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Use Plans

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USE PLANS

Auke Pols

17.1. Introduction

Designers do many things in the course of their working day: they sketch, tinker, consult with clients, drink coffee, etc. Some of these activities seem to belong to the core of actual design work, while others are more tangential to it. A major question in the philosophy of engineering design is thus: *What is engineering design?* This question cannot be answered without taking a stance on the ontology of design, or giving an answer to the question: *What is the object of engineering design?*

The use plan approach provides answers to both questions. Developed by Dutch philosophers of technology Wybo Houkes and Pieter Vermaas, most recently and comprehensively in their (2010) book *Technical Functions*, it argues that the object of design is a *use plan*, and thus, that design fundamentally is *the construction and communication of a use plan*. Characteristic of the use plan approach is that it is not so much focused on the *technical artefacts* that come out of design processes (see Chapter 15, "Artifacts" by Beth Preston, this volume) or their *functions* (see Chapter 18, "Function in Engineering" by Boris Eisenbart and Kilian Gericke, this volume). Instead, the focus is on *users* and what they do. Particularly, the use plan approach holds that we should see design fundamentally as enabling a series of user actions (with one or more technical artefacts) that allow that user to achieve a particular goal.

This chapter describes the use plan approach. First, it goes into what use plans are, how they are designed, communicated and executed, and how they can be evaluated. Second, it compares the use plan approach to two other philosophical approaches to the objects of design, namely, the function-based and affordance-based approaches. This serves to elucidate the workings of the use plan approach as well as some of its advantages and disadvantages. Finally, the chapter treats three criticisms of the use plan approach as well as replies to those criticisms, and reflects on some outstanding issues for the use plan approach in the conclusion.

17.2. What Are Use Plans?

The use plan approach assumes that design is best analysed according to the same framework by which actions in general are analysed in analytic philosophy: practical reasoning. Practical reasoning is the (rational) way by which an agent comes to answer the question: 'What should I do?' The use plan approach particularly follows Bratman's (1987) plan-based account of practical reasoning. In a nutshell, according to Bratman, agents address the question of what they should do by developing and prioritising *goals*, and then making a *plan* to achieve those goals. *Plans* are 'orderings of considered actions, undertaken for achieving a goal' (Houkes et al. 2002: 304). Use plans are then specific types of plans, namely, those plans that involve the use of one or more objects. The use plan approach has been inspired by works on artefacts and the importance of communicated intentions for their use (Dipert 1993), and earlier work on conceptualising design such as the Theory of Technical Systems (Hubka and Eder 1998).

By starting from practical reasoning, the use plan approach may seem overly rational and empirically not very accurate: when we act, we often do so from habit or impulse, without practical reasoning. Isn't design similarly messy? To answer this question, it is important to note that the use plan approach is an *ideal theory* of design. That is, it is not an attempt to generalise over a series of empirical observations on how actual design processes take place, nor is it a prescriptive model of the steps that designers should follow in their daily practice. Rather, it is a *rational reconstruction* of steps that need to figure in *any* design process in some way, whether in the field of mechanical engineering, architecture or anywhere else (Houkes et al. 2002). This means that those steps need not be taken explicitly, always in the same way, or only by one designer, but they have to be present in some way for a design process to count as such. Moreover, as a rational reconstruction, the use plan approach can be used as a normative tool to evaluate the rationality of design. It does this by investigating whether the ordering of considered actions that constitutes the designed plan can reasonably be expected to lead to goal achievement. For example: using a sieve to hold water is irrational—one cannot reasonably expect that filling a sieve with water will lead to its holding water. Similarly, if your goal is to design a container for holding water but you design a sieve as the artefact that should hold the water, you have designed an irrational use plan. The use plan approach thus is a theory of what design is and what the objects of design are, but it also offers us the tools to determine whether a given use plan is practically rational.

17.3. The Design of Use Plans

Houkes et al. (2002) work out the rational reconstruction of the design process in detail (see also Houkes and Vermaas 2010, Ch. 2). The first step in designing a use plan (in that paper still called 'user plan') is *goal-setting*. In practice, the goal will often be set by a client: it does not have to be a personal goal of the designer, though designer and user may be the same person. For example, a client may state that she prefers toast for breakfast over plain bread and ask a designer for help. Part of goal-setting is identifying the various *constraints* under which the designer has to work (time and money, but also skills and material available, etc.), as this determines which goals are achievable, or how close the 'ideal' goal can likely be approximated. Also, sometimes there may not be one designer, but several, or a design team to design the plan—how this collective plan design could work is analysed by Pearce (2016).

The second step is *designing the means to achieve the goal*. In this step the actual plan is designed. The designer investigates which actions should contribute to the realisation of the goal, and particularly, which artefacts should be designed and developed in order to enable those actions. To continue the example, the designer may consider various plans (toasting bread under the grill, baking it in a frying pan) before settling on a design for a toaster. The design follows the plan: a toaster designed for a single user will have different characteristics from one designed for a hotel breakfast buffet, not because the goal of toasting bread is different, but because the latter is used in a different context (many users, more space available for the toaster, etc.) In either case, it should be possible to undertake a series of considered actions to achieve that goal with the artefact, e.g. put the bread in the toaster, determine the browning level, turn the toaster on and take the toast out when ready.

In the third step, the *use plan* is *constructed*, the necessary *artefacts* are *designed and constructed* and the *use plan* is *communicated* to the relevant users. Houkes et al. explicitly list this as only one step because this step fully encompasses *artefact design*. They thus show how artefact design always follows plan design. Note, however, that plan design does not always have to be followed by artefact design. A designer may design a plan for toasting bread using a toaster, for example, but never design and construct the actual toaster, or leave it to another party.

The use plan approach considers artefact design to be 'product design' (Houkes et al. 2002), as it is but a part of the full use plan design. Artefact design consists itself of several substeps, namely, designing and executing a *make plan*: a series of considered actions, possibly (and typically) including the manipulation of one or more tools, aimed at producing an object with particular properties (cf. Houkes 2012). Houkes and Vermaas (2009) call the execution of this make plan '*manufacturing*': the physical construction of the technical artefact. Again, while manufacturing always has to be preceded by make plan design, a designer can design a make plan ('these are the specifications for making a toaster') without necessarily following it up with the manufacturing of the artefact. Note here that there is a difference between the use plan (a plan for achieving a goal, in this case, toasting bread) and the make plan (a plan for producing an object needed to execute the use plan, in this case, a toaster). However, the make plan can itself be a use plan for other artefacts; in this case, the tools needed to achieve the goal of producing a toaster).

In the fourth step, the outcome of the plan is *compared* to the goal or desired outcome. The result is then *evaluated* in the fifth step: determining whether the use plan is rational, that is, whether the designer can reasonably expect that users can achieve their goal by executing the designed plan. If so, the design process is complete. If not, the designer has to go through the steps again to check where the problem has originated, and remedy it. This can be done in various ways, from redesigning the artefact to modifying the original goal or constraints.

One characteristic of the use plan approach is that the threshold for what counts as 'design' is very low. Most humans can engage in practical reasoning, or think about ways to achieve their goals. Similarly, most humans will be able to appropriate artefacts for achieving novel goals, such as standing on chairs to change light bulbs or using crates as door-stoppers. Even hapless natural objects may be incorporated in impromptu use plans, such as when a hiker uses a log as a bridge to cross a stream, or a rock to hammer tent pegs into the soil. This already counts as use plan design, as all steps to create a new use plan are gone through (quickly).

Houkes (2008) holds that, while most humans can thus design use plans, there is a huge difference—in degree, not in kind—between impromptu plan design and the skilled and responsible activities of professional designers. Most people can pick up a rock and use it as a hammer, but designing an effective, efficient, safe and user-friendly toaster requires specialised skills and knowledge. This also gives designers a special, privileged position with regard to assigning functions to technical artefacts. Houkes and Vermaas (2010, Ch. 4; see also Vermaas and Houkes 2006a) show how this works by developing their ICE theory of function ascription on the basis of the use plan approach. Basically, the ICE theory justifies function ascriptions to artefacts on the basis of beliefs about their use plans, rather than on the basis of their physical properties. With regard to what needs to be believed in order for function ascriptions to be justified, the theory takes elements from three different kinds of theories of function ascription: the Intentionalist kind, where functions are ascribed on the basis of designer intentions; the Causal-role kind, where functions are ascribed on the basis of the causal role artefacts play in larger systems; and the Evolutionary kind, where functions are ascribed on the basis of the traits artefacts have been selected for over the long term. In this way, Houkes and Vermaas aim to use the strengths of each of these theories as well as to compensate for their individual weaknesses.

A different position on the issue of function ascription is taken by Scheele (2006) and Schyfter (2009). They argue that actual use is much more relevant for determining an artefact's function than the intentions of designers. In line with a rich literature on sociotechnical systems and social constructivist views of technology, they argue that theories of technical functions should take into account the social context and the social institutions in which artefacts are used. Scheele gives the example of a church that is now used/now functions as an event hall, while Schyfter points out that even for simple waiter's corkscrews, the 'right' way to use them is strongly determined by societal norms and institutions, not to mention that their function is constituted and sustained by a myriad of collective practices: particular ways of bottling wine, serving wine at restaurants, etc.

Houkes et al. (2011) respond that both frameworks, though they have a different focus, actually converge to a large degree. They argue that a social, 'collectivist' account of artefact use still needs a use plan-like account to properly explain what design is, and what the objects of design are. At the same time, they admit that the use plan account could use a collectivist account of actions to explain how social constraints affect plan design and execution, as well as how use practices ground and inspire design. Nevertheless, they also argue that a 'collectivist' account of artefact functions runs into several difficulties that the use plan account is better equipped to deal with. This holds particularly for properly analysing one-of-a-kind artefacts (e.g. a custom-made mould for casting a bell that has a function only for the craftsperson casting that bell) and defect types (the tokens of which only accidentally fulfil their intended functions), that are therefore no longer part of use practices.

17.4. Communicating Use Plans

In the previous section, the reader will have noted that communication of a use plan from the designer to the user is considered an inherent part of the design (step three) rather than a contingent activity. This may seem counterintuitive if one only considers enclosing a user manual with the artefact as a way of communicating (Houkes 2008). However, a use plan can also be communicated through advertisements, trainings or product demonstrations organised by or in close collaboration with the design team. Also, bear in mind that a large part of the communication of a use plan is done through artefact design itself: lights, buttons, handles, etc. Toasters, for example, often have big flat knobs that invite pressing down on them, to lower the toast into the machine. Indeed, the extensive literature on affordances, a concept from behavioural ecology introduced in the design literature by Norman (1988/2002; cf. Pols 2012, 2015), is an explicit recognition of the fact that design features do—and should—communicate to users how artefacts are to be used. In terms of the use plan approach, affordances are a very salient and immediate way in which designers can communicate (parts of) a use plan to users. Houkes and Vermaas (2006) distinguish three main ways in which users can (though not always do) come to rational beliefs about use plans: from the physical properties of artefacts (such as their affordances); from information about designer intentions (e.g. manuals, advertisements, training) and from behaviour and stories of fellow users.

An interesting difference between the practice-oriented affordance-based approach and the ideal theory of the use plan approach is how both approaches deal with misleading communication. Maier and Fadel (2009) give the example of a household ladder of which the horizontal brace looks like a step, but sports a sign stating: 'This is not a step'. For the use plan approach, this would count as rational design: the sign communicates part of a use plan that users violate at their peril. (Though if the sign is hidden or too small, a case can be made that the designer failed in communicating the use plan.) For Maier and Fadel, however, if the brace affords stepping, it is an undesired affordance and thus an example of bad design. This difference is not surprising, given that an ideal theory of design would assume an ideal, rational user, while Maier and Fadel aim for 'idiot-proof' design, or design for real users who at best exhibit bounded rationality.

Though proper communication of a use plan is necessary for ensuring that the user can properly use an artefact, it is not sufficient. Users may lack relevant skills to use the artefact, auxiliary items (such as batteries) or access to the physical context in which the artefact should be used (e.g. an electricity outlet to power the toaster). While it is not the responsibility of the designer to provide all these, communication of the use plan should include mention of necessary auxiliary items, needed skills or a certain context that might not immediately be obvious (Houkes and Vermaas 2010, Ch. 2).

A counterargument to the relevance of the designer for communicating use plans may be that many artefacts have been around for ages. The inventors of the wheel, the raft and the toothbrush have long been forgotten, yet their inventions are still used. Along the same lines, artefacts such as roads and paper have such obvious uses that explicit communication of a use plan by its designer seems unnecessary (Vermaas 2006).

Houkes (2008) argues that this counterargument has very little force for disproving the use plan approach. First, the use plans of these artefacts have simply been passed on through many different channels, including prior users, designers who adapted the original, etc. The use plan approach requires only that the use plan is communicated, not that there is always one-on-one communication between designer and user. Even in the case of artefacts for which the original use plan is lost, such as mysterious tools discovered in forgotten tombs, archaeologists often try to *reconstruct* use plans based on contextual information and secondary sources, showing the importance they assign to designer intentions (see also Vermaas and Houkes 2006a). Second, it is important to keep in mind the difference between kinds and types. While the toothbrush 'kind' has long been in existence, numerous 'types' have appeared on the market with flexible heads, extra-soft brushes, etc., and the specific use plans of those types are being communicated through packaging, advertisements, etc. (Houkes 2008).

17.5. Executing Use Plans

The use plan approach gives us not only an answer to the question of what *design* is, but also to the question of what *use* is. For the use plan approach, using an artefact is executing a use plan for that artefact (Houkes 2008).

If we spell out use in use plan terms in a similar way to design, the first step is for the user to *want/desire* to bring about some goal, and to *believe* that the goal does not (yet) obtain. Second, the user has to *choose* a use plan from a set of possible alternatives for bringing about the goal. (Not all possible alternatives have to be use plans for artefacts, e.g. when I consider whether I should use my bike to get to the store or simply walk.) Third, the user needs to *believe or verify* that the use plan is an effective way to achieve the goal. Fourth, the user has to *believe or verify* that the physical circumstances and their set of skills support realising the use plan—considering making toast for breakfast with my electric toaster makes little sense if I believe that there is a power outage in my neighbourhood. All these beliefs, together with knowledge of the use plan and possession of the skills needed to execute it, form *use know-how*. This use know-how is what serves as justification for users' claims that they know that an artefact can be used for achieving a certain goal (Houkes 2008). Fifth, the user has to intentionally *execute* the use plan. The sixth step is that the user compares the achieved state with the desired goal state. Seventh, if the user is confident that the achieved state is sufficiently close to the desired goal state (if not identical to it), s/he is done. Otherwise, several options are open to the user, including retries, repairs to the artefact and abandoning the original goal (cf. Houkes and Vermaas 2010, Ch. 2).

17.6. Evaluating Design With the Use Plan Approach

Because the use plan approach is a rational reconstruction of the design process, it can be used to check whether both use plans and their execution are *practically rational*. This section will first examine how the use plan approach evaluates artefact use, followed by how it evaluates use plans themselves.

When it comes to artefact use, the use plan approach allows one to evaluate whether it is *rational*, that is, whether the user justifiably expects that the artefact can be used in that way to achieve the envisioned goal, and *proper*, that is, whether it is the kind of use for which the artefact has been designed (Houkes 2006). If an artefact is used according to its communicated use plan, we speak of *rational proper use*, e.g. using a screwdriver to twist a screw into a board. Use can also be *improper*, when users create a new use plan for an artefact. This can be rational, that is, based on reasonable expectations: an example of *rational improper* use would be using a screwdriver to open a tin of paint after seeing one's neighbour do so successfully. Improper use can be irrational if not based on reasonable expectations: an example of *irrational improper* use would be trying to use a screwdriver as a toaster because one is confused about its physical properties. The final possibility is *irrational proper* use, where the designer's use plan is followed but one cannot justifiably expect it to lead to goal achievement, e.g. when a screwdriver breaks as soon as the user tries to tighten a screw due to some material defect. One reason why this distinction is so important is the division of responsibility: while the user is responsible for improper use of an artefact and its consequences, the designer is in principle responsible for irrational proper use and its consequences (Pols 2010) and may even be held liable (Houkes 2006).

Note that a use plan's being rational does not guarantee that every use according to that plan will be *successful*. One might justifiably expect a screwdriver to be usable to tighten a screw (rational proper use), but fail due to an unexpected lack of strength or a material failure that could not reasonably have been foreseen. Conversely, executing an irrational use plan may be successful through blind luck or having expectations about a possible use that, though not justifiable, turned out to be right.

About rational use, Houkes and Vermaas (2004: 59) write:

> In a rational plan, the user believes that the selected objects are available for use—present and in working order—that the physical circumstances afford the use of the object, that auxiliary items are available for use, and that the user herself has the skills necessary for and is physically capable of using the object.

Of course, there may be cases where the user is not fully responsible for irrational artefact use, e.g. when under pressure from an employing organisation to use the artefact in that way. This, however, is a situation where one of the general conditions for taking up responsibility is not met (in this case, being able to act freely; see Pols 2010) rather than a consequence of the way the use plan approach is structured. Houkes and Pols (2013) develop an account of what makes acceptance of technology in an organisation rational, combining the use plan approach with the Unified Theory of Acceptance and Use of Technology (Venkatesh et al. 2003), a model that predicts the adoption of information systems in organisations.

The use plan approach enables evaluating use plans according to the standards of practical rationality. Basically, this means that it allows one to check whether executing the use plan will lead to the desired goal; in other words, that the use plan is *effective* and *efficient* (Houkes and Vermaas 2010, Ch. 2). Houkes and Vermaas, though, are quick to remark that assessing effectiveness is always relative to other use plans (some methods might be more effective or efficient than others), context (a bike is not an effective method of transportation in the desert), specification of the goal (preparing a microwave meal might be an effective plan for a quick dinner, but not for a family Christmas dinner), the availability of auxiliary items and the user possessing the right skills and being able to execute the plan.

Besides effectiveness and efficiency, the use plan approach brings in other evaluative standards for use plans. Houkes and Vermaas (2010, Ch. 2) mention the following: *Goal consistency*, where if a use plan is meant to serve multiple goals, the user must reasonably believe that the use plan will do so (e.g. a phone cannot be used to take a picture and send it to someone else if it doesn't have a camera). *Means-ends consistency*, where the user must reasonably believe that all auxiliary items are available to execute the use plan. And *belief consistency*, where the user must reasonably believe that the use plan can be correctly executed if all the user's beliefs are correct. Whether this is actually the case does not matter for plan rationality. If I have good reasons to believe that I will be able to tighten screws with my screwdriver, but unbeknownst to me, the metal is so brittle that it will break as soon as I start, my use is rational, though as it turns out, unsuccessful.

The use plan approach is very good in evaluating effectiveness and efficiency, but it is also important to know what it *cannot* do. It tells the designer nothing about which moral values should be instantiated in the artefact and how trade-offs between them have to be made (Houkes 2008), nor is it intended to do so. Nor does it tell the designer anything about how to incorporate more practical values such as marketability and ease of manufacturing (Vaesen 2011) beyond that they could be applied as constraints in goal-setting. The only exception would be where an artefact becomes so unsafe or risky to use that values of practical rationality such as effectiveness and means-ends consistency become compromised. A toaster that has a 50% chance of exploding every time it is turned on is not only unsafe, it is also not a good toaster. Similarly, the use plan approach does not say anything about how stakeholders should be involved in design (see Chapter 24, "Human-Centred Design and Its Inherent Ethical Qualities" by Marc Steen, this volume), nor does it prescribe any methodology to guide the assembly of the technical artefact itself. Finally, while the use plan approach describes how the use plan can be *communicated* properly, it does not analyse how artefacts or use plans could *prescribe* or *invite* particular actions or *mediate* our perception of the world. This has traditionally been the domain of science and technology studies (e.g. Latour 1992) and (post-)phenomenology (e.g. Verbeek 2005). However, Pols (2013) shows how these phenomena could in principle be analysed as changes in our reasons for action, and thus that they could be analysed under the umbrella of practical reasoning, just like the use plan approach.

17.7. Use Plans, Functions and Affordances

The use plan approach has been developed in response to the primacy of technical *functions* as the focus of the philosophy of design and technical artefacts. It is not the only alternative design approach that arose from dissatisfaction with the limits of function-based approaches: affordance-based design has sprung from that origin as well. Though functions are the subject of Chapter 18, this section will compare function-based, plan-based and affordance-based accounts, and show why Houkes and Vermaas consider a use-theoretic account more fundamental and more accurate than a function-theoretic account.

The use plan account has first been described in Houkes et al. (2002), who suggest that it best fits Cummins's (1975) account of functions as, basically, the causal contribution something makes to the capacities of systems that contain it. (For example, the function of a jet engine is to generate thrust, because that is the causal contribution it makes to an aircraft's capacity to fly.) However, the use plan account is only properly compared to function-theoretical accounts in Houkes and Vermaas (2004). Here, they claim that use plans are more fundamental than functions and thus, are the proper answer to the question of what the object of engineering design is. The reason for this is given in Section 3: the design of the use plan always precedes the artefact design phase during which the actual technical function is implemented. Indeed, for their ICE theory of function ascription, Houkes and Vermaas (2010, Ch. 4) define functions in terms of use plans.

The reason Houkes and Vermaas consider use plans more accurate is that theories of technical functions tend to focus on *proper* functions. Use plans similarly consider 'proper use' but are much better situated to also take *rationality* into account. This is because this factor is not dependent on artefactual properties, but on the properties of agents and their physical and social context. For instance, the proper function of my car might be to quickly transport me, but if I lack driving skills, and moreover, a hurricane has blown my car into a tree, I cannot properly use it, even if it is otherwise undamaged. Due to the physical circumstances and my lack of skills, I cannot execute a rational proper use plan for my car. (Alternatively, we could say that it is impossible for me to design a proper use plan for my car that is also rational: under the current circumstances, there is no way in which I could use my car to transport me quickly.)

Another advantage of the use plan approach is ontological parsimony. That is, if I use an artefact for another purpose than the designer intended it for (e.g. standing on a chair to change a light bulb), the artefact does not suddenly gain an extra property/(accidental) function. Rather, the artefact remains what it is; I just plan a new use for it.

It should be noted here that some proponents of function-theoretic accounts are aware of the relevance of contextual factors and have taken them into account as well (cf. Pols 2015; Vermaas and Houkes 2006a; Chandrasekaran and Josephson 2000). Houkes and Vermaas have done so by using the use plan approach as a basis for their ICE account of functions (Vermaas and Houkes 2006a; Houkes and Vermaas 2010). Thus, function-theoretic accounts have been made more accurate through the introduction of contextual factors. To the author's knowledge, however, no attempt has been made so far to argue that functions are more fundamental than use plans.

Houkes and Vermaas are not the only ones who have developed an alternative account of design and the objects of design in response to the (perceived) shortcomings of function-based accounts. Another alternative is the affordance-based account of Maier and Fadel (2009). Maier and Fadel consider functionalist accounts to be overly concerned with transformative aspects of design (e.g. how an artefact transforms electricity into motion, or vice versa) and neglect non-transformative considerations. For them, the fundamental objects of design are *affordances*, opportunities for behaviour and relational entities that depend on characteristics of both artefact and user. For example, a chair affords sitting because of its material characteristics as well as because of characteristics of human anatomy. If a chair is covered in barbed wire, it does not afford sitting (unless one is wearing armour). Neither, however, does a regular chair afford sitting to babies, who lack the capacity to remain upright by themselves. Design, for Maier and Fadel, is 'the specification of a system structure that does possess certain desired affordances in order to support certain desired behaviours, but does not possess certain undesired affordances in order to support certain undesired behaviours' (2009: 23).

Pols (2015), who has compared the notions of use plans, functions and affordances in greater detail, has argued that this definition entails that use plans are more fundamental than affordances as a description of the design process, for the notion of 'desired affordance' inevitably begs the question of what makes an affordance desired. This would be the use plan, or the combination of the goal that is to be achieved by using the artefact, and the series of actions by which it is to be achieved. Nevertheless, plan design according to the use plan approach would be quite compatible with artefact/product design according to affordance-based design: Pols (2012) explains in detail how both are related.

17.8. Criticism

The use plan account is not without its critics. In this section I discuss three general criticisms that have been levelled at it and Houkes and Vermaas's responses: some actual, some hypothetical. The first is that, contrary to most classical function accounts, it is not able to properly describe artefacts that require little or no user actions to operate, such as jet engines. The second is that it is too far removed from actual use practices to even count as a proper rational reconstruction. The third is that its method of rational reconstruction itself may be structurally biased against particular groups of designers.

The first criticism is that there is a whole class of artefacts that work with little or no user interactions, namely those artefacts that are components of other artefacts. For example, a jet engine consists of many individual artefacts, none of which are explicitly operated by any user. Function-based approaches can ascribe subfunctions to these artefacts through functional decomposition (e.g. van Eck 2011). Likewise, affordance-based approaches like those of Maier and Fadel (2009) have artefact-artefact affordances to deal with interacting components (e.g. 'this cog affords being rotated by another cog'). As components are not directly interacted with by the user, however, no use plan is available, the argument goes. Thus, they are a significant blind spot for the use plan approach.

The reply here is that this is not so much a problem for the use plan approach, as well as a salient difference between the rational reconstruction of the use plan approach and engineering practice. Added to that is the fact that this is an example that function-based approaches seem made for, for the relational/contextual factors for components are always clearly established in advance. The context for a jet engine component is always a jet engine. Vermaas (2006) has shown that for the design of such components, the use plan approach can be 'bracketed': component design is covered almost completely by the technical product design phase in that sense. However, even component functioning is always embedded in a use plan—if not for the jet engine, then for the jet itself. The description of components in function terms is thus not plan-less but plan-relative. Houkes and Vermaas (2010, Ch. 6.2) argue that for components that are complete artefacts, plan aspects become almost impossible to bracket. Thus, they argue that, while many components can be adequately described in terms of (sub-)functions, sooner or later, reference to plans is inevitable.

A second criticism can be found in Lucy Suchman's (1987/2007) book on plans and situated actions, in which she criticises a plan approach to human action in general. Her arguments form a challenge for the use plan approach's conceptualisation of use as the execution of a use plan as well. She argues that users *rarely plan their use in advance*. Instead, they mostly perform 'situated actions', where they check the opportunities for action an artefact offers at each given moment, and do what they think is likely to help them achieve their goal at that moment. For example, when using a copying machine, users tend to act on the information presented to them in subsequent menus, rather than planning every step in advance. Similar observations have been made by De Léon (2003) on the use of artefacts in cooking.

Vermaas and Houkes (2006b) agree with Suchman's empirical observations about users but argue that they do not threaten their account. Rather, they argue that designers should make sure that a rational use plan exists for the artefact, but that there is no reason why users cannot engage it with a 'light' or 'high-level' use plan that allows for a lot of situated actions and responses to the environment. Indeed, even detailed plans have to leave many specific actions open to the user: those that do not matter for goal achievement (e.g. where exactly in the kitchen to put your toaster) or because more specific instructions would make no sense (e.g. how exactly to move your finger to push the knob on the toaster down). Similarly, use plans have to be communicated to users, but there is no requirement that the full plan has to be communicated in advance rather than step by step. Thus, though the use plan account is at its core rationalistic, it is also very flexible and able to incorporate many different design and use practices, as long as they adhere to some basic criteria of practical rationality.

A critical reader might not be satisfied by this answer, noting that defining 'executing plans' so broadly as to include all kinds of non-planned, situated behaviour seems more like a conceptual slight-of-hand than a robust analysis. Hypothesising about the response, it seems that Houkes and Vermaas would likely address this concern by pointing out that their central concern is to develop a theory of engineering design and its objects, rather than a theory of their use. Looking at the division of labour between designers and users underscores this: the more users deviate from the rational ideal and exhibit bounded rationality (not to mention forgetfulness, irascibility, carelessness, etc.), the more important it becomes for designers to plan for this and ensure that this plan is presented to the user clearly and step by step. Thus, if users are successful in achieving their goals by situated actions, this might attest to the quality of the underlying plan and its communication rather than serve to disprove it.

A third criticism that could be brought against the use plan account, or more broadly, against the use of rational reconstructions and ideal theory in analytic philosophy, regards its validity as a method of analysis. Houkes and Vermaas stress that the use plan approach is intended not to reflect actual design practices, but rather as an ideal theory of design. This allows them to focus on rational rather than idiot-proof design (as Maier and Fadel 2009 do), but also forces them to translate Suchman's

(1987/2007) situated actions and Scheele's (2006) and Schyfter's (2009) social institutions into a framework in which humans are individualist, plan-based reasoners.

Ideal theory and its corresponding concept of humans as rational individuals, however, has been criticised, most notably by feminist philosophers. In a nutshell, the criticism is that such theories are not so much *ideal*, identifying how humans would 'ideally', or 'in perfect circumstances' behave, but *biased* in valuing particular aspects of humans over others, particularly their capacity for practical reasoning. While every model is a simplification of reality, this particular simplification has been accused of being problematic because it favours the thought and behaviour of particular kinds of humans, namely, Western higher-educated white males, over others. For example, Jaggar (1983) has criticised Rawlsian ideal political theory of over-valuing individual characteristics such as rationality over characteristics that humans share as family or community members, and incorrectly seeing rationality as value-neutral and detached. Code (1995) has similarly challenged analytic ideal epistemology for being overly concerned with propositional knowledge ('X knows that *p*') and hardly with the personal and social characteristics one must have before one can say, e.g., that one 'knows a person'.

To substantiate this criticism against the use plan approach specifically, one could go down several paths. One could be to analyse whether there are indeed cultural or gendered differences in conceptualising (the objects of) engineering design (e.g. Faulkner 2007; see also Chapter 48, "Feminist Engineering and Gender" by Donna Riley, this volume) and if so, whether the use plan approach can adequately incorporate them. Another, more radical one could be to question the prominence of analytic practical rationality itself in engineering design and build on a different conceptual foundation altogether, as Schyfter (2009) does.

Following either path lies outside the scope of this chapter. However, if we again hypothesise about the answer, Houkes and Vermaas would likely refer back to the introductory chapter of their (2010) book, in which they explicate not only the goals of the use plan approach and the ICE theory of function ascription, but also explain their 'design specifications' for a theory of technical artefacts. These are: being able to distinguish between stable, 'proper' functions and more transient 'accidental' functions; being able to accommodate the concept of malfunctioning; offering support for function ascriptions; and being able to accommodate functions of innovative artefacts (p. 5). Criticism that shows that the use plan approach (and thus, the ICE theory) is not actually able to meet its design specifications, such as Schyfter (2009) aims to give, is a real challenge for Houkes and Vermaas. More radical criticism that were to pose different design specifications for a theory of technical artefacts, however, might not necessarily be such a challenge. Rather, it would be an opportunity to engage in a dialogue about exactly what kind of answer we are looking for when we ask what engineering design or its object is.

17.9. Conclusion and Outstanding Issues

Though the use plan approach has been around for less time than function-based approaches to design, it has established itself as an elaborate and solid theory of what design and its object is. As such, it is not only a theory of the design process, but also of what designers need to communicate to users, and what makes use of an artefact rational and proper.

The claim of the use plan approach to be more fundamental than function-based approaches holds so far, though its claim that it is more accurate is being contested by function-based approaches that take rational or contextual and user aspects into consideration next to designer intentions. As a rational reconstruction or ideal theory of design, it has particular strengths and weaknesses. Among its weaknesses are that its empirical validity is hard to prove, that various other ideal theories in philosophy have been shown to be biased rather than value-free in their abstraction, and that its prescriptive value for (beginning) designers may be limited. Any prescriptive value of the use plan approach can be said to be incidental rather than intended, given its primary aims of providing a rational reconstruction of design and a conceptual basis for the ICE theory of function ascription. Among its strengths are that it sketches what an ideal design process should look like, and thereby provides us with a tool to evaluate actual design processes according to the standards of practical rationality.

The use plan approach is not a closed method, though the number of publications on it has dropped off sharply after publication of the Houkes and Vermaas (2010) *Technical Functions* book. Some open issues that remain are the following. It currently ignores the creative aspect of design—how designers get their ideas and how they 'play around' with different designs to come to new insights. It assumes one designer and one user, and it does not describe the interactions within a design team (but see Pearce 2016), or between multiple involved stakeholders such as product designers, testers, clients, prospective users, affected third parties, etc., who may all be different. This matters for issues of responsibility, such as whether a design team can be properly held responsible for an irrational proper use plan. It does not look at integration and coherence in artefact design (all from Houkes et al. 2002). More generally, the claim that the use plan approach can count as a rational reconstruction of the wide variety of actual design practices, including across cultures and genders, remains under-investigated. Remedying this would require interesting yet considerable empirical and conceptual work.

Related Chapters

Chapter 8: Prescriptive Engineering Knowledge (Sjoerd Zwart)
Chapter 15: Artifacts (Beth Preston)
Chapter 16: Engineering Objects (Wybo Houkes)
Chapter 18: Function in Engineering (Boris Eisenbart and Kilian Gericke)
Chapter 21: Engineering Design (Peter Kroes)
Chapter 48: Feminist Engineering and Gender (Donna Riley)

Further Reading

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Crilly, N. (2010). The Roles That Artefacts Play: Technical, Social and Aesthetic Functions. *Design Studies,* 31(4), 311–344. (A consideration of the non-technical functions of artefacts, including social, ideological and aesthetic ones.)

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