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# The impact of virtual simulation tools on problem-solving and new product development organization

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**Abstract**

New product development nowadays makes heavy use of IT instruments such as virtual simulation tools. The main motivation for introducing virtual simulation tools in new product development is to speed up development and lower its cost. Virtual simulation tools, however, do much more. They introduce profound changes in the organization, including the nature of problem-solving, bearing the potential to increase new product development performance beyond cost and lead time reduction. Understanding these profound changes, we argue, holds the key to unlocking the potential of virtual simulation tools for improving new product development performance, including more innovative products. We support our argument with a case study from the European auto industry.


*Keywords:* New product development; Problem-solving; Simulation; Experimentation; Automotive industry

## 1. Virtual simulation tools can do much more than just speed up product development and lower its cost

Virtual simulation tools now play a very important role in new product development. They have been widely hailed to significantly cut development time and costs (Thomke, 1998a, 2001a). Accordingly, virtual simulation tools are often introduced in new product development to reap precisely those benefits. In the academic literature, virtual experimentation is also often regarded as a way to overcome the cost and time limitations of physical experimentation methods. Limiting virtual simulation tools to such considerations, however, misses an important point. In this article, we argue that the contribution of virtual tools to experimentation goes well beyond the incremental improvement of the results obtained with physical experimentation.

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Virtual simulation techniques can do much more than just reduce the cost and increase the speed of problem-solving (West and Iansiti, 2003). At the same time, though, they also trigger profound changes in the nature of problem-solving (Baba and Nobeoka, 1998). Building on previous studies that have established the importance of organization in new product development performance (Rothwell, 1977, 1992; Pavitt, 1998), we argue that in order to reap the full potential of virtual simulation tools, beyond cost and lead time effects, adapting the organization is required. To do that, it is beneficial to understand how virtual simulation tools impact problem-solving.

One of the most important motivations for introducing virtual simulation tools is that cost and time requirements of physical experiments are not always compatible with strict new product development (henceforth NPD) process time and cost constraints. Due to these latter, engineers often opt for the "carry over" of components and system of components from the previous model generation to the next one, leading to conservative design. Moreover, physical prototypes incorporate engineering solutions that often are already obsolete by the time the prototype is built. The results of physical experimentation are thus often not fully relevant for engineering development. The use of virtual development tools contributes to overcome these limitations. In fact, they not only help reduce experimentation costs due to the speeding up of the testing phase, the reduction of the number of costly physical prototypes and redesign linked to their fast obsolescence, they also improve design quality via the availability of information very early on in the development process (front loading problem-solving, Thomke, 1998a).

Virtual tools, however, help engineers to *observe* phenomena, which are much less readily observable otherwise. To illustrate the point, consider the following example: cost reasons provide a severe limit to the number of physical prototypes that can be built for crash tests. At the same time, however, it is imperative car models pass the NCAP crash test (http://www.euroncap.com) with a good mark. Given the fact that there are at least 400 components (our interview with product development engineer) that affect such a crash test, it is impossible to isolate precise cause–effect relationships among all the parts without repeating the experiment several times. Hence, car designers and engineers have to manage a trade off between costs and accuracy of the experimentation. Virtual simulation tools have enabled, in this respect, almost infinite iterations of the same experiment and, importantly, isolating one parameter in each run. As compared with physical experimentation, they therefore approach a "laboratory-type controlled environment". In this way, a great variety of hypotheses on the causal relationship between the design characteristics and the crash test performances can be tested (at a reasonable cost).

As Schön (1983, pp. 157–158) has explained, the reason is that the residual traces left by using virtual simulation tools are stable, and the designer can examine them at leisure while the pace of action can be varied at will. Savings in cost and (preparation) time therefore also have another, indirect, effect: they provide the possibility to perform learning sequences in which one takes account of previously unanticipated results (Schön, 1983, pp. 157–158). In this way, virtual experimentation allows testing hypotheses that are not constrained by the logical bounds of the premises one starts from. It thereby enables non-conservative design, which is important in order to achieve distinctive new designs (Wheelwright and Clark, 1992).

## 2. Introducing virtual simulation tools triggers profound changes in the organization, including the nature of problem-solving

There is ample evidence in the literature that introducing new technology into an organization triggers changes in the way tasks are accomplished, and thus in organizational processes (Barley, 1986; Barley and Kunda, 2001; Orlikowski, 1996, 2002).[2] Technologies alter institutionalized roles and patterns of interaction, change organizational and occupational structures by transforming patterns of action and interaction, via roles and social networks, tasks, skills and relations among incumbents of different roles (Barley, 1986, 1990). Such changes often go beyond the effects intended and considered by the technology's designers (Orlikowski and Iacono, 2001; Orlikowski and Barley,

[2] Our paper thus also addresses the lack of significant attempts to examine the *consequences* of the implementation of virtual experimentation technology for the adopting organization (D'Adderio, 2004).