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'Let's do it first time wrong... but FAST'

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In the beginning of 1990 he co-founded the Dutch-Flemish creativity network called KreaNET which offers a platform for professionals in the area of creativity.
He is also a member of a committee on Value Management within DACE (Dutch Association of Cost Engineers) and chairman of the KIVI NIRIA department on Engineering Design (Royal Institute of Engineers).

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ProRail is the owner of Dutch Rail infrastructure, delegated by the Ministry of Transportation, and responsible for constructing and maintaining the rail infrastructure. The agency itself has no design and construction expertise. With Value Engineering ProRail has a decision making tool to decide whether a design delivers value for ProRail and if not what could be done to improve value.

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Summary
A well-structured format with a systematic application of creativity and idea generation techniques as well as evaluation and decision techniques in a group process can lead to significant increase in value, provided that specific conditions are satisfied. Reference is made to known techniques that are being applied and to practical examples from industry. Conditions that have to be met will be illustrated. Best practices will be given for successful VE studies.

Structure of paper
After a general introduction and a specific short introduction of some essential notions a typical format of a VE session is demonstrated. Techniques that are being used in typical VE studies are discussed and illustrated in 4 cases. Reflection on these cases leads to conclusions and recommendations with respect to successful application of VE. Last but not least it leads to the necessity for further research.

1. General introduction

It is generally observed that conceptual thinking in functions rather than in objects is difficult for many people. Only when concrete solutions are within sight reference and measurement can be made to what one really wants in terms of 'value'. Furthermore there is a widespread misconception that we always have to 'hit right' the first time. This is being stimulated by hypes like 'First Time Right'. It is demonstrated that even when we have the illusion to hit first time right the ultimate result will not be the optimal one if one reasons back with hindsight. Progressive insight shows that every consecutive phase is a sub optimization of the very phase at stake with the preceding choices as given. This range of sub optimizations can itself be optimized if one has the guts, time and budget for a review by means of Value Engineering. Admitting this effect, an extrapolation can be made in the sense that the first 'shot' does not have always have to be a 'hit'. In other words, make a rough and fast great leap forward – in analogy with Rapid Prototyping – and draw up an inventory of all essential feedback (in terms of Value; being defined as Functionality over Cost). A Value Analysis exercise (in the most literal meaning of the word) by means of the 'FAST tool' carried out on these new options can drastically shake up the outcome!

2. Short introduction of some essential notions and definitions

In Engineering Design the most essential notion is the function F that has to be fulfilled in order to satisfy the requirements set at the beginning of any design project. It is a combination of an active verb and a measurable noun, like 'transporting water'. A decomposition of a problem into several sub-problems leads to a hierarchical constellation of functions to be fulfilled: a Function tree.
The linear opposite of a design process is a decomposition of a material object or technical system – sometimes called reverse engineering. This process leads to a set of parts (Fi's, Function implementers) that in the right 'hierarchical constellation' leads to a Product tree of e.g. a pump (to transport water).
Both processes are analysis type of processes: one leading to a decomposition of a problem – the other to a decomposition of an object. A design process in its purest form can be seen as a consecutive development of a function tree and its material counterpart, the product or object tree. A typical redesign process can be seen as a reverse process of the former process in the sense that an existing design is the vehicle to guide one through a decomposition process while at a certain moment of 'abstraction' one turns 180 degrees to pick up the 'design track' in a top-down way.

Figure 1: Result of a design process.

Figure 2: Result of a decomposition of a design.

Value can be described as the degree of ideality of a function implementer Fi to fulfill its function F related to the sacrifice that had to be made, expressed in ‘cost’, often noted as V = F(Fi) / $(Fi).

Value Analysis, Value Engineering and Value Management are terms that are often mixed up but from a historical point of view can be arranged in a way as depicted in fig. 3.
VA is being regarded as a tool with which in an analytical way the value V can be calculated as described above. VE is a method or a technique with which a designer can continuously monitor the performance in terms of Value.
VM is a general management approach or attitude towards optimizing the Value of a design using tools such as QFD, FMEA, DfMA, Taguchi, etc.

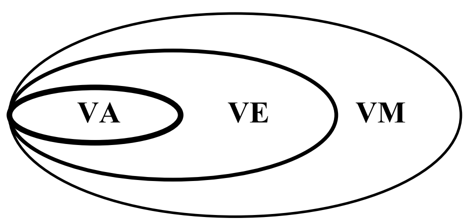


Figure 3: VA, VE and VM in relation to each other.

Value Engineering job plan is a specific approach to use VE as a technique in a group process in which an existing design is reviewed and reengineered while optimizing the Value.

FAST (Function Analysis System Technique) is a technique with which the earlier described trees can be represented in relation to each other whereby within the function tree answers to ‘What’ type of questions(= abstract) are given, and within the product tree answers to ‘How’ type of questions (= concrete). When constructing a product tree from a function tree one should ask ‘how’ a function is going to be

implemented and when re-constructing a function tree from a product tree one should ask 'why' the implementation is being chosen (in terms of a function).
The typical processes are combined in fig. 4.

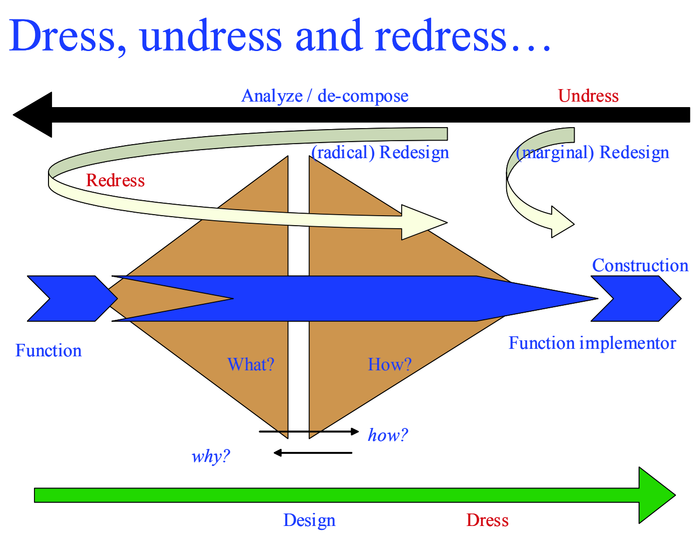


Figure 4: Designing and redesigning.

3. Typical format of a VE study

As described a VE job plan is a typical format in which a VE study is carried out. In fig. 5 the format of a VE study is given as a part of a complete job plan. The VE study is preceded by a *Preparation phase* in which the goals/scope and VE team are established. Furthermore information, schedule, location and necessary facilities are determined. After this the real study can start with the following phases:

<u>Value Engineering study</u>

1. *Information phase*: Information gathering and analysis on project at stake.
2. *Function analysis phase*: Analysis of design or problem at stake with FAST and allocating cost to functions.
3. *Creative phase:* Generation of ideas from a functional perspective while focusing on the functions with the highest potential value.
4. *Evaluation phase:* Prioritization of ideas with pre-defined criteria. Selection process of best ideas with potential value increase.
5. *Development phase:* Further development of the selected ideas and elaboration of consequences for implementation of solution.
6. *Presentation phase:* Presentation of results of Value Study to all relevant stakeholders.

Next the *Reporting phase* takes place in which management or project leader are formally briefed with the consolidated results of the study – to be implemented in the last phase, the *Implementation/feedback phase.* Here the effectiveness of the VE study is measured by the implemented improvements. Evaluation of the VE study itself can lead to improvements in the next study.

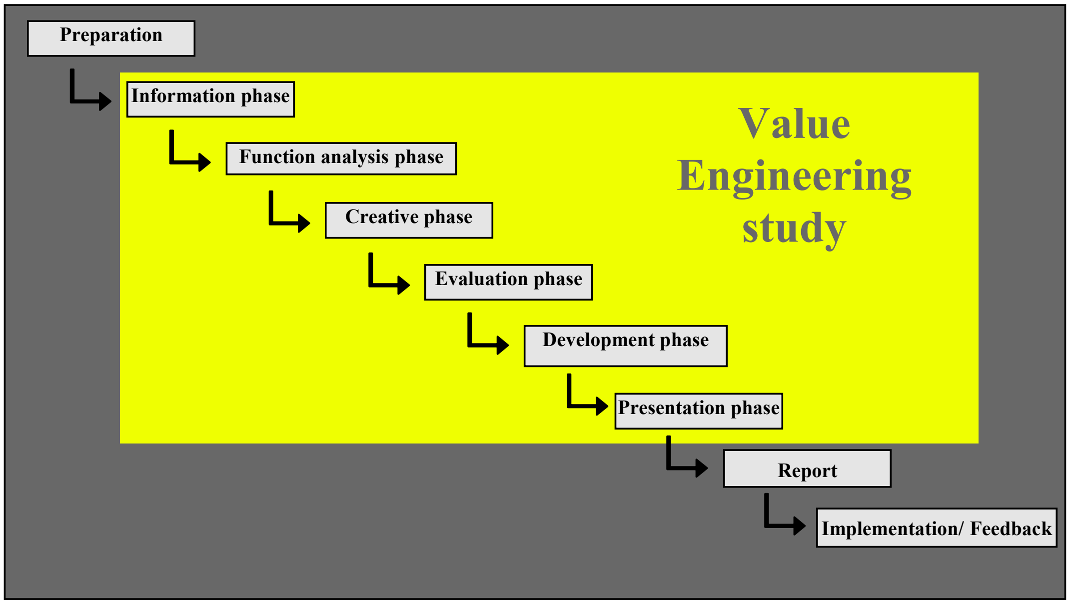


Figure 5: Format of a Value Engineering job plan.

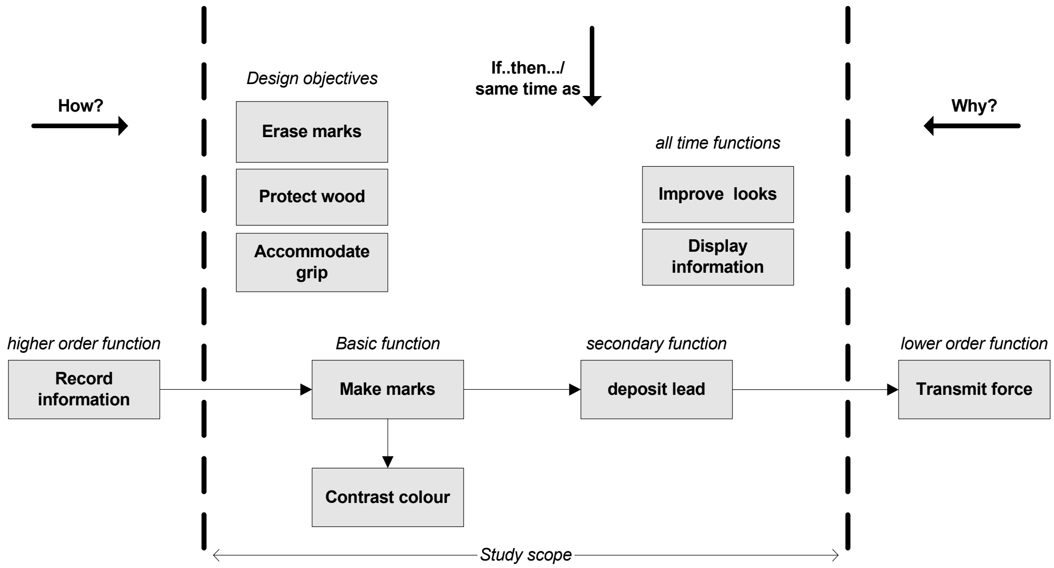
4. Techniques used within the VE job plan

FAST (Function Analysis System Technique)
A function is formulated with an Active Verb and a Measurable noun. This formulation forces you to define the basic need in terms everyone understands. Furthermore with functions you distance yourself of the physical object and thus gives you openings to new ideas.

FAST gives you insight in:
- Relations between functions.
- Missing functions.
- Levels of abstraction.

There is no ideal diagram to represent function structures. It is an aid to better understand the project and to focus on the functions with poor value in the Creative phase. The team needs to have consensus over the diagram.

A short introduction of FAST will be given with the help of the following example: a pencil. You start asking the question “what does it do?” and brainstorm functions. Then you build the model by asking the ‘how’ question from left to right. And check with the ‘why’ question, from right to left. If this doesn’t make sense, a function is probably missing or wrongly formulated. Downwards are functions that occur at the same time.



Study scope	Determines the levels of abstraction of functions under investigation
Design objective	Functions that need to be performed, but are not part of the basic functionality
All time functions	Functions that always need to be performed
Higher order functions	The ultimate goal of a project (vision, policy etc.). Outside scope of study
Basic function	The essential function, without it there is no purpose
Secondary functions	Derived functions supporting the basic function (design choices)
Lower order functions	Functions not relevant within a study. Outside scope of study

Figure 6: FAST diagram for a pencil.

What does a pencil do? It makes marks. Why does it make marks? To record information. Since ‘record information’ could be done in various ways, i.e. with a computer, and the study object that we are trying to improve is a pencil, ‘make marks’ is the basic function. When this function is left out, the pencil will be useless. When you make marks, you want to contrast color, so you can read it. How do you make marks? By depositing lead. How do you deposit lead? By transmitting force. Why do you transmit force? To deposit lead.

Besides making marks you one might want the pencil to achieve other objectives, like erasing marks, protecting wood and accommodating grip. These will be the ‘Design objectives’. Furthermore it may have to be a beautiful pencil at any time and you may want it to display information on it (type of lead; name). These are ‘all the time functions’.

Idea Generation tools

When finding alternative solutions/implementations for functions to be fulfilled one can use different techniques such as brainstorming, brain writing, metaphors, wildest idea, Nominal Group Technique, Mind Mapping, etc.

Since the generation of ideas is essentially different from choosing the best, one should be aware of the fact that these two different processes are separated from each other in order to be effective. In any type of real world problem complexity demands the use of alternating skills for solving these respective problems. Since in our brain these processes also take place in different hemispheres (Right for divergent thinking and Left for convergent thinking; see fig. 7) it is important that in a group process the 'collective right brains' are activated in this phase. In case the problem is complex and the group is large (6 or more) an experienced facilitator might be essential for keeping the communication going in the interaction of 'left' and 'right'.

Left for deductive or adaptive thinking **Right** for inductive or innovative thinking

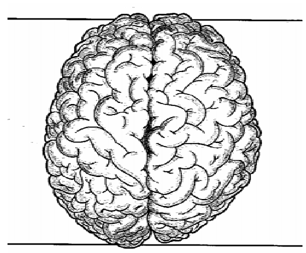


Figure 7: Left and right brain thinking.

In literature one can find different guidelines for different settings in which idea generation takes place. The most important guidelines are:

- Suspend judgment.
  Critical judgment should be postponed until evaluation is being done. Evaluation in this stage frustrates the process of freely generating ideas.
- Ideas should be used as triggers to associate to new ideas.
  Building upon each other's ideas can open new perspectives.
- Quantity over quality.
  In the first phase quantity matters – quality is being judged later on.
- Infeasible and weird ideas are welcome.
  Since feasibility is a criterion that must be used later, at this moment 'anything goes'.
- Sketching should be encouraged.
  In line with 'A picture says more than a thousand words' one should be encouraged to draw. It also facilitates the process of association (see fig. 8).

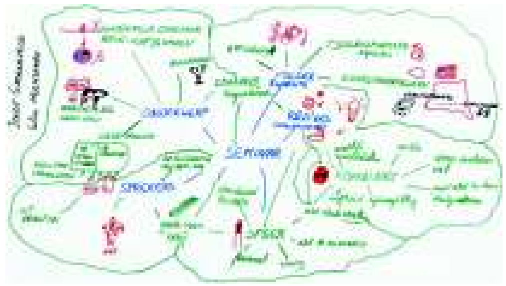


Figure 8: The process of association in a MindMap of a brainstorm session.

- Of course for every technique one should consider an individual or a group approach and if the number of attendants is high whether it should be done in a plenary way or in parallel subgroups. When working in subgroups it is worth while to have different techniques to be used for possibly different sub problems.

Figure 9: Subgroup brainstorming in parallel with other groups.

<u>EVAD tools</u>

Evaluation and Decision tools to help us prioritize and select the best ideas/concepts. It is important that in a group process the 'collective left brains' are activated in this phase. Selection of these tools in a VE study is based on the level of transparency and structure needed and/or time available. Two common tools, the Morphological Chart and the SMART method will be described.

<u>Morphological Chart</u>

After having generated several ideas for different sub problems it is essential to have a structured overview of all these ideas and possibly linked together in a compatible way. One of the techniques to be used here is called a 'Morphological Chart'. In fig. 10 an example is given for the design of a fitness machine. Vertically sub functions (= sub problems) are given and horizontally generated implementations are given. In this case four combinations of sub solutions are combined into complete concepts.

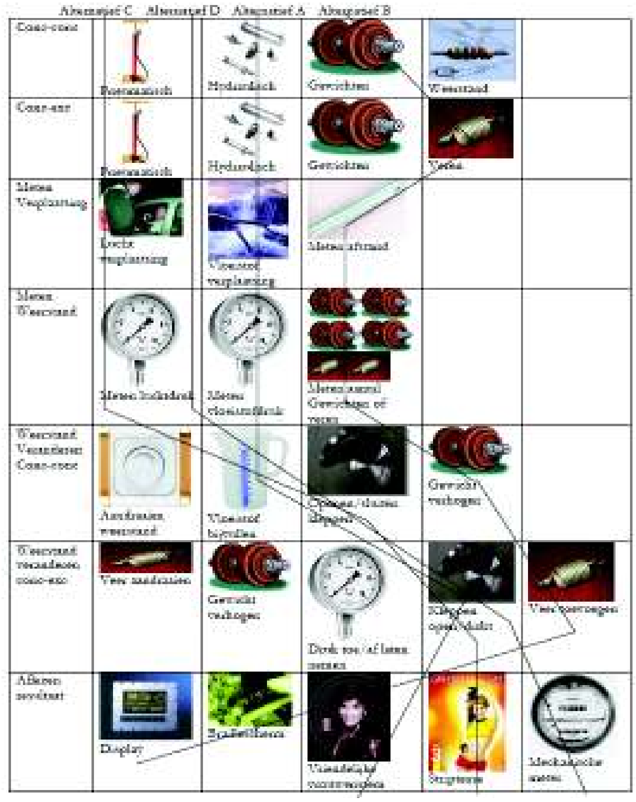


Figure 10: Morphological chart for the design of a fitness machine.

From these four concepts the 'best' solution must be chosen. In order to be able to decide which one is the 'best', criteria have to be defined. These criteria can be deduced from the design requirements and from 'internal' requirements as well as additional 'external' requirements. Weighing of these criteria can fine-tune the evaluation process. After scoring the alternatives they can be ranked.

SMART (Simple Multi-Attribute Rating Technique) method

The advantage of this tool above all other Multi-Attribute Rating Techniques is that is has a reference, on which you can compare the alternatives as well as to what an optimal solution would score. The sum of the individual weight factors adds up to 1. The score of an alternative is established by multiplying the score on a criterion by the weight and in the end accumulating these outcomes on all criteria. An example is given in table 1 where three alternatives sum up to a total performance greater than the baseline design.

	Criterion 1	Criterion 2		Criterion 3	Criterion 4		Criterion 5	Total
	Constructability	Maintainability a) rail b) non rail		Future fit	Disturbance a) rail b) road		Esthetics	
Weight	**0.30**	**a) 0.15**	**b) 0.05**	**0.13**	**a) 0.22**	**b) 0.05**	**0.10**	**1.00**
Baseline design	60 / 18	60 / 9	70 / 3.5	50 / 6.5	70 / 15.4	60 / 3	60 / 6	60.4
Alternative 1	71 / 21.3	76 / 11.3	73 / 3.7	68 / 8.8	67 / 14.7	68 / 3.4	60 / 6	69.2
Alternative 2	68 / 20.3	76 / 11.3	74 / 3.7	77 / 10	61 / 13.4	69 / 3.4	63 / 6.3	68.6
Alternative 3	78 / 23.3	76 / 11.3	71 / 3.6	68 / 8.8	74 / 16.4	74 / 3.7	57 / 5.7	72.8

Table 1: SMART method.

5. Four cases

i) Secured bicycle parking at a Railway station

Starting point
The main project goals where:

- improve quality of bicycle parking at a railway station;
- increase capacity of parking,

both resulting in additional needed space.

The proposed design stated:
Required capacity is 585 parking places. Till then the parking provided space for 420. This capacity increase needed to be realized on the existing location: within a monumental train station. The only way to realize this was to place a second level on top of the ground floor level.

The VE study goal was ‘to improve value’.

Procedure
Optimization of the design by VE, using a VE job plan approach.

Result
After considerable analyses there turned out to be a miscalculation of the long term capacity. Instead of 585 places, only 489 were necessary. With simple adjustments to the existing situation, this increase in capacity could be met, resulting in a simpler, cheaper design on the ground floor only! Note the savings of the alternatives in table 2!

	Parking places	Investment-costs (€)	Savings		Investment costs per bicycle (€)	Savings per bike	
			€	%		€	%
Baseline design	*596*	*842.000*			*1.413*		
Alternative 1	420	483.400	358.600	43	1.150	263	19
Alternative 2	460	507.400	334.600	40	1.103	310	22
Alternative 3	450	496.000	346.000	41	1.102	311	22
Alternative 4	490	520.000	322.000	38	1.061	352	25

Table 2: Savings of alternatives bicycle parking.

ii) Railway under crossing

<u>Starting point</u>
In fig. 11 the original situation is portrayed.

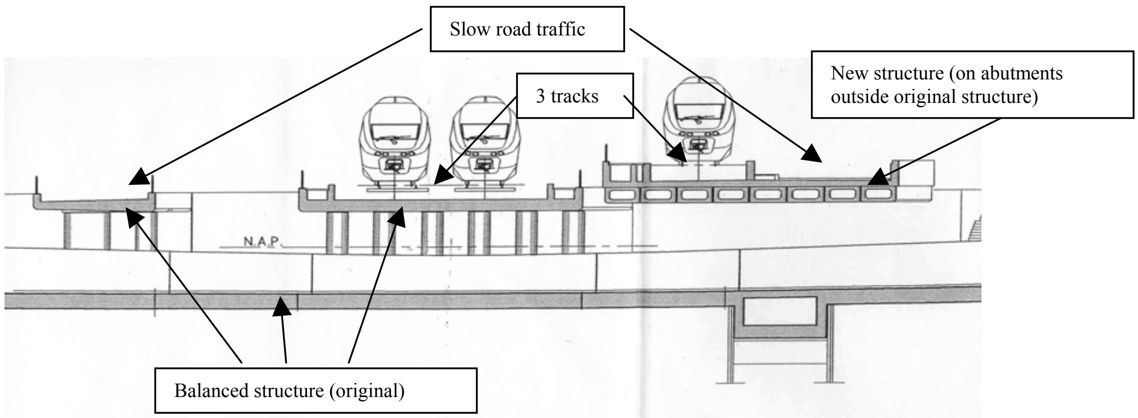


Figure 11: Original situation (cross section).

The main project goals where:
- increase rail capacity by adding a track (4 tracks in total);
- reserve space for future platform.

The proposed design (see figure 12) after the design exercise consisted of:
- esthetic design: bridges on same level, openings in between the bridges;
- provision for space in the centre for a future platform;
- raised tracks due to rail bridges which will be slid on top of the old bridge in the center;
- three new bridges (twice slow road traffic and once rail bridge);
- heavy concrete as dead weight on the under crossings floor to avoid floating when the original center bridge is demolished.

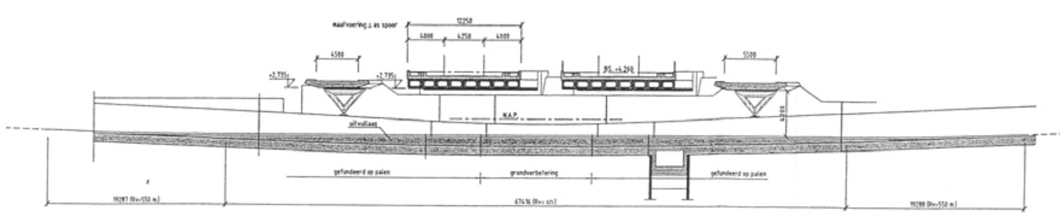


Figure 12: Proposed design (cross section).

The VE study goal was ‘to improve value’.

<u>Procedure</u>

Optimization of the design by a VE study – the VE job plan was applied.

<u>Result</u>

In figure 13 alternative 3 following from the session is pictured.

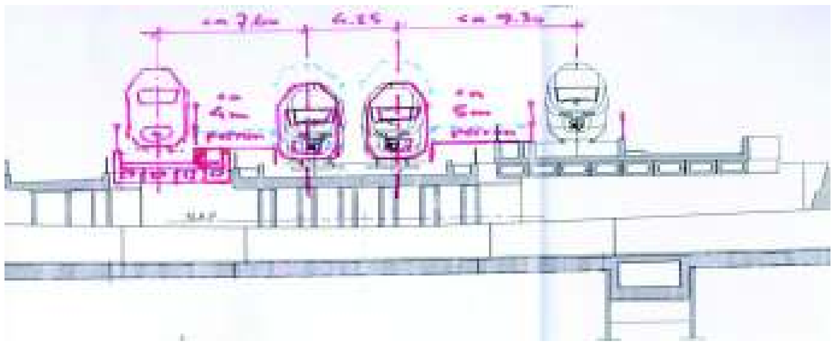


Figure 13: Alternative situation after VE (cross section).

Among the benefits of this alternative where:

- no work in the railroad, meaning:
  - less disturbance in rail traffic,
  - safer working circumstances,
  - less procedures (no planned disturbances);
- a lot cheaper! (in the end 50 % cost savings were implemented);
- increased performance;
- realization is a lot quicker (compensation for extra design effort).

	Construction cost [K] (x 1.000 Euro)	Potential cost savings (x 1.000 Euro)	Potential cost savings (%)	Potential ROI (VE costs: potential savings)	Performance (0 - 100)
Current Design	2.810,30				61,4
Alt 1	1.243,30	1.567	56%	1:165	69,2
Alt 2	2.144,60	665	24%	1:70	68,6
Alt 3	739,9	2.070	74%	1:218	72,8
Alt 3a	682,6	2.128	76%	1:224	

Table 3: Savings and performance of alternatives railway under crossing.

iii) Train station

Starting point
The main project goals for this specific train station where:
- increase transfer capacity;
- connect both sides in the future;
- upgrade bicycle parking;
- preserve the original station roof.

The proposed design (see figure 14) after the design exercise consisted of:
- tunnel will be built from the south (at the bottom side in the picture);
- temporary measures for existing commercial activities will be taken;
- width: 24 m with pillars in the center (crosses the points of support of the station roof);
- only half of the tunnel, passenger transfer (figure 14 gives the future situation where the second phase – connection to the other side – is also completed!).

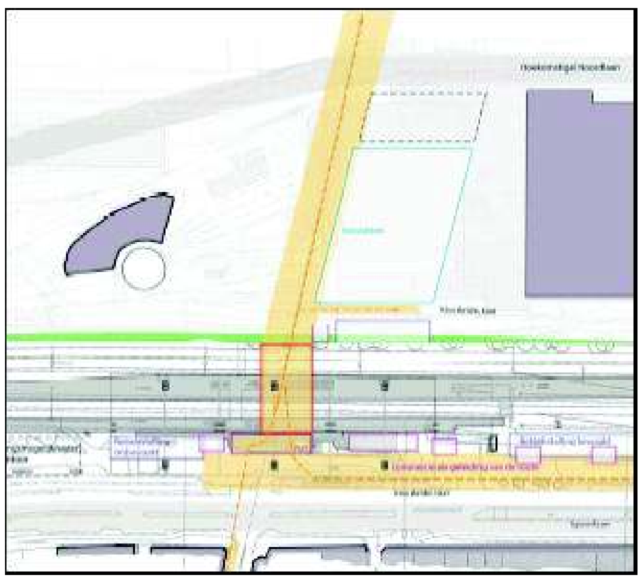


Figure 14: Proposed design.

The VE study goals where:
- reflect on the functionality and assumptions;
- improve value.

Procedure
Optimization of the design by a VE study – the VE job plan was applied

<u>Result</u>
In figure 15 alternative 4 following from the session is pictured.

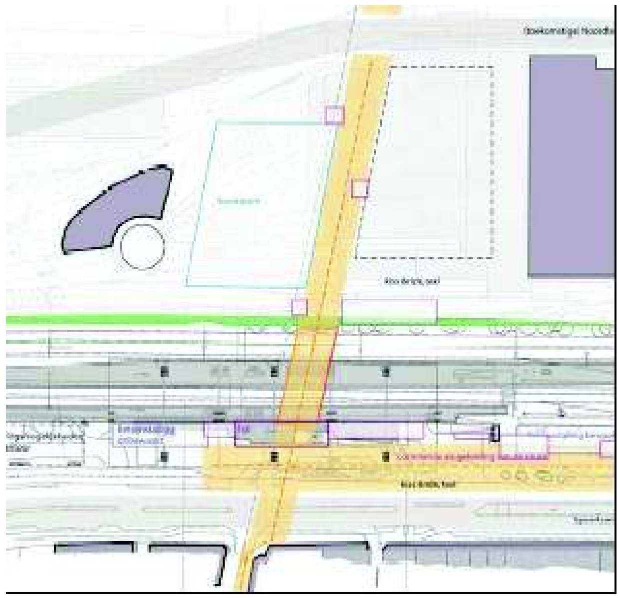


Figure 15: VE proposal 4.

Among the benefits of this alternative where:

- by building from the north side a faster/better/cheaper building method could be used; also less temporary measures are necessary for commercial activities;
- the tunnel crosses the railroad in angle which means that the width could be maximized without crossing the points of support of the station roof – the width is 18-20 m;
- there is a good connection with the city center;
- the whole tunnel is € 5,9 mio. cheaper (- 23%) than half the tunnel in the proposed design;
- insight was given in the cost consequences of requirements; hereby trust was regained from the local city council;
- cooperation and commitment from the local city council can be beneficial and speed things up in the request of permits;
- the design process was accelerated.

iv) 'Betuwelijn'

Starting point
A preliminary design of a non-passenger railway connection between the port of Rotterdam and the German border was the starting point for this exercise. For a specific part of this line, 22,5 km, potential value improvements should be inventoried (fig. 16).

Figure 16: Part of railway under consideration.

Procedure
A simplified 'loose format' VE job plan session of one day was used in a group of about 45 people from a.o. engineering, building contractors and subcontractors, procurement, etc. Two facilitators guided this process.

Result

Figure 17: Construction element of nearly finished railway.

It resulted in a concrete list with improvements and potential savings, adding up to a potential of € 32 mio. (=20 %) cost reduction in the initial budget of € 154,3 mio. while maintaining its functionality!!
About two years ago the real achievement was calculated at 12 % savings of the initial budget. A part of the nearly finished railway can be seen in figure 17.

6. Reflection on the cases

Reflection on each of the described cases will take place along aspects like: format of the session, the use of idea generation (IDG) and evaluation (EVAD) tools and the group process taking place. For all cases, generalized conditions are discussed.

i) Secured bicycle parking of a Railway station
The VE job plan was applied on this project.

IDG and EVAD tools were used several times in succession. The following steps and techniques were used:
Plenary brainstorming session per function.
In plenary discussion of the ideas, the best 3 concepts were identified.
The team was then divided in 2 multidisciplinary groups and used Brain writing pool to further develop ideas on all the 3 concepts.
Each group then selected the best idea per concept and presented this to the other team.
At the end of the 6 ideas, 2 were selected for further inspection and evaluation.
The evaluation of these 2 ideas were done by the SMART method

ii) Railway under crossing
The VE job plan was applied on this project.

As in the previous case idea generation and EVAD tools were used several times in succession. The following steps and techniques were used:
Plenary brainstorming session per function.
In plenary discussion the most important function was selected and from this function the 3 best concepts were identified.
The team was then divided in 3 multidisciplinary groups and each group was assigned to 1 of the 3 concepts. They then used morphology to combine the brainstormed ideas of all other functions to create alternatives.
The best alternative was developed some more before presenting it to the other groups. At the end the 3 ideas were evaluated by the SMART method.

iii) Train station
The VE job plan was applied on this project.

As in the previous case idea generation and EVAD tools were used several times in succession. The following steps and techniques were used:
Plenary brainstorming session per selected function.
Individual selection with the use of the Nominal Group Technique (rough selection with coloured dots).
The outcomes of the Nominal Group Technique were discussed plenary. 4 concepts were identified.
The team was then divided in two groups each investigating and developing 2 of the concepts
The results were then presented to the other group.

iv) 'Betuwelijn'
The applied 'Alliance approach' as well as VE proved to be very successful. With respect to VE we used a succession of plenary and parallel group discussions whereby the first parallel groups where constituted of mono-disciplines and the later parallel groups of multi-disciplines.

Figure 18: Plenary presentation of group findings.

Figure 19: Parallel group discussion.

First the common introductory steps of VE were taken with special attention to the backgrounds of idea generation and the essence of thinking in functions rather than thinking in objects. After plenary discussions several groups were formed alongside their respective technical backgrounds or disciplines. In these parallel mono-disciplinary groups specialists were asked to find potential optimizations w.r.t. their specific domain expertise and concentrated on a material subsystem of the railroad under consideration. Subsequently in a plenary session these results were internalized and discussed after which new groups were formed, but then multi-disciplinary. In these groups, the optimizations were discussed and even further optimized because now there was an interaction of disciplines with an optimization on a higher level as a result! Also these results were plenary discussed. In another constellation in parallel groups calculations were made of partial potential cost savings multiplied by its probability to occur; these partial results were added up to one total potential cost savings amount as stated earlier.

Conditions VE
In order to have optimal advantage of VE, a.o. the following conditions have to be fulfilled:

1. A well organized and structured plan is necessary. To set this up is an art of its own. The following model is used within ProRail to get a feeling of factors that determine how a plan should be set up. The factors that have an impact on the set-up of a study are illustrated in figure 20 – the direction in which they influence each other is given. The set-up depends of the following factors:
   - characteristic of the study object;
   - team size;

- study duration;
- team setup;
- study objective.

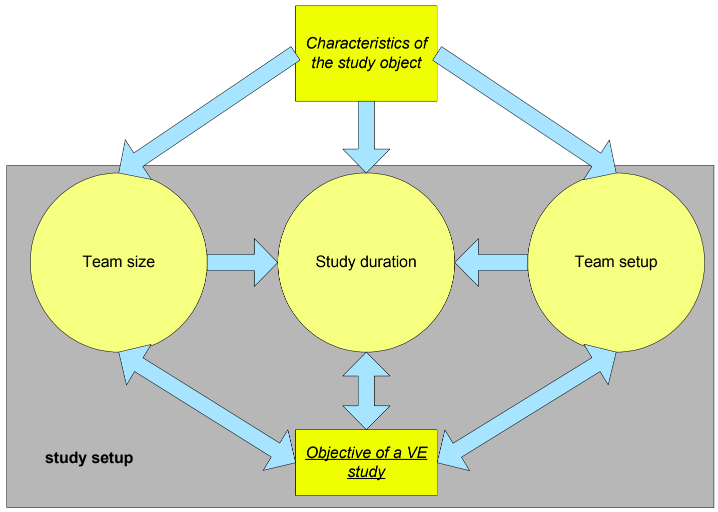


Figure 20: Relations of VE impact factors.

The characteristic of the study object is an external factor. The other four factors are part of the study set-up. The matrix cells in table 4 describe the nature of the influence.

Team size	A larger, more complex project could mean more parties should be involved.			
Duration	A larger, more complex project demands often a longer duration.	The bigger the team, the more time you probably need.		
Team setup	In some cases it is advisible to use a neutral team, or not to include some of the stakeholders, due to e.g. political sensitive issues or because you know that parties won't cooperate.		The shorter the study duration, the more knowledge of the project you need within the team.	
Objective of a VE study		The bigger the teamsize, could mean less achievements given a certain time. If this doesn't match with the study objectives demanded, the team size could be altered.	The shorter the duration, could mean less achievements given a certain time. If this doesn't match with the study objectives demanded, the duration could be altered.	The set up of the VE team is usually based on the objective. On the other hand the team setup could determine what the outcome is.
	Chracteristics of the study object	***Team size***	***Duration***	***Team setup***

Table 4: Nature of influence of VE impact factors.

2. The composition of a team is a very important success factor. If you don't have the right people in your team, it will affect results immediately. Some reminders:
   a. Set up a multidiscipline team with the relevant expertise an representation.
   b. Use a multi-skilled facilitator.
3. Follow the job plan. Don't skip steps. Each step has its purpose and is input for the next. Make sure you have sufficient time to go through the process.
4. Commitment with respect to time, budget and attendance is very important. Especially the last. Team members should attend the whole study.
5. Make sure you organize a neutral, stimulating setting in which workshops take place.

7. Best practices, promoters and inhibitors for a successful VE study

Value Engineering can be applied on everything, anytime. In most cases, if not all, VE will be applied for a specific reason, this can be for:

- (re)design – marginal (using only alternative implementations for functions) or radical (using alternative functional decompositions);
- problem solving;
- decision making;
- finding fundaments for choices made;
- acceptance finding;
- reducing time;
- creating transparency in decision making;
- or perhaps just to save money.

The ProRail example in figure 22 gives insight on how to select projects to effectively utilize VE. Besides that, there are four main factors that could determine the effectiveness of VE:

- ***Timing:*** The best timing of a VE study is in early design. In early design the scope allows other ideas to be implemented with little impact on schedule and agreements, whereas later in design changes will be harder to implement due to

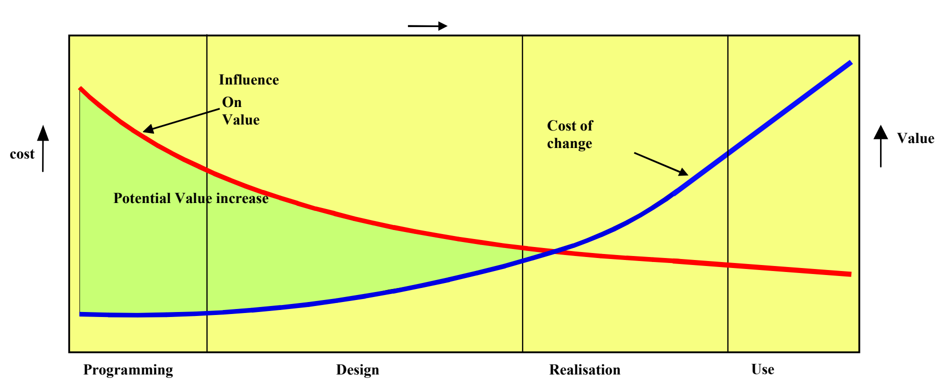


Figure 21: Potential value benefits against lifecycle stages.

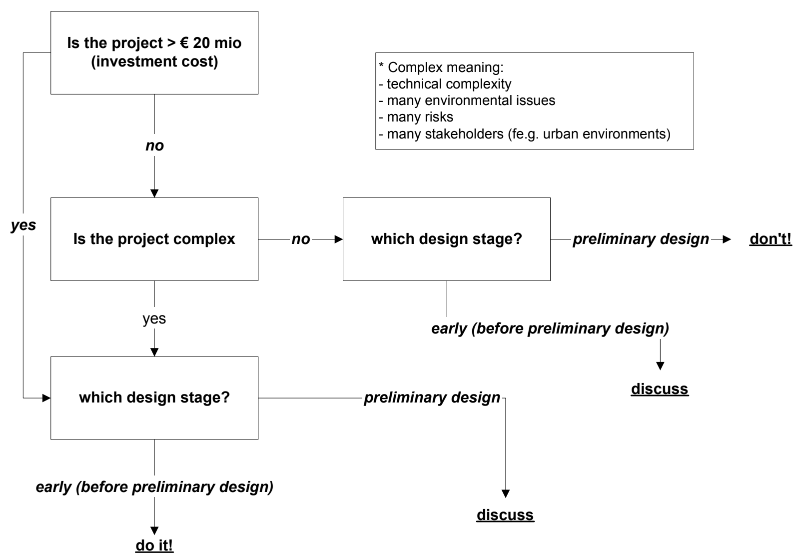
high costs associated with this. Figure 21 illustrates this for construction projects.

In the programming stage changes, even radical, can be implemented with little effort and against little cost.

- ***Complexity:*** Complexity is defined here as the amount of factors which have an influence on a project of product/service. These factors could be environmental influences, technological complexity, risks etc. The more complex a project is, the better the use of VE.

Example ProRail

Selection model based on project characteristics



Checklist based on results

1. Consensus, understanding and tuning of stakeholders.
2. Taking away dissatisfaction/gaining trust (involving/taking part in a study).
3. Making a project more explicit, necessary for i.e. political reasons or as a conformation (in decision making).
4. Directing a design (i.e. when a design consultant delivers a design with low quality).
5. Solving specific design problems.
6. When handing over a project => information transfer.
7. Speeding up the design process (direct communication and decision making).
8. Increasing commitment to a project of different stakeholders.
9. With budget problems.
10. Verification of scope and specs/requirements.

Figure 22: VE selection model ProRail.

- ***Repetition:*** When large quantities of a certain product are produced, even small savings per product could lead to major savings in total. € 0,10 of savings when you produce 20 mio. products a year = € 2 mio. in total savings.
- ***Size:*** When you don't have repetition like in Construction, than size could matter, even though the project is relatively simple. For instance if you have a € 100 mio.

railway project and after a VE study 2 % savings were implemented, it is still a large saving and a good Return on Investment of VE.

8. Optimization of Value Engineering by fine-tuning the moment(s) of intervention(s).

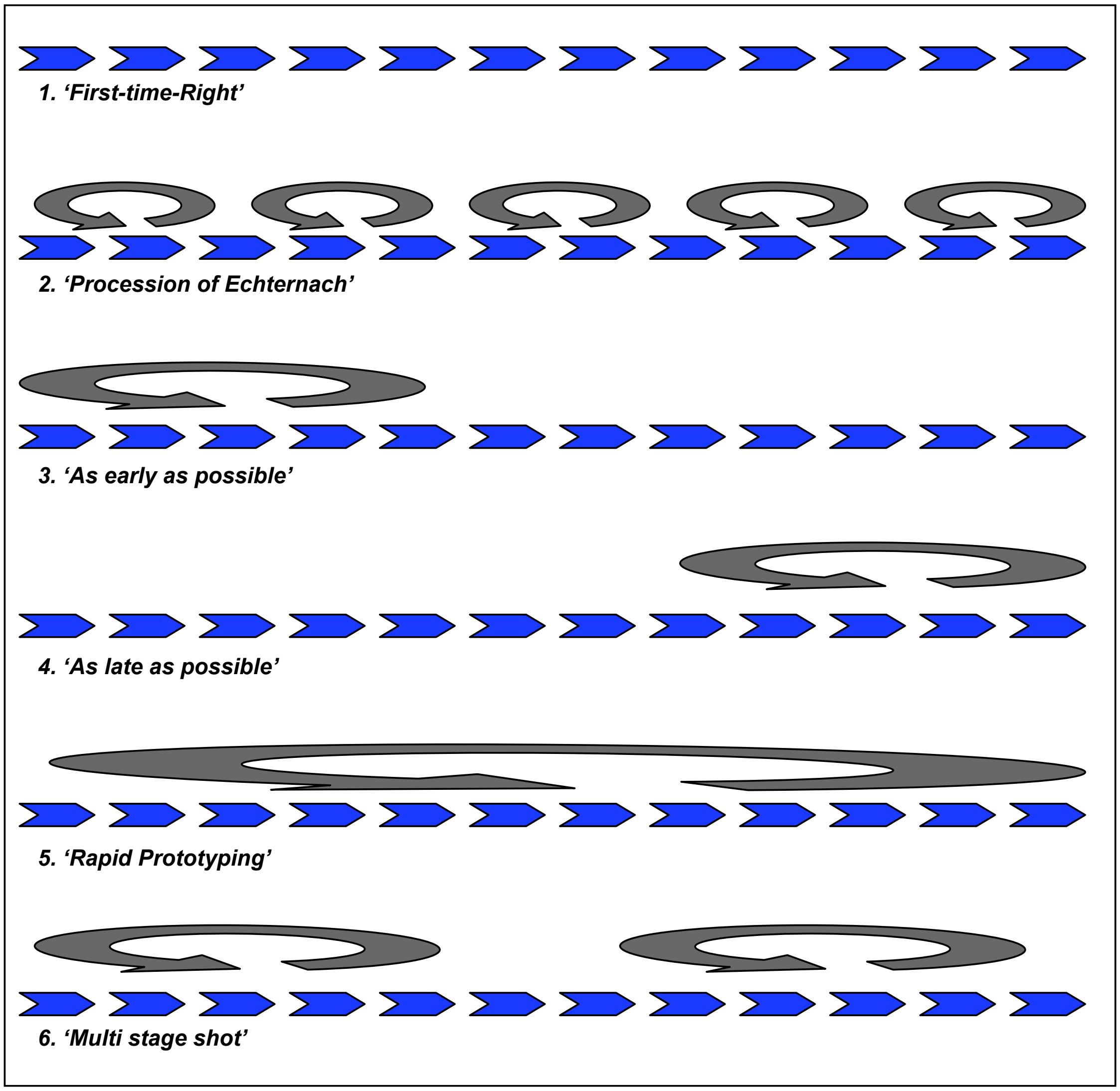


Figure 23: Value Engineering 'Design Processions'.

When optimizing the moment of 'intervention' with VE it might be helpful to describe some typical processes as illustrated in figure 23.
In the first situation a design process in its purest form is given – one can call it 'First-time-Right' because there is no step back. Every step forward is well-considered and

thoroughly planned. The whole process takes a lot of time and the end result is of a high quality.
The second situation illustrates the occurrence of many intermediate iterations caused by 'progressing insight' – sometimes called a 'Procession of Echternach' (three steps forward, two steps back…). It is a stumbling process whereby learning by trial & error leads to an end result in a relative shorter time than situation one and with less effort.
The third situation can be seen as carrying out a VE study in a preliminary design. There can be a considerable shake-up of the preliminary design because of the intermediate review on a moment that not all decisions have been made yet.
In situation four the VE exercise is carried out quite late when many design decisions have been made and consolidated so there is less 'shake-up effect'.
The fifth situation can be seen as a 'Rapid Prototyping' like exercise whereby a first rough (design) shot of hail is being fired and thereafter a careful analysis of the impact, followed by a more precisely aimed fine-shot.
The last situation is a multi stage application of reviewing by Value Engineering.

From the previously described experiences one could draw the conclusion that a VE study must be carried out 'the earlier the better' because important decisions have not been taken yet. On the other hand one could say that you can only shake up something when there is something to shake up… In other words, the effect of VE can be more significant when a large re-engineering effort has to be made.
It is also obvious that if one plans a VE session very early in the design, the re-design time left until completion of the project is almost as long as the original project time and again the same effect occurs, namely that 'new' progressing insight might increase the need for a new shake-up. This means that it is an illusion to think that with VE in an early stage 'the trick has been done'. It is also very important to realize that optimizations or major changes due to a VE approach are not the consequence of 'failures'. It is like climbing a mountain – once you are on the top you can see what was the shortest way up.

From these observations one can easily draw the conclusion that there is an engineering contradiction and one has to compromise, i.e. make some concessions and optimize the moment of intervention. However, another approach can be followed to solve this paradox by combining two processes and use the benefits of both! First a Rapid Prototyping approach is used in order to gain a lot of feed-back. This resembles the shot of hail and can be done FAST… With the feed-back, more appropriate decisions can be taken when redesigning the 'prototype'. This might lead to design processes that take less time, deliver results more focused on the goal, create common understanding and acceptance and last but not least more Value!

Of course further research is needed into optimizing the number of prototyping loops and when to start them under what conditions.

In the mean time VE itself still has a long way to go to find support from within different industrial disciplines.

Herewith we are back at the title again: ***'Let's do it first time wrong… but FAST'***.

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