electronic material under increasing technological perfection. While we may spend hours to find the right lamp to our home, it is likely that we simply buy the first, cheapest or most efficient light bulb we can find to put in it.

Another reason for thinking further about the idea that the material expressions of technology are hidden rather than non-existent is that early examples of technology, particularly before devices are working perfectly, often have very strong expressions in themselves. In the early days of radio and television, for instance, expression of signal transmission and reception were present as noise and distortion of the sound and image. Depending on circumstances such as weather conditions or placement of the antenna, the transmission would change slightly and thus expose basic characteristics of the technologies used. Here, the technology, the material building the object, was present but since then every effort has been

made to hide these expressions away, gradually achieving more technically perfect image and sound. There are, however, examples where the expressive qualities of such technology, especially when not working properly, have been developed and emphasised, for instance in electronic music[32].

In everyday life, the expressions of technologies as material in our things become subject to (re)interpretation. When using mobile phones, it is still possible to experience the basic expressions of the communication technologies used to build the object. For instance, this 'material' shows at places where the communication cells do not provide optimal coverage, for instance when indoors, in tunnels or in certain areas at the countryside. Here, the connection will come and go, sometimes without us doing much at all. The expressions of this technological material clearly affect the way we communicate, among other things resulting in interrupted conversations or distorted sound.

While sometimes frustrating, we have also learned to use such material expressions to our advantage, as it enables a series of new ways of ending unwanted conversations. By referring to batteries running low, by making sounds ourselves to imitate the noise resulting from a fading connection, or by simply saying that we can not hear the other anymore, we can end a conversation in ways not previously imagined in the social protocols of phone use. Here, the expressions of technology as design material have been given an interpretation in terms of use that certainly was not intended by the designers of the technology itself and that is not included in any functional description of the device.

These examples are anecdotal, but they might indicate that technologies do have material expressions that come into play in design that are not captured within typical functional frameworks since they exist outside the intended use of the thing.

Form Elements

Since new technologies are almost 'immaterial' in presence, notions of form as, for instance, physical shape will perhaps not apply in the same way in the same way they used to. As discussed above, primary expressions of these new materials exists in time rather than space. Taking computational technology as an example, central characteristics depend on notions of states, of processes, of algorithms, of programs being executed. Similarly, expressions of a mechanical engine comes from combustion and the resulting movement – consider the experience of driving a car when there is water in the gas or when the engine does not ignite properly.

Thinking about the form elements evident in these expressions, it is, however, also clear that it is not pure temporal form, but temporal form as manifested through some kind of spatial 'surface' (in the widest sense of the word)[33]. The results of computational processes are evident to us through displays and through other devices, the electric material of the lamp through the glowing wire, and so on. In other words, temporal form elements need to be given some kind of spatial presence in order for us to be able to perceive and thus use them, just as a piece of music has to be performed for us to listen to it. This also implies that only that which we somehow make express itself through this spatial surface will be present to us.

That temporal form needs spatial manifestation has some interesting consequences for how we can think about the form of technological objects. First of all, the relation between temporal form and how we design it to be manifested in space is, to some extent, arbitrary by convention rather than by necessity – for the most part

there may be multiple design options available. For instance, there is nothing about computation *per se* that requires us to use typical LCD or CRT screens to display the results. The basic requirement is for some kind of dynamic spatial surface capable of displaying the temporal structures that computations generate. In practice, this means that we are free to use any material that is somehow capable of expressing states. To build a computer display, we are therefore free to choose material according to what expressions in use we are interested in, be it textiles[34], wood[35], water[36], or something else.

This provides a foundation for thinking about how to relate technology as material to traditional design materials in terms of form: while traditional design materials primarily have spatial form elements, technologies like computation primarily have temporal form elements. Working with combinations of such materials therefore means working with combinations of spatial and temporal form and exploring how spatial form elements are used to manifest temporal structures.

If we investigate form in this way, we might re-think the design of a lamp, imagining what might happen between on and off, how the patterns printed on the lampshade might be reconsidered in relation to a much more dynamic light source, how a lamp might be used as a computer display, etc. While not a very sophisticated example of form, it illustrates how the distinction between what is considered a concern for form and material, and what is just technology present in the background, could be made to break down to give way for an understanding of the overall presence of the object.

Next, one could proceed to re-think the form of a mobile phone and in what ways it depends on elements that do not reside in the device itself but rather in the complex systems of servers, antennae, etc., that 'builds' the thing as it appears in use. Then we would see that while its spatial form elements are bound to the material object as we experience it in our hands, its temporal form elements are not – when just 'using' the thing, how could we tell if a given process is carried out in the device or somewhere else in the network? But although the physical thing no longer defines the object entirely, we can still talk about the form and material of the object as experienced here and now, given this interpretation of the relation between spatial and temporal form elements of objects.

CONCLUDING REMARKS

The way things have been presented here, the distinction between 'technologies' and 'materials' is not so much a matter of 'what' something is, but what perspective we have when we look at it. Turning back to the things themselves – how they present themselves to us, and how we relate to them – there are several reasons for developing an understanding of technology as material in design. First, it takes as a foundation long traditions of exploring new materials in craft and design, enabling us to better understand the challenges to form, material, expressions and aesthetics that these new technologies bring in relation to more established materials and practices. Further, it could provide a framework for working with technology in combination with other materials, something that will

be of increasing importance as computers and electronics make their way into almost all kinds of everyday things and environments.

Another reason for developing a non-instrumental account to complement our focus on the practical functions of technical objects, is that it could open up design with respect to how, when and why concerns about functionality and use enter into the design process thus making as more sensitive to the presence of the object as such.

To be able to address challenges such as the one posed Tonkinwise, such complementary views might be necessary:

> What is at issue is not whether designers are capable of designing nothings rather than things, that is to say, services rather than products, but rather whether designers are capable of designing things that are not finished. It is less a matter of designing a different sort of thing than a matter of a thoroughly different form of designing, one that is perhaps better described as form of 'continuous design' or 'redesigning'.[37]

With regards to the problematics of over-determining functions, we can use complementary perspectives to revisit questions such as: What are the boundaries of the design act with respect to acts of use, of interpretation and appropriation of objects? Is the determination of the use of an object an act of design or an act of use? Thinking of technology design as crafting objects with form that needs to be interpreted positions us quite differently with respect to such questions in comparison to creating objects with functions that need to be understood.

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[31] Cf. Thomas Binder *Intent, Form and Materiality in the Design of Interaction Technology* in: Dittrichm, Floyd and Klischewski (Eds.) Social Thinking: Software Practice, MIT Press, pp. 451-468. Cf. also Jonas Löwgren and Erik Stolterman *Design av informations-teknologi: Materialet utan egenskaper* Studentlitteratur, 1998. (Revised version forthcoming as *Thoughtful Interaction Design; A Design Perspective on Information Technology* MIT Press.)

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[33] Lars Hallnäs and Johan Redström *From Use to Presence: On the Expressions and Aesthetics of Everyday Computational Things* ACM Transactions on Computer-Human Interaction (ToCHI) Vol. 9 No. 2, ACM Press, 2002, pp. 106-124.

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[35] Daniel Rozin *Wooden Mirror* (Exhibited at SIGGRAPH 2000, Art Gallery, July 23-28, New Orleans, LA, USA.)

[36] Wisneski, Ishii, Dahley, Gorbet, Brave, Ullmer and Yarin *Ambient Displays: Turning Architectural Space into an Interface between People and Digital*

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[37] Cameron Tonkinwise *Is Design Finished? dematerialisation & changing things* Design Philosophy Papers Issue 3, 2004.