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Influence of context variation on quality of solutions: experiences with gasifier stoves

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Abstract

Many global sustainable development issues affect large numbers of people, e.g. clean cooking. Most current projects focus on a specific use context, therefore do not scale well to new contexts and consequently do not reach enough beneficiaries. We present an approach, Context Variation by Design (CVD), in which insights from different contexts are intentionally combined early on in the process to develop solution directions. This creates a richer solution space than when contextual variations are developed sequentially. The rich solution space is then the basis for these contextual variations which might include connections and synergy between them. We discuss several real-life project examples that demonstrate that this approach indeed creates a basis for better solutions. In particular, confronting insights from different contexts at an early stage reveals new solution directions. To fully capture the potential the approach needs to be applied throughout the design process.

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Keywords: Large scale issues; clean cooking; gasifier; design approach; complexity; shared solution space; scaling, sustainability

1. Introduction

As introduction to this paper we briefly discuss how global innovation flows have developed over the past century, and how these represent an increasing level of complexity. Not all strategies for global innovation have acknowledged that aspect. We will then continue by discussing complexity and how to use it for our benefit.

1.1 Global innovation flows

The history of innovation that crosses geographical boundaries goes back for millennia. For now we will limit

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ourselves to the past century. In a somewhat simplified fashion we can roughly distinguish the following stages, derived from Govindarajan [1]:

1. Western countries dominate inventions and application in new products. According to Vernon [2], once labour costs become a differentiating factor companies decide to move production to low-cost countries, but still have Western markets as their main beneficiary. MNCs (Multi National Companies) are the dominant players in this phase.
2. With end-users in other markets becoming more affluent and accessible, they get served by means of roughly the same products, lightly adapted to (assumed) local preferences on mostly superficial level (colours, visuals, names), although even there many failures have occurred [3].
3. Upon such failures and with the rising self-awareness of less affluent countries, they began developing products for their own markets based on local knowledge, much of it very context-specific.
4. With the further evolution of so-called emerging markets, the EMFs (Emerging Market Firms) move into the front seat, scaling up production and sales of the local inventions. While at the same time the "Base of the Pyramid" paradigm [4] emerges, Western MNCs however more often than not have difficulty in developing appropriate products for these markets because of lack of contextual understanding [5].
5. Reverse innovation: inventions and applied products and modes of thinking that initially were intended to serve marginalized beneficiaries in emerging economies (Base of the Pyramid segments), turn out to be relevant for Western economies as well. [6, 7]

For all stages one could claim that innovators had a global outlook and were dealing with complex situations. In fact this was not the case and this has serious consequences. To understand this better we have to briefly elaborate on the concept of complexity and its relevance for global innovation, in particular with respect to large scale issues related to basic human needs.

1.2 The increasing role of complexity

To be able to assess how well certain strategies address the complexity of society, it is necessary to first have an understanding of what complexity entails. A complex system consists of a diverse multitude of parts, many of which are interrelated and we cannot oversee let alone control and manage neither their interrelations nor the consequences thereof. This makes the system's behaviour as a whole unpredictable [8]. What we *can* say is two things: the answer to dealing with complexity does not lie in applying a narrow focus, zooming in, clinging onto one strategy, i.e., trying to manage away the complexity [9]. Rather, the uncertainty that is engrained in complex systems [10] should be accepted, and should be turned into a benefit by using a mind-set of "fighting complexity with complexity" [11]. Of course this to many people sounds daunting and therefore requires further guidance.

Before we address that concern, it is also relevant to highlight an immediate consequence of complexity in the realm of large scale social issues. The currently preferred strategy to develop, implement and then scale a solution (usually involving a physical product), is to focus on one context, design and test it there, optimise the value chain including production, and only once it becomes a success start with scaling. The most encountered problem then is the mismatch with requirements in a next context, necessitating (partial) redesign of the solution and often the production system. At the same time, especially for the beneficiaries in the Base of the Pyramid segments, one of their main concerns is affordability, and scaling up production is one of the main strategies that a company has to increase affordability. However, if a new solution needs to be developed for each context, it will be hugely challenging to reach the volumes that enable economies of scale.

By applying the principle of "fighting complexity with complexity", another type of strategy emerges. It basically refers to the same process but in a more discursive way; in this case, start at the end: 1. You know that to substantially contribute to reducing a large scale issue, you will need to achieve scale, 2. That scale, i.e., the range of target groups, is dispersed over many contexts, 3. Their needs have to be addressed in a way that also enables an efficient design of the production system, thereby facilitating economies of scale effects, 4. It then helps to have insights in what the requirements in these contexts will be. In other words: by recognising, accepting and then working *with* complexity you can develop new strategies that enable you to work with it instead of pushing it away for now. This realisation is the starting point for the remainder of this paper.

1.3 Structure of the paper

In support of this mode of working we refer to an evolved design approach that acknowledges complexity and uses it as productive basis for high quality solutions that can be quickly adapted to various contexts and therefore create more impact against lower overall costs. This approach is called Context Variation by Design, or CVD [12].

We have executed a number of pilots using this approach in various countries in Africa and Asia. In this paper we zoom in on the ones related to clean cooking, more specifically clean cooking using gasifier technology. In light of what we described in section 1.2, this is a relevant topic because of two reasons: 1. The negative effects of current cooking habits, technologies and fuels (health, deforestation, fuel costs) turn it into a very large scale issue, amongst others reflected by a mortality of 4 million people per year [13]. 2. Strategies to address it so far in majority show one of the following major flaws: either product design does not focus well on end-users [14], or assuming that a one-size-fits-all strategy will work [15]. In both strategies companies place more importance on efficiency by mass producing a core universal product [16] than on effectively taking into account the complexities.

This paper briefly describes the CVD approach and its rationale in section 2, then shows and discusses a number of examples taken from pilot cases in section 3 thereby demonstrating the first part of the CVD process in practice. This results in section 4 with conclusions on how the added value of CVD can be enhanced and investigated further.

2. A next step design approach

2.1 Dealing with complexity in design

It does not fall within the scope of this paper to extensively reflect on the entire archive of design literature that mentions complexity. We will only mention some main points and representative authors here, in order to demonstrate how CVD builds on and expands existing notions:

- various authors like Dorst [17, 18] have stated how thinking like a designer is suitable to approach complex situations, e.g. by reframing issues several times before moving towards solutions;
- while designers have the capacity to deal with complexity, they do not always live up to that promise [19];
- some like Jones [20] focus on the necessity to approach design from a systemic perspective;
- high-end design firm IDEO has popularized the term “design thinking” [21].

One way to see how these notions have planted the seeds for CVD is by referring to instructions in the design thinking toolbox by IDEO [22] that stipulate to “find inspiration in analogous situations”. CVD expands this notion by making explicit that these situations most importantly include other use contexts where the same issue is encountered, *especially* if these contexts display different dynamics. Typically such a context is another country or even continent, but could also be another region or segment. Instead of using such different dynamics as argument to push these contexts outside of the (initial) scope, declaring such considerations to be too complicated or just labelling them as inspiration, CVD on purpose draws them inside the scope. This focus on *intentionally combining and creating connections between insights from different contexts* is the main difference with other approaches.

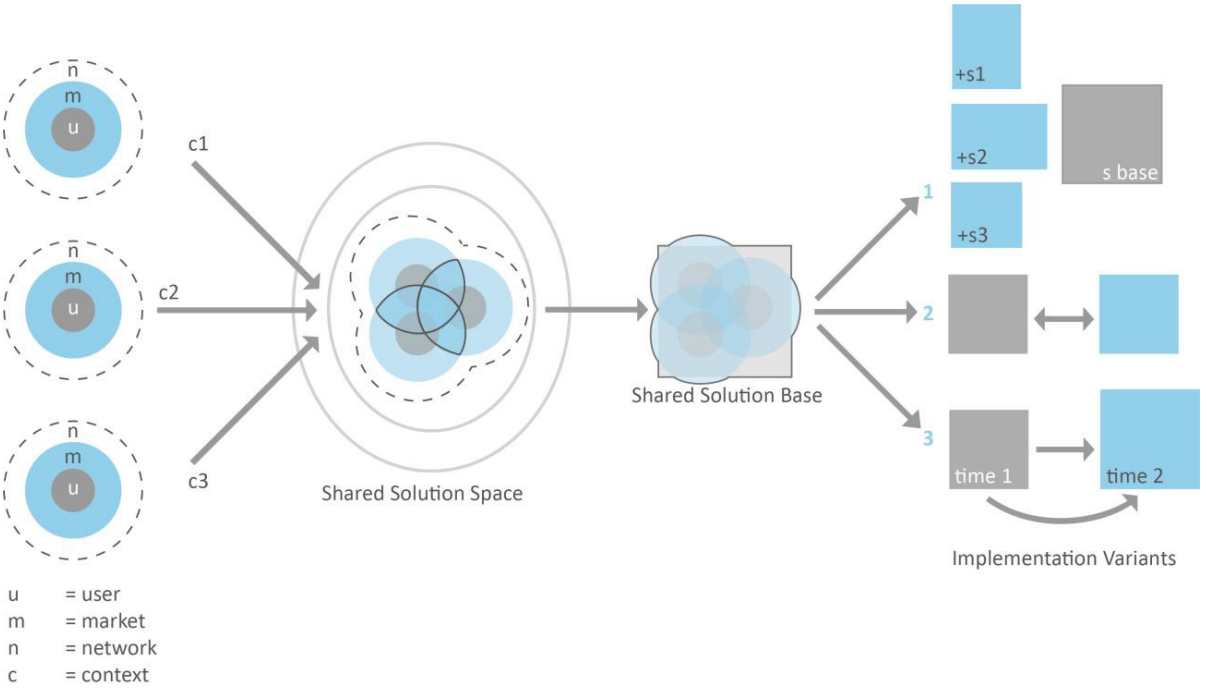

Fig. 1. CVD approach visualised. Insights from three contexts (c1, c2, c3) are combined in a shared solution space.

Combining insights occurs in the so-called shared solution space, the middle part of Figure 1. By letting the different insights interact, a multiform and much richer analysis of the issue is performed. This results in shared insights that feed into a shared solution base from which contextual variations are more easily derived. By taking this step early in the process, the implications for the entire chain, including the production system, are clearer much earlier than compared with traditional scaling strategies, with contextual differences becoming apparent only much later. Combining insights in an early stage still allows for different implementation strategies, which we will not go into in this paper.

2.2 Empirical research method

The approach is interesting for multinational companies from all continents, but they are also reluctant because making changes to their current mode of working is difficult [23]. Therefore we did our pilots with small companies, which had local presence in the countries they were targeting and were more open to experimentation. The examples focus on the first part of the CVD process, and primarily demonstrate how it encourages creativity, which is likely to result in better and more adaptable solutions. All cases were executed by junior designers, actively working together with the companies and supervised by senior design experts.

3. Findings in practice

The examples below come from three cases that all include at least one country in Africa, and deal with the topic of clean cooking using gasification technology. The examples are based on detailed analysis of the notable differences between mono-context insights and shared insights and consequences for the design concepts.

The topic of clean cooking is extra challenging since it involves habits that are culturally specific. Besides that aspect other known differences between contexts occur for example in terms of availability and diversity of fuel, market/ prices, distribution strategy including geophysical situation (e.g. is much biomass available, how accessible are villages in terms of transport), education level of end-users, availability of alternatives and eco-system around that [24]. In short, a ‘solution’ is more than just technology [25].

3.1 Cases and examples

Case 1: Two African countries: South-Africa and Uganda
Example 1.A: from one context it became very clear that price of purchase and subsequent fuel savings would be a main argument for end-users to switch fuels. While costs were thus a factor, they did not make the link to cleaner cooking having positive health effects (and thus lower health costs). This element was verified in the other context with a similar result. Vice versa, from the second context the – initially surprising – priority for aesthetics of housing and household appliances surfaced. This was verified in the first context where it was confirmed that a recognisable disadvantage of the smoke from old stoves was that it blackened the indoor environment. This triggered the designers to explore other arguments, resulting in the aspect of safety being mentioned in both contexts by end-users. While it is conceivable that a mono-context research would have revealed the latter, by letting end-user preferences from different contexts *interact*, the analysis was richer from the start, thus preventing the designers from being satisfied with a user preference that was only specifically mentioned in one context.

Example 1.B: the typical family sizes in the respective countries vary. Starting in a specific context would result in optimising the size/ capacity of the stove to the family size that is prevalent there, which clearly complicates scaling to contexts with other typical family sizes. In one of the contexts it was also found that family members often move from rural to urban areas, thereby increasing the desired cooking capacity in the latter context, while buying multiple stoves is outside their financial reach. This combination of insights creates a great opportunity: designing stoves whose capacity can be easily extended, with extensions in part being paid by loyalty points. End-users thus stay connected to the stove company for a longer time and don't have to make a one-off decision: they can extend when required. One might even consider saving loyalty-points on family level. While working in any mono-context would likely have resulted in focusing on a particular family size, by *allowing the complexity* of considering different family sizes, new ideas for the business model (and product design) emerged.

Case 2: Three countries: South-Africa, Uganda, Cambodia
Example 2.A: from two contexts the requirement for stability of the surface for the stove was important for stirring, for the third context a clear desire was the option to grill food. For this a stable device is also required. So while dominant cooking habits vary, they can still lead to the same requirement. Furthermore, considering the requirements that would not be found as combination in any of the single contexts also raises the creativity-invoking question how the grilling requirement might best be combined with the pan stirring requirement. As such letting the insights interact leads to identification of a joint requirement as well as a thought provoking question.

Example 2.B: in one context the users prefer a "shiny" look, presuming a higher quality product coming from a reputable factory; this also affects the desired colours (white, black) and size (large). In two other contexts, the appearance was less important, but rather it was preferred that it would be portable, which implies it being lighter (perhaps have a less stocky look) and/or small. One way to comply with the variety of requirements could be to have a (stable) supporting block in a 'hard' colour that can be added at the bottom of the stove to enlarge its appearance for the first context, while not being a fixed part for the other two contexts. If the other two contexts would have been taken as starting point, the option of the supporting block would not likely have been thought of, thereby blocking or at least delaying a successful entry in the first context.

Case 3: Two countries: South Africa and Rwanda (focus on business model aspects)
Example 3.A: in one context the main discomfort that people experience is the time and effort it takes to collect their cooking fuel (wood), which they can however collect in abundance even in excess of their needs. They can use the surplus for trading. In the other context the main discomfort is the price of the fuel (paraffin) and costs rising proportionally with level of fuel use. Whereas these seem totally different circumstances, a shared insight is that in both contexts the aspect of affordability is important. From the first context we can borrow the concept of trading something which the end-user has in abundance, from the second context we can borrow the idea to let fuel costs for the end user not rise proportionally with the volume they use. If we let these insights interact, it is possible to have a context-independent policy of encouraging the end-user to trade something (s)he has in abundance with the supplier, in return for a regressive 'price plan', i.e., more fuel results in lower average price.

3.2 Experiences when applying CVD

The previous section described a wide variety of examples of insights that were obtained in the shared solution spaces and arguments why these insights are likely to lead to higher quality solutions and would not likely have been generated just based on the information from one context. We will now briefly look at how the designers who have used CVD experienced it, also in comparison with other approaches they are used to.

- For several of the designers, an eye-opener was that when being 'forced' instead of just nudged to include a totally different view context-wise, made them realise that when they had focused on a specific context, while seemingly sensible, this had in practice caused them to forget other angles.
- At the same time it was at times also surprising how elements in different contexts were the same or similar. As the designers claimed we are less different as often thought, but also in surprising ways. Elementary aspects might be quite similar, but drivers might be different, or the other way around.
- CVD broadens your mind but in a more purposeful way then just getting inspired from 'anywhere' or trying to draw analogies, which is taught in other design approaches. CVD seems to strike a good balance in guiding designers towards pulling in inspirations that are neither too closely related nor too far removed, which according to recent findings by Gonçalves [26] stimulates both relevance and creativity
- In particular the phrase "think like a designer" (i.e., apply 'design thinking') is made more concrete. By being *explicitly* encouraged to consider multiple contexts you are encouraged to do more cross-checks, verification of possible solutions and think about "what could be" instead of "what is and what comes next". This skill is called abduction [27], which represents a key difference between designers and engineers and apparently CVD does stimulate this explicitly.
- In many cases companies will already have some ambition to enter other markets but assume they have their hands full with the initial one. However, a lesson from the pilots is that you can already benefit from explicitly considering requirements from other markets to improve your current design. The initial quality is likely to be higher, or put more crudely, the CVD-process can result in 'no-lose' design: it does not involve a compromise on the short term and makes future contextual adaptations easier.

From the different cases the finding emerges that different types of shared insight exist. There was no evident upfront way to distinguish categories. Based on the materials that we collected so far we could for example use labels like "a shared insight refers to a similarity on a higher abstraction level", "a shared insight reflects awareness of a hidden shared common denominator", "a shared solution space reveals existence of different manifestations of the same core phenomenon". These formulations are basically variations on the same theme, which might be summarized as: a shared insight is a meta view on (aspects) of the problem that lets you see it in a new light, so you can be pointed in a solution direction that otherwise would have remained hidden.

4. Conclusions and next steps

Based on the cases discussed we draw a number of conclusions:

- Society experiences a range of large scale issues, in different contexts in parallel. This makes immediately clear that there is a need for developing solutions that effectively address sets of requirements from these different contexts. Traditional strategies to start with one context and then scale up once successful would take a very long time and be very costly due to multiple redesigns of products and production systems.
- Use of the approach Context Variation by Design (CVD) does address this concern. It requires some flexibility in terms of contents because short-term results are more difficult to predict than when starting in one context, but once more clarity is obtained the requirements for product and production system can be determined that are more resilient, i.e., can cover a wider area of contexts, from the start.
- Perhaps counter-intuitively with regards to the aforementioned flexibility, using CVD to its fullest potential requires a rigorous attitude. Designers expressed in hindsight that they would have benefitted more if they would have used it consistently throughout their project. CVD encourages an attitude that leaves more room for flexibility but it also needs to be a conscious choice to capture the full potential.

- Building on the examples and the experiences of the (junior) designers, the following tentative framework can be derived for the *types* of shared insights that can emerge from a shared solution space. While tentative, such a framework can help designers to somewhat structure their results of the shared solution space: 1. Overlapping requirements (input for core part of solution), 2. Conflicting requirements that encourage creativity to create satisficing solution, 3. Requirements that are crucial to meet in one context upon explicit confrontation, create nice to have or better solution-aspects for other contexts, 4. Context specific insights reflect a common denominator ('anchor') on a higher conceptual level, 5. Contextual information reflect different manifestations of the same underlying driver.

The relevance of CVD for sustainable manufacturing may be summarized as follows: solutions (including products) that are aimed at meeting basic needs of many people have to be affordable to be adopted on a large scale. To be able to achieve economies of scale advantages that can increase the affordability, production systems need to be designed to accommodate this. This can only be done effectively if there is an outlook on what the system needs to look like. CVD enables companies to create insights much earlier on than currently is the case, about the sets of requirements for the products once these enter other contexts than they initially planned. Even while these products do not need to be the same for all contexts at all, by having more clarity on the different contextual variations early on, companies are better able to take this into account when designing their production system or network. This enables them to achieve production scale advantages, which helps to improve affordability, which is a prerequisite for market adoption for solutions that address basic needs.

These conclusions give rise to a number of guidelines for next steps:

- More pilots and more extensive projects will provide insights to refine the approach, including getting a more informed feeling on the best mix between freedom and guidance during the process.
- The notion of shared solution spaces resulting in more creative, richer and better solutions will be researched explicitly in more cases.
- Based on the experiences so far it seems to be justified to push for more explicit inclusion of at least the underlying rationale of the CVD approach in design and possibly production management curricula.
- In follow up projects the eventual effect on speed and costs for scaling ideally are included as well More specifically, investigating the influence on the manufacturing process of developing contextual variations instead of mass-producing one universal product or developing user-group specific products will be interesting, because this influence may be decisive in getting companies to adopt the approach.

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