

Value in Conceptual Design Context

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Abstract

Value is used in various contexts in engineering design. By general definition, value describes the importance or worth of something for somebody. In design context, value is qualified by the degree, how well somebody's needs are fulfilled. Value is determined by properties, which can be divided into various categories and the goodness of a technical system is measured by deviation from an ideal solution.

In business the product shall provide greater value and benefit to a stakeholder than the required investment. This brings out that the value content is different depending on the viewpoints of technical system, user or producer. How this divergence shall be discussed and exploited by product developers to enable development of innovative products?

Product value is created during the originating process, which is the primary value chain for the producer. Once the product is taken into use the user's value chain is activated. These value chains can be simultaneous, partly simultaneous or consecutive. Accordingly, the product value is relative and depended on the viewpoint, time and place. The value assessment has different aspects, which shall be evaluated using measures like universal virtues or money.

In this paper we study value aspects and their influence to the product development process and concept and how they relate to incremental product innovations.

Keywords: Product development, conceptual design, value assessment

1 Introduction

Product developers cope with versatile problems while generating alternative product concepts and evaluating which solution will be processed further to a final product. Idea generation often desire proper seeds to be further developed, but practical customer preference probing might be more un-structured to deal with.

Customers do not differ from any interest group during decision-making – judgement is done according to benefit analysis. Benefits, consisting of different elements of product value, are evaluated case by case, relatively depending of time and place. Variations between different customers burden the producer's task to fulfil internal and external demands. In today's business, the introduction of radical innovations in industry is rare, because majority of product concepts are the type of dominant design. How the enterprises can explore potential product improvements to create win-win type of solutions and generate profitable business?

Product value and value chain is not very typical way to approach product development requirements. This study introduces an approach to utilize value viewpoints to structure and direct development actions in a way, which may provide understanding of decision-making preferences. The approach is mainly directed to configured or tailored products, but may be considered also with other products or businesses.

2 Value in design science

Value, defined in dictionary [11], describes the importance or worth of something for somebody. In design science, value has several more detailed definitions, which are reviewed briefly below.

Hubka [4] refers that the value of a design includes definitions like how the needs are fulfilled; wellness or the feel of pleasure is initiated. Value is defined according to product properties, specified by means of technical, economic, ergonomic, aesthetic, use, performance, image or total properties. Value is accumulated during the engineering process, as the product requirements take their forms. Timely this creation process is called as “product maturity” and is depended on the capability of the engineering team.

Altshuller [1] presents the absolute value of a product by an ideal solution. This may be reached with an utmost solution, in which the functionality is realized without any sacrifice. The technical solution is considered as the only definitive merit for the solution, which mainly neglects all other business approaches.

Pahl and Beitz [7] refer to use-value-analysis, later documented in VDI 2225. Evaluation to determine the value of a product, usefulness and strength are considered in respect to given objective, since the value of a solution is not absolute. Value comparison of different concepts is made with pre-defined weighted parameters; from which the overall balanced value profile is calculated. The profile can be also used to show weak spots of weighted sub-values or to determine satisfactory solutions. The method is also referred to be used to evaluate relative value; technical value compared to economic value. Ulrich and Eppinger [10] introduce similar type of matrix evaluation charts in combination of QFD, which aims to mathematically choose the best solution.

Pugh [8] approaches the value from more practical engineering viewpoint and warns that the numbers used in decision matrices have entirely different meaning compared to numbers in engineering analysis. Judgement by numbers may not have any relationship to facts or reality. Selection of criteria as well as weighting values presents generally the opinion of the evaluator. Pugh proposes to use relative measures; better than, worse than or same than.

Cooper [2] presents, that value is subjective and perceptions vary with the buyer. Two people can look the same product and judge it to have different value. When defining the value the first question shall be: value to whom? After that can the relevance of the value or worth be raised. In competitive market the product and its position is always compared to similar products.

Several attempts to connect value and cost have been made in the literature. Well know methodology, value engineering, has its merits while finding more economic streamlined solutions. However, the major risk while aiming to put a price tag for each product function or property doesn't really reflect the market or user aspect – it is the whole product, which is

bought, not just a set of separate features. This method may work in case of purely configurable products or services, where one can pick only those properties he/her wants. Thus, it is questionable if any producer can or will provide such full variability and configuration for customers – in some extend the basic product platform always exists, which has to be chosen as a baseline.

3 Value in business context

The main prerequisite for successful business transaction is that the benefits from the product or service shall be remarkably greater than the paid or given sacrifice [9]. The benefit may be interpreted as the value to a stakeholder. In business environment there exist two main viewpoints: product or service provider (producer) and buyer (user). Both of these two parties define and formulate their value aspects, which need to be reconciled during the acquisition process.

The pure financial analysis and key figures naturally set the decision baseline for investments. This business operational viewpoint may be called as primary assessment. However, each enterprise has also regulations by statute, strategic selections or tacit preferences guiding the values and their importance [Figure 1]. Within this aspect, the value gets much more versatile elements beyond technical properties – and also much more difficult to evaluate and measure.

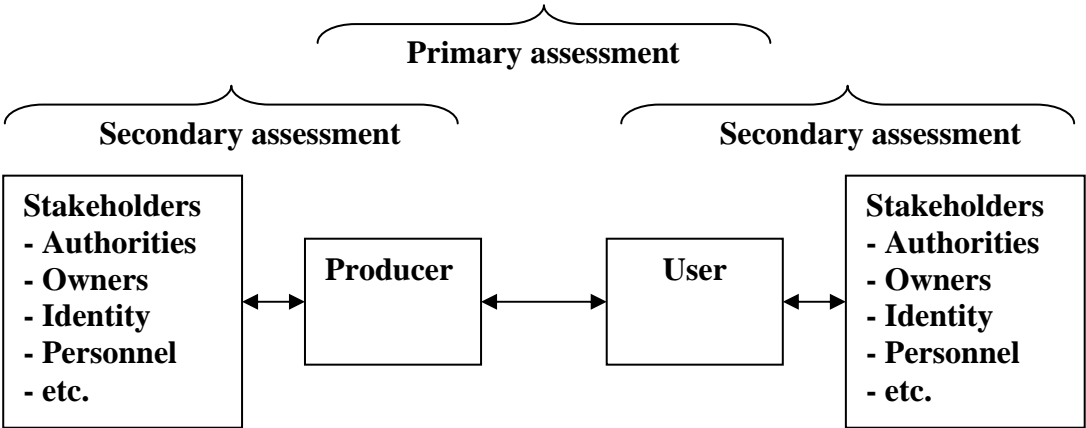


Figure 1. Value assessment dependencies

The value assessment differs between consumer and business-to-business products. Instead of the product image or personal preferences dealt with consumer products, we assume that the evaluation of investment products is more rational than emotional.

The operating environment of an enterprise affects how the value is evaluated; a primary assessment for product or service transaction is that the need and offering shall meet in terms of beneficial results. Secondary assessment defines the verified alternatives following the business strategy. Evident is that due to changing world, the preferences of valuation differ and depend on the viewpoints of the producer and user as well as time and place.

3.1 Value chain and value propagation

Value chain describes and defines the actions, which create and accumulate the product or process value. Generally this is considered to include only direct manufacturing and production actions, but during the product originating process, the conceptual solutions and decisions shall also be considered as value chain.

Different value chains can be identified during the product life cycle. The value chain begins, when the first actions of the originating process has been taken and ends when all product responsibilities and services have been closed. Generally the producer's value chain includes the engineering process from product idea or opportunity identification to end of the product support. In business environment, several shorter value chains may be identified, if product or service responsibilities are directed to separate units or enterprises.

The user's value chain begins, when the product is handed-over for operation and ends as the disposal takes place. The overlapping of the value chains is typical; as the today's business trend demands to provide services along the whole life cycle – it may even appear that the producer's value chain extends beyond the user's.

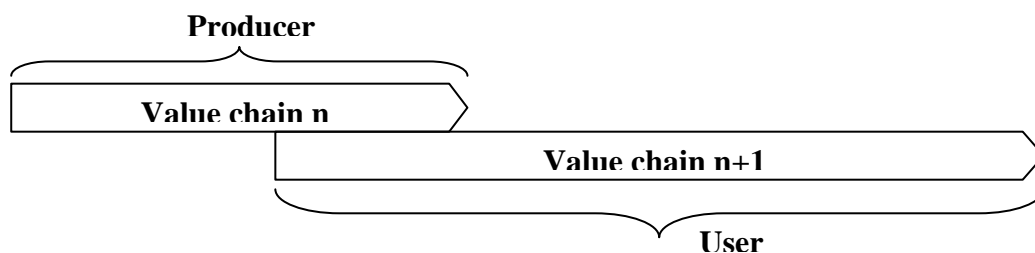


Figure 2. Overlapping value chains

According to chosen business strategy, the value chains can be consecutive, simultaneous or partly simultaneous and they may have common interests. However, the different value chains impact to product value depending on the value aspects and viewpoint. The two main viewpoints (or value chains); the producer's and the user's can be identified as being the borderline of the transaction. These viewpoints and their impact to conceptual design are taken as basis for this study.

3.2 Creation of a value chain

If we consider the prerequisites for an enterprise how it generates the added value; the value chain in business environment can be created basically in three different ways:

- By acquisition; purchase, licensing, leasing
- By change; re-engineering, modernization, production change
- By development, idea, innovation, new application

In any case, the value chain is different from the viewpoints of a producer and a user. If we consider a situation at a time and future aspects, the development of the value chain is essential for maintaining the competitive position. A product or service, used for generating income, needs improvements and the degree of innovativeness impacts directly to value chains. However, the value and its change are depended on the time and place.

The value evaluation and measurement is challenging for the development team. Scientifically the value aims for the absolute and the product properties should follow that ideology. Different measures can be used depending on how wide consideration is used. An approach to evaluate the complete manufacturing performance of a product design is presented by Olesen [6]. By using the universal virtues as measure, a good example of valuation can be made. However, in business environment the mostly used valuation is money.

3.3 Viewpoints of value, value profiles

The approach of universal virtues may be expanded to consider also the user's aspect. The product is the mean in the value chain in both producer's and user's processes. Similar valuation elements will be used for the evaluation. However, both parties set their own criteria, according to their business strategies.

The prerequisite in business transactions is that the diverse aspects of the product or service value match. Practically this means that the benefits shall justify the spending. The producer aims to develop products or services, which match the customer's values. On the other hand, the producer has profitability targets, which shall be fulfilled at least on the long term to ensure the existence of the enterprise.

In Figure 3 is shown two business viewpoints of value elements, universal virtues. In business case the elements have different weights depending on the viewpoint. However, the scaling of the elements shall be defined in a way, which can be interpreted to the development team. Different grades and weightings can be found in the literature, but practically each numerical evaluation leads to the trap which Pugh [8] noticed; none of the elements can be measured with same scale and the summation of element scores erases possible showstoppers.

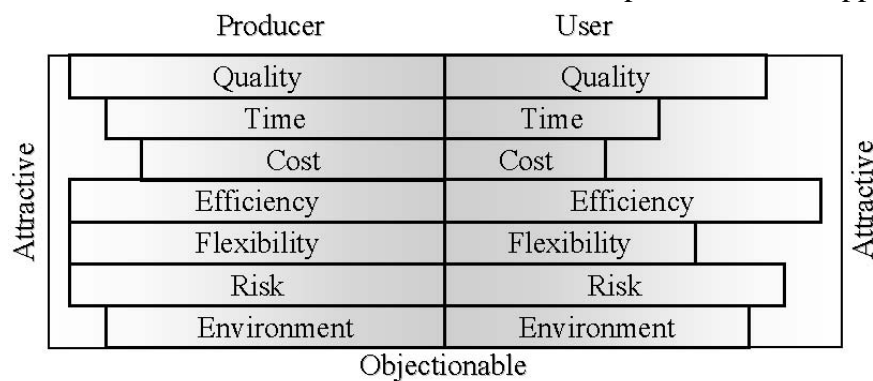


Figure 3. Two viewpoints of universal virtues

If we study a bit further on with the value elements, we may assume that the goodness of each element is relative to time, place and viewpoint. At the moment of decision, conceptual design or acquisition, the valuation is based on the best knowledge at that particular moment. The knowledge includes the estimation of the benefits during the expected life cycle.

As mentioned earlier, the weighing of the elements varies. In case of an artefact, the functionality or technical goodness as such are not the only criteria for the evaluation; all related features and properties will be valued within the elements.

However, even the electronic spreadsheet-type inquiries have been entered into business to business transactions, the individuals still do the final judgement. Somehow it is worthless to even try to find an absolute scale for rational decision-making. History, experience, similarity, existing products easily over-rule any fact-based evaluation, mainly due to difficulty to convert objective mindset into factual number. Attempts to convert value into monetary scale, but many of the elements, like quality, time, flexibility and risk, are difficult to measure. Specifically, if the evaluation involves the approach of the total cost of ownership, it may appear that neither the cheapest nor the most expensive is the most valued.

During a business decision, it is typical that two or more alternatives are contrasted against each other and an absolute scale is not necessary. While comparing the value elements, the evaluation may be simplified into three categories:

- Objectionable, value element has objections and acts as resistant for selection (concept or acquisition)
- Neutral, generally must-to-be type of element, does not impact on decision
- Attractive, positive experience, acts positively and supports selection (acquisition or concept)

A simplified case example of strategic selection, which overrules many value elements, can be found on port logistics business; an acquisition of a quay crane is an investment for twenty years. Generally the annual maintenance and repair costs are about 2 percent of the acquisition cost, however the variance between different suppliers can be from 0.7 to 4 percent. In case the buyer takes into account the support costs and residual value, a difference of 20-30 percent higher investment cost can be easily justified. Alternatively, if only looking for the lowest purchase price by strategy, some of the product providers may even not offer for such case.

4 Concept Development

The most important decisions during the product development process are done while concept alternatives are evaluated and selected. As considering the basics for a successful development project; the product commercialization and accumulated sales, the different value elements have the key role and they shall impact on the development process.

The challenge of the producer is to develop and maintain competitive products for chosen customer groups, as well as find new target groups to increase or recover sales. Simultaneously, the producer shall actively explore product improvements to increase his profitability. Profitability improvement can take place in two ways; either decreasing the costs activated during the originating process or increasing the product value for the user (customer).

If we study a bit further the conceptual design stage, when the comparison and selection of product functionality, architecture and properties take place. As a technical system, the producer's aspect generally presents the "idea in" elements, e.g. how the product realisation concretizes. Contrary, the user's aspect is more "idea with", as the use of the product is focused [3]. However, fulfilling the both aspects, product innovations shall take place to bring benefits for on or more stakeholders.

4.1 Conceptual alternatives and value elements

The universal virtues, as originally meant for evaluating product design for production performance, can be used also for two-sided evaluation of value (Table 1). Whilst Olesen [6] listed the attributes in each element for production performance, the attributes for user value elements may be interpreted as follows.

Table 1. Value elements of producer (production) and user

Value element	Production performance [6]	User value
Cost	Direct labor and materials cost Overhead cost (indirect cost); shop floor management, space cost	Direct acquisition cost (price) Indirect costs; inquiry, evaluation, testing,

	Production control, quality cost, purchase, etc.	Operation costs, energy, consumables, maintenance, spare parts, repairs, disposal
Quality	The ability of the product to comply with the desired functionality (with a low level of quality control, rework, scrap cost).	The ability of the product to keep functionality, up-time, need of repair, aging and degradation of components and materials
Flexibility	The versatility and adaptability of the manufacturing (related to product design).	The flexibility to adapt changes in use or process, relocation
Risk	The major manufacturing risk embedded in the product design.	The risk of delay on start-up, skills needed for operation, availability of spare parts, need of maintenance expertise
Time	The ability of the product to allow a short lead-time.	The ability of short delivery and start-up time, maintenance time, duration of warranty time, total lifetime
Efficiency	How efficiently can personnel be utilized? How efficiently can our resources be utilized?	How efficiently the process is utilized, performance, resources and energy usage, MTBF
Environment	Environmental consequences of the product design during the manufacturing process.	Environmental consequences during product use and disposal

For product development, the user value sets different view to criteria and product specification requirements. Generally, the customer is not willing to pay features or properties, which mainly support the producer's interest. Unfortunately, often the two views are in contrast and the producer has the challenge to cope with the contradiction – however only in comparison to its competitors in case there are no other potential alternative solutions on the market.

How to cope these elements with product development? If we study the value profile, the two views of elements, we notice that any absolute measure cannot be set. Generally, while the customer makes his/her evaluation between suppliers, it is a trade-off situation. Each provider has its value profile and some of the elements are type of neutral, elements, which just have to be there at acceptable level. The real comparison is then the question of significant differences; even one very attractive element (often cost) can sift the selection – specifically if the decision does not consider total cost of ownership type analysis.

Product innovations, which bring benefits either for the producer, user or both, may be considered in much wider aspect than just from technical viewpoint. Quite often, if product improvements or developments initiate from producer's own interests, customers may not accept them. Value elements provide guidance for what kind of topics may be used for idea generation. Product innovations need not to be revolutionary or radical to boost successful product sales. Incremental innovations for existing products or concepts may provide just enough advantage against competitors. However, a risk exists for large enterprises and their R&D sections being too focused only on incremental innovations. Numerous examples may

be found where radical innovations have superseded mature products and revolutionized the markets [5].

5 Conclusions

Generally the product development project drivers initiate from customer requirements and focus mainly on functionality. Business success is depended on the capability to introduce competitive products to the market. Innovativeness is often considered only a technical privilege, but quite often launched successful innovative products involve other properties or features, which are welcomed by customers.

Product development actions, which companies launch, shall be studied in wider perspective than just technically. Value assessment from two viewpoints; producer's and user's provide one approach to evaluate and consider different trade-offs for development decisions. Often the business interests and values for producer and user consist of similar elements, but result contradictory approaches. Utilization of value assessment may provide better understanding to develop products, which value profiles match between producer and user.

This paper presents an approach to better utilize value and value chain considerations into product development.

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