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THE VALUE MANAGER

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- To encourage the use of the Value Management process by sponsors.
- To establish and maintain standards of Value Management practice in Hong Kong.
- To contribute to the dissemination of the knowledge and skills of Value Management.
- To establish an identity for the Institute within Hong Kong and overseas.
- To encourage research and development of Value Management with particular emphasis on developing new applications of the process.
- To encourage and assist in the education of individuals and organisations in Value Management.
- To establish and maintain a Code of Conduct for Value Management practitioners in Hong Kong.
- To attract membership of the Institute to support these objectives.

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EDITORIAL

Welcome to the second issue of The Value Manager 2007. In this issue, we are happy to have three outstanding papers on the use of Value Management in Product Design presented. “A TRIZ Based Value Management Process for Selecting Façade Solutions” is a paper written by Chen et al., in which a TRIZ-based ANP model was introduced. It was regarded as a useful and practical model for designers to evaluate different façade solutions, not only applicable to new builds but also to the refurbishments to existing buildings. In the paper titled “Value Enginnering (VE) Application Study in the Optimization of Expressway Tunnel Construction”, Wang and Zhang presented a case study to illustrate how to apply VE to expressway tunnel construction optimization in the Mainland China. The study showed that VE team achieved great success in reducing project cost and saving time. Last but not least, “Weight and Cost Savings by Increasing Quality/ Reliability for Aircraft Products and Components” by Axel Peter RIED was a paper introducing a set of sophisticated Management Techniques which were substantial for the Aircraft Industry and the Airlines. Such techniques were reported to offer tremendous new potentials for weight and cost reductions up to at least 30%. I hope you will enjoy reading these papers.

Jacky Chung

Editor, The Value Manager

MESSAGE FROM THE PRESIDENT

David Yau
President of HKIVM

In several conversations with our Past President Tony Wilson, it is common to find managers on site who report that they have "value engineered" this and "value engineered" that whilst referring to cost cutting items and not Value Engineering where workshops have been held and savings to the project is substantial. Nevertheless, even small workshops do provide value if a few professionals can come together, brainstorm, provide function analysis and a job plan. So all of us may do it out of habit in our daily routines, creating a value chain using the verb noun functions to solve what problems is laid

A TRIZ BASED VALUE MANAGEMENT PROCESS FOR SELECTING FAÇADE SOLUTIONS

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ABSTRACT

This paper aims to introduce a TRIZ (the Russian acronym for Theory of Inventive Problem Solving) based management process model for selecting the most appropriate solutions of building façades. To set up the model, environmental values of building facades are analysed with respect to their lifecycle performance and impacts; in addition, an Analytic Network Process (ANP) is integrated with the TRIZ process in order to support decision-making in facades selection. Therefore, a TRIZ-based ANP model is finally set up. It is conclude that the proposed method for façade selection is useful and practical for designers to evaluate different façade solutions not only for new builds but also for the refurbishments to existing buildings.

INTRODUCTION

The façade or envelope of buildings is an essential element of any design and construction strategy, because it is a significant aspect of building structural systems and it informs the design of building services systems through its capacity to influence energy use throughout the lifecycle of buildings. In a market driven by increased competition, the building envelope industry has to face the challenge to develop a building envelope or façade to meet the consumers' demands such as lower cost, more adaptable, smarter, and lower maintenance, while reducing adverse environmental impacts such as energy use, air and water pollution, and waste (DoE, 2001). In this regard, it is necessary to provide an effective tool for the practitioners in both design and construction teams to select the most appropriate façade solution for their specific building projects. The objective of this paper is to introduce a novel multicriteria decision-making process based on Analytic Network Process (ANP) and the Theory of Inventive Problem Solving (TIPS or TRIZ) with respect to the value chain management in the project development of buildings. To achieve this target, this paper will first introduce some research methods adopted in this research, including literature review, the TRIZ method, and the ANP method; after that, the paper will provide some research outputs based on current research progress, including a group of Key Performance Indicators (KPIs) for façades assessment, an ANP model for decision-making in façades assessment, a TRIZ based value added process for inventive remodelling to enhance the ANP model, and a knowledge base integrated with the TRIZ based decision-making process to facilitate remodelling. It is concluded that the TRIZ based value added process can eventually support good decision-making in selecting the most appropriate façade solution for a specific building project, and the TRIZ based value added process can be very useful in remodelling ANP models in generic multicriteria decision-making.

METHODOLOGY

The methodology comprises several research methods focusing on objectives of this research, including literature review, prototyping, system analysis and development, and quantitative analysis. This paper will describe some of research methods towards the research targets, including a group of Key Performance Indicators (KPIs) for façade assessment, which are summarized according to existing building assessment systems and quantitative selection criteria, a decision-making model, called FaçadeChoice, which is set up based on the KPIs using Analytic Network Process (ANP), a TRIZ based value added process for continually improving the effectiveness of FaçadeChoice model by inventive remodelling through refining KPIs, and a knowledge base of façade cases for facilitating the TRIZ based value added process. Questionnaire surveys and statistical analysis for FaçadeChoice ANP model construction is also necessary but will be adopted in future studies for further proof of KPIs. All research methods will be adopted in sequence to achieve the aim of this research that is to build a practical FaçadeChoice model to support the design and construction of building façades or envelopes with regard to innovation and environmental sustainability. Some key research methods to achieve individual objectives are described below.

LITERATURE REVIEW

The literature review aims to obtain comprehensive information that are essentially relevant to the KPIs for façade assessment from current literatures, and it is conducted to continuously pursue professional and academic publications, reports and guidelines from selected resources via the Internet and interviews. In order to extract a group of KPIs to set up the FaçadeChoice ANP model, the literature review firstly focuses on some existing building assessment systems, including

- BQA (Building Quality Assessment, by Building Economics Bureau, UK),
- BREEAM (Building Research Establishment Environmental Assessment Method, by Building Research Establishment Ltd., UK),
- BSAT (Building Sustainability Assessment Tool, by the Department of Trade and Industry, UK),
- CASBEE (Comprehensive Assessment System for Building Environmental Efficiency, by Japan Sustainable Building Consortium, Japan),
- DQI (Design Quality Indicator, by Construction Industry Council, UK),
- Eco-Quantum (Environmental Performance Express of Buildings, by IVAM, Netherlands),
- GBTool (Assessment Framework & Green Building Tool, by the International Initiative for a Sustainable Built Environment, Canada),
- GMB (Green Mark for Buildings, by Building and Construction Authority, Singapore),
- HK-BEAM (Hong Kong Building Environmental Assessment Method, by HK-BEAM Society, Hong Kong),
- IB Index (by Asian Institute of Intelligent Buildings, Hong Kong),
- IB Rating (by Shanghai Construction Council, Shanghai, China),
- LEED (Leadership in Energy and Environmental Design/Green Building Rating System, by U.S. Green Building Council, USA),
- MATOOL (a matrix tool for assessing the performance of intelligent buildings, by Building Research Establishment Ltd., UK),
- NABERS (National Australian Built Environment Rating System, by Department of the Environment and Heritage, Australia),
- Office Scorer (Sustainable Refurbishment/Redevelopment Decision Support Tool for office buildings, Building Research Establishment Ltd., UK),
- SPeAR (Sustainable Project Appraisal Routine, by Arup, UK), and
- Sustainability Checklist (Assessment of the social, environmental and economic impact of a proposed development, by the South East England Development Agency, UK), etc.

In addition, the literature review also focuses on some specific guidance relevant to building façades. For example, there is a review of

Building Envelope Technology Roadmap, which was developed by the representatives of the building envelope industry facilitated by the U.S. Department of Energy (DoE, 2001), and aims to provide a 20-year industry plan for building envelopes.

TRIZ

TRIZ is the Russian acronym for the Theory of Inventive Problem Solving (TIPS or TRIZ), which is a problem solving methodology based on an extensive study of the world patent database made by a Russian inventor, Genrich Altshuller, and his team (Greenall and Barnard, 2006); and they discovered that inventors from completely different technical backgrounds and geographical locations were applying essentially very similar techniques in solving problems. As a result, the TRIZ was created to reveal those techniques and developing methods to assist in their inventions, and it can be used by everyone to improve their problem solving capabilities (TIC, 2006), including visualizing technical systems from new perspectives, revealing all known possible solution concepts, seeking ideal solutions, developing superior products by overcoming system contradictions, predicting future product and technology evolution, and establishing an absolute competitive advantage.

ANP

The ANP is a general theory of relative measurement used to derive composite priority ratio scales from individual ratio scales that represent relative measurements of the influence of elements that interact with respect to control criteria developed by Saaty (1996). As a multicriteria decision-making process, an ANP model consists of two functional parts, including a network of interrelationships among each pair of nodes or clusters, and a control network of criteria/sub-criteria that control interactions based on interdependencies and feedback. To conduct decision-making process, the control hierarchy is generally employed to build an ANP model, and it is a hierarchy of criteria and sub-criteria for which priorities are derived in the usual way with respect to the goal of a system being considered. The criteria are used to compare the clusters of an ANP model, while the sub-criteria are used to compare the nodes of a cluster. Regarding how to conduct façade assessment by using ANP, a four-step ANP procedure is summarized in Figure 2, including model construction, paired comparisons, supermatrix calculation, and final assessment. The research outcomes being presented in this paper include a group of KPIs for developing and applying an ANP model, the FaçadeChoice ANP model, a TRIZ based decision-making procedure for a value added process in façade assessment, and a façade casebase to support the TRIZ based value added process.

ENVIRONMENTAL VALUES OF FAÇADES

In this research, the environmental value of building facades is evaluated by using a group of KPIs, which have been divided into 6 indicator clusters, including Adaptability, Affordability, Durability, Energy, Intelligence, and Well-being. To further define the group of KPIs, pilot research has been conducted to review previous research works from all over the world. Table 1 describes current KPIs for the 6 indicator clusters and their specifications.

THE FAÇADECHOICE ANP MODEL

The FaçadeChoice is a multicriteria decision-making model developed using Analytic Network Process (ANP) (Saaty, 1996). There are two main clusters inside the model, including the cluster of Criteria and the cluster of Alternatives. The Criteria cluster comprises 6 sub-clusters, including Well-being subnet, Adaptability subnet, Durability subnet, Energy subnet, Affordability subnet, and Intelligence subnet. The model is designed to select the most appropriate façade solution from several alternatives in the process of evaluation, or to make a comparison between a proposed façade solution and a reference façade solution within a same category in the process of assessment. Figure 1 illustrates the FaçadeChoice ANP model. The Alternatives cluster consists of two nodes in a pilot study, including Façade A and Façade B, which are two building envelope candidates to be evaluated for a specific building project. On the other hand, the Criteria cluster consists of 6 subnets, including the sub-cluster of KPI Group t (t=1~6) in accordance with the 6 KPI groups mentioned in Table 1 (refer to Figure 1). All indicators involved in the Criteria cluster are collected based on the implementation of the framework of literature review and the value chain of building project development (Clements-Croome, 2004).

Table 1: The environmental value focused KPIs for façade assessment.

No.	Clusters	No.	KPIs	Suggested measurement
1	Adaptability	1.1	Capacity to the adaptation of components	Component flexibility for replacement
		1.2	Resistance to maintenance & refurbishment	The amount of C&D waste and other pollutants
		1.3	Society (Appearance, Ethics & Community)	Public preference with regard to the surrounding harmonization & heritage value
		1.4	Ecology	The level of life-cycle toxicity from the façade system
2	Affordability	2.1	Life-cycle cost	The cost of design, construction/refurbishment, maintenance, demolition
3	Durability	3.1	The life of services	The expected service life of façade system
		3.2	Fire resistance	Fire resistance rating
		3.3	Resistance to external loads (wind, seism, etc.)	Structural reliability of façade system
		3.4	Resistance to pests	Biological hazards resistance
4	Energy	4.1	Life-cycle environmental impacts	The embodied energy or CO2 emissions of façade system
		4.2	Energy efficiency	Average energy loss (emission from the façade system) per year
		4.3	Energy use	Average energy cost per year
		4.4	Solar energy effectiveness	Light-to-solar gain ratio (LSG)*
5	Intelligence	5.1	Control strategies	The level of interaction between façade system, occupants, and the natural environment
		5.2	Integration of systems	The level of efficiency to implement the control strategies
		5.3	Emergency response	Integrated security system alarms
6	Well-being	6.1	Aesthetics (views, colour)	The level of aesthetics with respect to occupants
		6.2	Daylight	Daylight factor
		6.3	Room intelligibility/clarity	Reverberation absorption coefficient of the façade
		6.4	Background sound level	Sound reduction index of the façade
		6.5	Temperature	Thermal insulation coefficient (U value)
		6.6	Relative humidity	The level of relative humidity (45~50%)
		6.7	Air movement	The influence of the façade to indoor air distribution
		6.8	Indoor air quality	The level of air fresher (decipols)
		6.9	Ventilation	The level of ventilation control relevant to the façade system
		6.10	Ergonomics	The level of ergonomics considering backache, eyestrain, repetitive strain injury, etc.

* Light-to-solar gain ratio (LSG) = visible (light) transmittance (VT)/ solar heat gain coefficients (SHGC).

TRIZ BASED VALUE ADDED PROCESS

Value management plays a key role in the construction industries that continually quest for continuous improvement and innovation (IVM, 2006), and it has been successfully applied both to the strategic planning of the business, and improvement in performance in addition to delivering best value throughout the project lifecycle. The value chain (see Figure 2) can reflect key stages at which value management processes are conducted. For building façade selection, products information and clients' requirements actually need to be respected by the design team (see Figure 2). Regarding façade selection for each individual project, a multicriteria decision-making model has been proposed using Analytic Network Process (ANP) approach (Chen, et al., 2005). However, it has been noticed that there are still some problems with the pre-defined ANP model. For example, the decision-makers may wonder whether the ANP model has covered a sound group of indicators, which is critical in ANP modelling. In this regard, a TRIZ approach is integrated into the decision-making process with respect to help decision-makers to refine indicators for the ANP model on a daily basis (see Figure 2). The purpose of this integration is to enhance the ANP based decision-making process for façade selection by using the advantages of TRIZ in refining indicators, which are critical in ANP modelling; and it is believed that TRIZ is the right tool that can ensure that the decision-making team have an inventive and consummative understanding of the key business needs and success criteria of clients, users and stakeholders. As a matter of fact, the authors have tried to use TRIZ methods in indicators selection and the ANP model illustrated in Figure 1 is just a current model with refined indicators. Therefore, the authors summarized their work in ANP modelling and remodelling here, and think that the proposed TRIZ based ANP approach can be quite useful in the value management process of façade selection and other complex decision-making processes where models need to be refined for more accurate results.

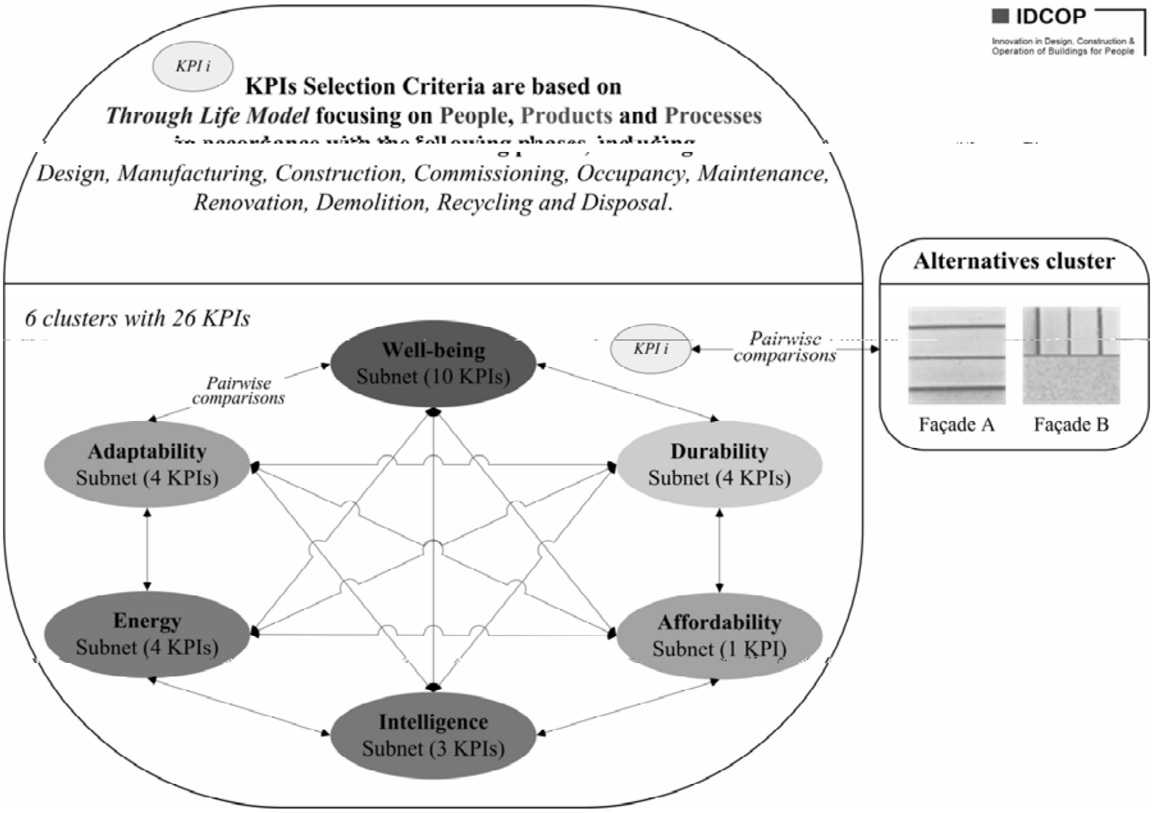

Figure 1: The FaçadeChoice ANP model.

FAÇADE CASEBASE

According to the IVM (2006), the value management considers that the involvement of multi-disciplined users and stakeholders at the earliest strategic and tactical workshops to be of paramount importance. In this regard, a façade casebase is proposed to be integrated with the TRIZ based value added process (see Figure 2), towards which knowledge about existing building facades can be reused for the inventive remodelling of ANP. There has been a pilot façade casebase developed by the authors and it has also been used into the TRIZ based ANP remodelling.

CONCLUSIONS

This paper presents a research into TRIZ based value management process with the ANP for decision-making in façades assessment. It is the research initiative to integrate the TRIZ method with the ANP method inside a value chain of the project management of buildings. In some pilot research within the research team, it has been proved that the ANP is effective in façades assessment; and the TRIZ is very useful to refine KPIs for remodelling the ANP model. Moreover, the TRIZ based value management process with the ANP is an innovative generic procedure for decision-makers who are willing to apply multicriteria decision-making techniques in problem solving.

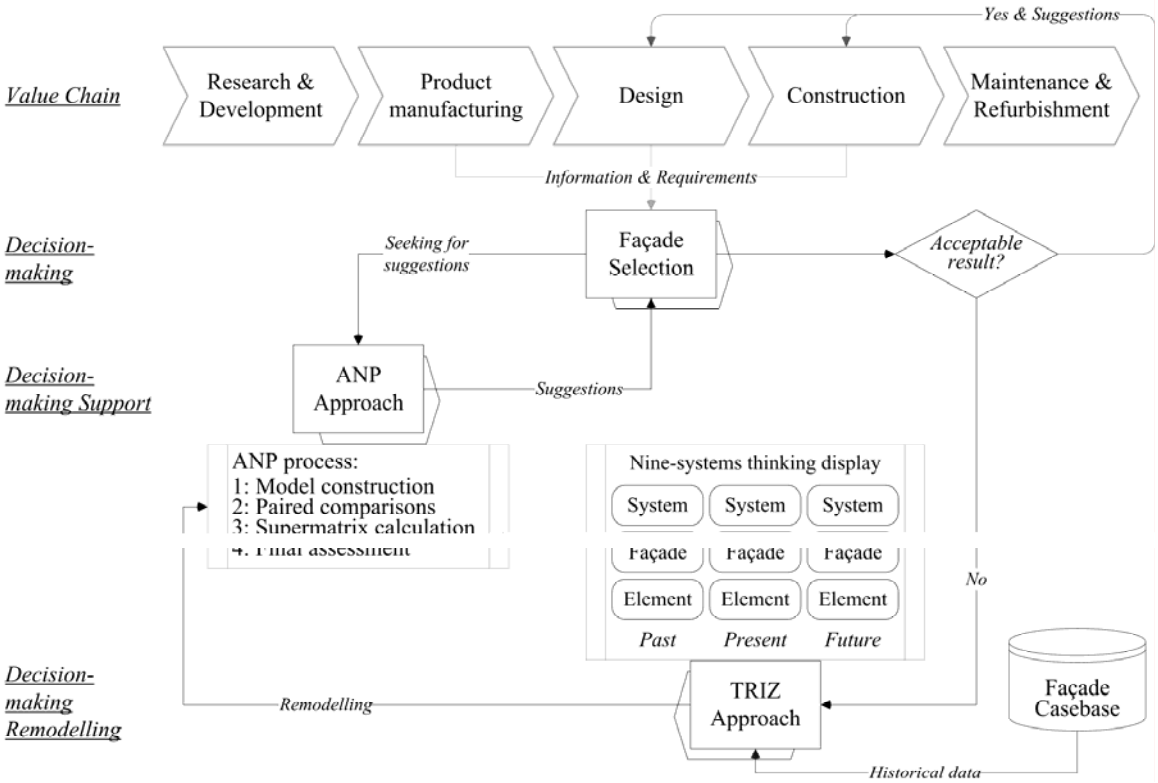

Figure 2: The TRIZ based decision-making process for façade assessment

ACKNOWLEDGEMENTS

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REFERENCES

Chen, Z., Clements-Croome, D.J., Kaluarachchi, Y., Jones, K., and Hong, J. (2005) FacadeChoice: A decision-making model for innovation and environmental sustainability in the design and renovation of building envelopes. Proceedings of CISBAT 2005: Renewables in a Changing Climate - Innovation in Building Envelopes and Environmental Systems. 28-29/09/2005. Lausanne, Switzerland. 13-18.

Clements-Croome, D.J. (2004) Intelligent Buildings: Design, Management and Operation. Thomas Telford, London.

DoE (2001) Building Envelope Technology Roadmap. Representatives of the Building Envelope Industry, U.S. Department of Energy (DoE), Washington DC, USA.

Greenall, R., Barnard, S. (2006) Inventive Problem Solving (TRIZ). Practical Training Solutions for Industry, Milton Keynes, UK.

IVM (2006) Value Management in Building and Construction. Institute of Value Management (IVM), UK. <http://www.ivm.org.uk/vm_sector_building.htm> (28 July 2006).

Saaty, T.L. (1996) Decision Making with Dependence and Feedback: the Analytic Network Process. RWS Publications, Pittsburgh, USA.

TIC (2006) What is TRIZ? Technical Innovation Center (TIC), Inc. <http://www.triz.org/> (29 July 2006).

VE APPLICATION STUDY IN THE OPTIMIZATION OF EXPRESSWAY TUNNEL CONSTRUCTION

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China

INTRODUCTION

Value Engineering (VE) is a special value acquiring technique which based on the relation analysis between function and cost of a selected object. Miles(1945) first put forward this managerial idea and gave a systematic expatiation in his book: 'Techniques of value analysis and engineering' 。

The main idea of VE is to fund out the best matches among various functions and costs of the selected object by adopting special analytical methods, and through creative means to archive the best value. This technique has acquired great application in practice since its emergence（Nakagami，1998）,especially in engineering field, such as project design, construction optimization and project management. However, this technique got much less attention and application in China（Shen，Liu ，2004）. Many factors which had caused this result could be found, e.g. from economic constitution to project special benefit mechanics (Zhang, Ma,2004), besides, the Chinese national VE standard has never amended since its draft two decades ago, whereas the economical and managerial environment have drastically changed in China in these years (Zhang，Chen，Sun，2003).

In this paper, around a case study, carry out the discussion of how to introduce VE idea, technique to expressway tunnel construction optimization: (1) The acceptance of VE idea among the managers and engineers, (2) using WBS (Work Breakdown Structure) approach to obtain function system diagram (partially using Function Analysis System Technique, FAST), (3)using questionnaire to obtain and distribute weights and scores among functions in different levels. The VE team action in this case had archived great success both in project cost cutting and time saving. Further more, by this application most managers and engineers in this project got the chance to access VE idea, they showed great interest and some of them had grasped the main methods of VE.

BACKGROUND OF THE CASE: KUIGANG TUNNEL

700M's long, located in the eastern section of Meizhou-heyuan Expressway (118KM) in the north-eastern area of Guangdong Province, Kuigang tunnel is one of the largest tunnel along the line, it belongs to the second road base contract, the beginning mile stage is : LK3 + 540 - LK4 + 240 (left), K3 + 535 -K4 + 235 (right), the mountain which the tunnel passes through stands on 265 M's high, and the largest buried depth is 130M, both of its outlet/inlet gate were designed in the middle of the mountainside. According to the Chinese National Specification of Expressway Tunnel Design (JTJ26-90), the main designed dimension of the tunnel is: net high: 6.9M, net width: 10.50M.

The construction environment were very complex, for the landscape which the tunnel located in belong to mountainous region, and there lack communication road near the working site, besides, the construction quality requirement was high and construction time limit was short. Considering all of those factors, the project was very difficult to finish, see Figure1. The engineering line belonged to the second road base contract spans to 5.2KM's long, its excavating and filling earthworks are 1.045 million M3 and 1.424 million M3 separately. The main sub units of this section are: a large bridge, length: 307M, two small bridges: total length: 29M, 15 culverts: total length: 1077M, two tunnels, the total designed cost is 139.048 million RMB Yuan. See Table1.

Figure 1: Kuigang tunnel under construction

Table 1: The main sub units and cost allocation in the second road base contract

Item	Jixiongshang tunnel	culvert	Small bridge	Pass road	Kuigang tunnel	Jixiongshan tunnel	Road base	Total cost
Cost (M. Yuan)	1.40302	8.6064	6.359	1.4042	46.0607	17.0267	30.5273	12.40145
Percent (%)	11.31	6.94	5.13	1.13	37.14	13.73	24.62	100%
Rank	4	5	6	7	1	3	2	/

VE ACCESS AND LEARNING

In fact few Chinese engineers and managers had systematically accepted the education of VE theory before, some of them only knew of the main concept of VE, nearly all of them had never taken part in any VE action such as training and application, and lack of both VE knowledge and experience. Because of this poor background, at the beginning of this project, a strong VE training was carried out which covering all the personnel, besides, engineers and managers who in charge of the key sub engineering units had accepted other special training such as team management and creative inspiration cultivation, etc. these prelude actions had gotten great outcomes, for just after the trainings several in house VE groups had set up. E.g. the VE team for Kuigang tunnel construction optimization.

VE OBJECT SELECTION

An important step in VE action is to rightly select an object within the defined VE scope for further study, and many methods can be adopted for the selection, here in order to archive more effectiveness by less work, we selected the most costly sub unit, namely the Kuigang tunnel as VE study object. From Table1 it could seen that the designed cost of Kuigan tunnel was amount to 46.0607 million Yuan and ranked the first among the section, in the term of VE, Kuigan tunnel belongs to the key minorities. Other studies had showed that the functions and cost of road base, culverts were approximately matched. But for Kuigang tunnel, not only its designed cost was high, but also its construction technique requirement was strict and time consuming, its risk was high comparing with other units.

FUNCTION SYSTEM ANALYSIS

Function system analysis is a main content in VE action, at fist of this, a series of function decomposing and function definition were done.

Top function definition

Function decomposing was relatively simple, for it could be done according to Working Breakdown System (WBS) of this project. See Figure 2

Figure 2 showed that the tunnel engineering could be divided into 9 stages: exterior tunnel body excavation; tunnel gate engineering; interior body dig; initial stake protection; drainage; lining; road pavement; ventilation & lighting; decoration. Tunnel functions included: transport smooth; body sustain; conduction road vibration to the bottom; water protection and drainage, slinky. By investigation and inquiring to 5 specialists, the above function definitions were suitable.

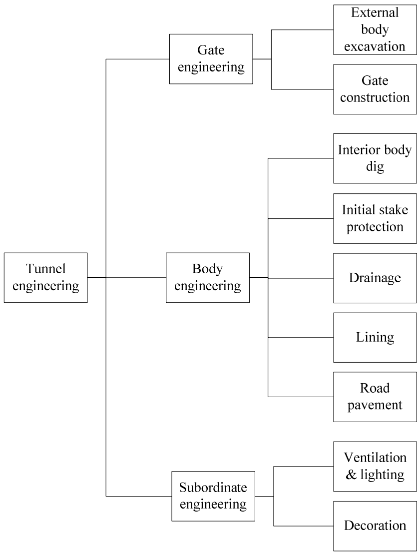
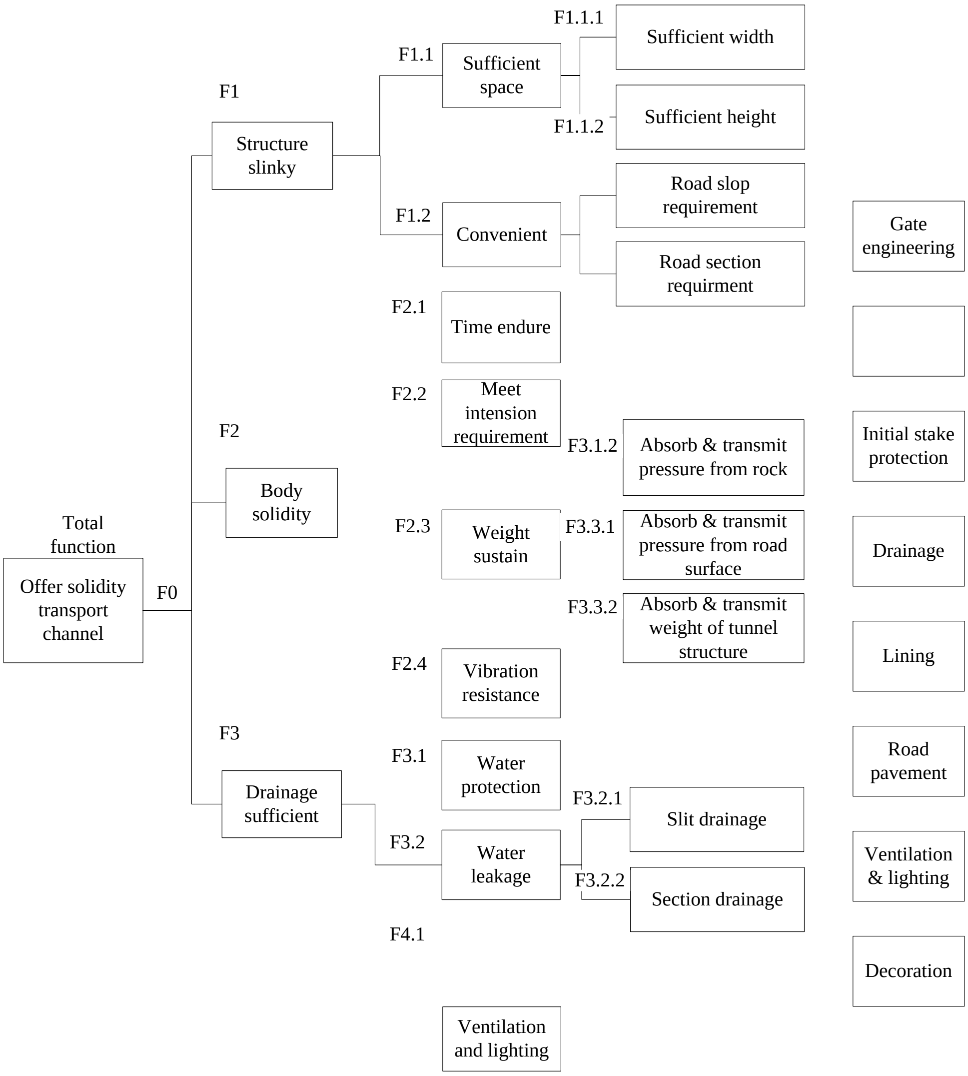


Figure 2: WBS of Kuigang tunnel engineering



Function analysis system

Based on the WBS, carried out detailed function decomposing, after function analysis and synthesis, the tunnel function could be structured in 4 levels, see Figure3.

FUNCTION APPRAISING

Function coefficient definition f_i

According to above function analysis system, here used the function coefficient appraising approach, e.g. Multi-scale Marking (MSM) methods to calculate function value and appraise. 5 tunnel specialists were invited to use MSM/0-10 to score F1~F4. Then: $f_i = F_i / \sum F_i$, see Table 2.

Table 2: Function coefficient definition of F1~F4

Function	Specialists					Sum of score	Function coefficient
	1	2	3	4	5		
F1	12	15	15	16	9	67	0.223
F2	21	21	20	20	22	104	0.347
F3	16	13	12	11	21	73	0.243
F4	11	11	13	13	8	56	0.187
Total	60	60	60	60	60	300	1.000

Function cost definition

According to WBS diagram, the tunnel engineering project could be decomposed into 10 sub units, so here allocated the designed cost to them accordingly. Further, the cost should be decomposed and allocated according to function classification, then got the function cost c_i, and transformed them into unitary from: $c_i = C_i / \sum_i C_i$, see Table 3.

Table 3: Function cost definition: present cost and cost coefficient

Serial No.	Tunnel body		Function cost of F1~F4(ten thousand Yuan)			
	Sub unit	Cost (ten thousand Yuan)	F1	F2	F3	F4
1	Exterior tunnel body excavation	148.54	32.68	50.01	35.15	30.70
2	Tunnel gate building	20.00	4.42	5.85	4.97	4.76
3	Interior body dig	1058.30	197.55	384.52	310.43	165.80
4	Initial stake protection	1206.87	233.59	404.89	319.24	249.16
5	Drainage	508.34	120.31	150.81	159.28	77.95
6	Lining	1001.87	213.7323	313.9193	270.5049	203.71
7	Road pavement	132.14	36.56	38.32	32.15	25.11
8	Ventilation & lighting	466.97	115.19	144.77	93.39	113.63
9	Decoration	63.03	15.97	17.65	11.98	17.44
Present cost		4606.07	969.99	1510.71	1237.1	888.25
Cost coefficient		1.000	0.211	0.328	0.269	0.193

Function value coefficient calculation:

Now could calculate the function value v_i:

$v_i = f_i / c_i$, see Table 4.

Table 4: Function value coefficient

Function	f_i	c_i	v_i
F1	0.223	0.211	1.057
F2	0.347	0.328	1.058
F3	0.243	0.269	0.903
F4	0.187	0.193	0.969
Sum	1.000	1.000	

After the calculation of function value coefficient, the next step was to appraise. Three possible condition of f unction value coefficient could exist in 3 states:

- (1) If =1, means that the function important degree matched its cost, the present cost of the function was suitable.
- (2) If <1, means that the function important degree is unworthy of its cost, the present cost of the function was high, and this function should be listed as a main object to be improved. In this case, the main improvement is to cut cost.

- (3) If >1 means that the function important degree is over matched it cost, possible factors are: [1] the present cost is lower, and can meet the requirement of function realization. Under this condition function may be reached through cost increase. [2] may be exist excess function than requirement, under this condition this function should also be listed as study object.[3] there have some specialties either in technology or in economy. Which the function is very important but only need less cost to realize it. Under this condition the function needn't to be further consideration.

FIND THE TARGET FUNCTION VALUE OF TUNNEL

First, allocated cost to functions according to the function important coefficient $C_i^1 = f_i \sum_i C_i$.

Then compared C_i^1 with C_i, make the lower to be the target function cost. Third, calculating the cost deduction: $\Delta C = \sum_i (C_i - \min(C_i, C_i^1))$, see Table 5.

Table 5: Function cost appraising

Function	Designed cost C_i	Function coefficient f_i	Reallocate cost according to f_i $C_i^1 = f_i \sum_i C_i$	Determine target cost	
				Function target cost $\min(C_i, C_i^1)$	Cost deduction $\Delta C = \sum_i (C_i - \min(C_i, C_i^1))$
F1	969.99	0.223	1027.15	969.99	0
F2	1510.71	0.347	1598.31	1510.71	0
F3	1237.1	0.243	1119.28	1119.28	117.82
F4	888.25	0.187	861.34	861.34	26.91
Total	4606.07	1.000	4606.07	4461.32	144.75

After the whole target cost and function coefficients had been determined, the expected function target cost and the total cost deduction could be calculated. These were showed in Table 5.

Table 4 shows that the value coefficient of drainage function (F4) was only 0.903, this mean that too much cost had been allocated to this function, Notice that from Table 5, the expected cost deduction of F3 $\Delta C_3 =$ was 1.1782 million Yuan. It took 81.40% of the total expected cost cutting down. In fact later investigation had approved this guess.

For F1, F2, they value coefficients were around 1, these mean that they cost matched the function. Compared with F3, these two parts should be set aside. F3, F4 were selected for further study.

IMPLEMENTATION AND VE ACTION APPRAISING

The optimal proposal

VE analysis has showed that the original design of drainage and gate engineering were unsuited, and suggest amending them. Through creative suggestion and unrestricted discussion, some good amending idea emerged, such as: change the original drainage mode to two side slots, one side maintenance pass to side maintenance passes, change the rock anchor-hold mode, etc. After redesign, the drainage system alone nearly1million Yuan was saved.

VE action appraising

The VE action in Kuigang tunnel had not only successfully revealed the design deficiency, but also given out a quantity of creative optimal suggestions, which firmly supported the redesign and construction optimization. Cutting down the cost and shorten the construction time.

SUMMARY

There exerts a phenomena which managerial work is clearly separated from technical work. The former is usually accomplished by managerial personnel whereas the later is concurrently done by technicians. In fact these works can't be divided clearly in modern large project construction. The problems raised from project design, construction period are mainly in pairs, such as cost/quality, time limit/ quality, technical difficulty/quality, safety/cost, etc. by combining managerial idea, skills to technical methods, and by solving the above problems through different, creative ways, many times we can obtain good effectiveness in project management. Among the combining methods VE is an excellent idea, theory and methods. This was approved again in the case of Kuigang tunnel engineering.

REFERENCE

Miles, L.D. (1972).Techniques of value analysis and engineering (First Published in 1961), 2nd ed., McGraw-Hill, New York, 1972， pp.1-2.

Nakagami, Y. (1998). Characteristics of VE study and application in Japan through comparison of American and Japanese conference papers. Save Intl. Conference Proceedings. http://www.value-eng.org/catalog_conference，1998.php. pp.31-316.

Shen, Q.P., Liu G.W.(2004). Applications of value management in the construction industry in China. Engineering, Construction and Architectural Management, 11(1):9-19.

Zhang, C.J., Ma, Q.G. Recognition on the Complex Mechanics of Value Engineering (VE) Application System. Value Engineering & Technology Innovation. Proceedings of the 2nd VETI International Conference (ICVETI’2004),16-18,Oct., 2004. Beijing: International Academic Publishers, 2005. pp. 69-77.

Zhang, C.J., Chen，W.X., Sun, D.C.(2003). Study on the VE Procedure and its Improving Approaches，J. of South China University of Technology (SCUT), 2003，5(31):25-33.

WEIGHT AND COST SAVINGS BY INCREASING QUALITY/ RELIABILITY FOR AIRCRAFT PRODUCTS AND COMPONENTS

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Ried Management Methods, Germany

ABSTRACT

The paper describes well proven sophisticated Management Techniques which can achieve, when practiced consequently, outstanding results. It is substantial for the Aircraft Industry and the Airlines as well to develop new products and components which are lower in weight and cost. At the same time quality and reliability of these products must be enhanced. The implementation of sophisticated Management Techniques offers tremendous new potentials for weight and cost reductions up to 30% and sometimes more. Completed projects will be presented.

WEIGHT AND COST SAVINGS

Aircraft manufacturers, airlines and all suppliers of this industry have one common goal to reduce weight and cost by enhancing quality/reliability at the same time.

Sophisticated management techniques and tools can achieve the following targets very well if applied consequently:

- highest safety factor for all aircraft components
- lowest possible weight
- low manufacturing and assembly cost
- extremely short Time to Market (TTM)
- Unique Selling Points (USPs) compared to the world wide acting competitors
- implementation of special options for each key market

Value Engineering as the best proven technique can be strongly recommended as the main Management Tool. Also Project Management should be applied simultaneously.

PROJECT MANAGEMENT IN THE EARLY DESIGN STAGE

On the basis of specific customer requirements and very intensive

- world wide market research studies
- world wide competitor benchmarking
- and patent analysis

New products and services will be developed by applying Project Management in the early Design Stage of Aircraft Industry products.

As any product or component for the use in aircrafts has to perform highly sophisticated functions and quality requirements at the lowest possible cost, Project Management and its techniques must be applied from the very first moment on.

WORLD WIDE ACTIVITIES

Preceding to the Development, Design, Testing and Manufacturing Phase intensive world wide activities must be completed:

- Market Analysis of the key markets China, Japan, Far East, Europe, USA and Canada
- International Competitor Benchmarking
- International Patent Analysis
- Analysis of safety regulations, requirements and test conditions in the key markets

DUTY BOOK DEVELOPMENT

On the information basis mentioned above a highly qualified expert team develops the Duty Book for the specific product under study.

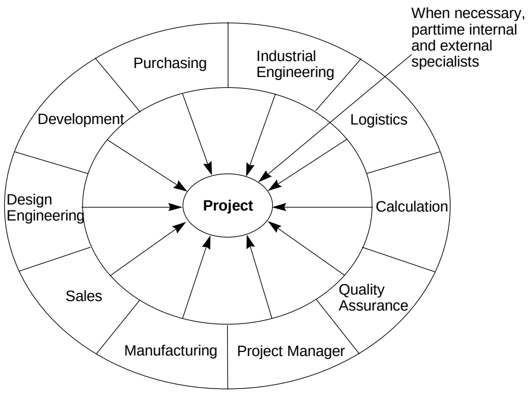

Figure 1: Project management steering team (PST)

One very important part of the Duty Book development is also the definition of all design specifications and test conditions at this early stage. Duty Books for the main components to be delivered by the suppliers are developed during this phase by using the PM Techniques.

The Project Team also prepares a detailed function analysis by using the F.A.S.T. Techniques.

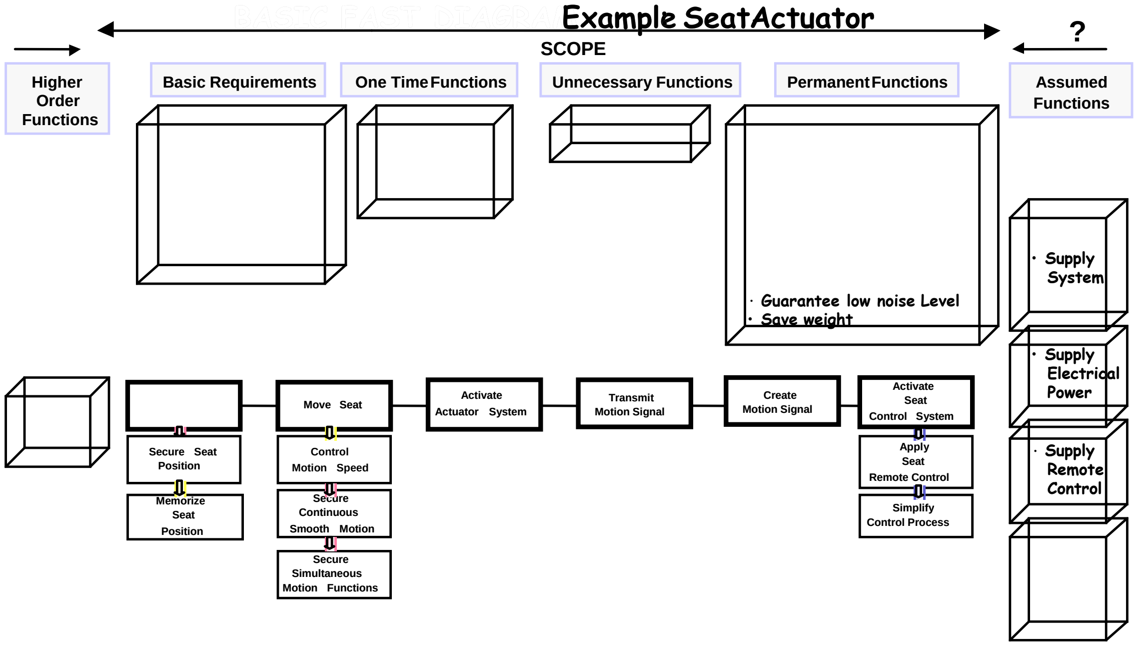

Figure 2: F.A.S.T. Diagram of key functions

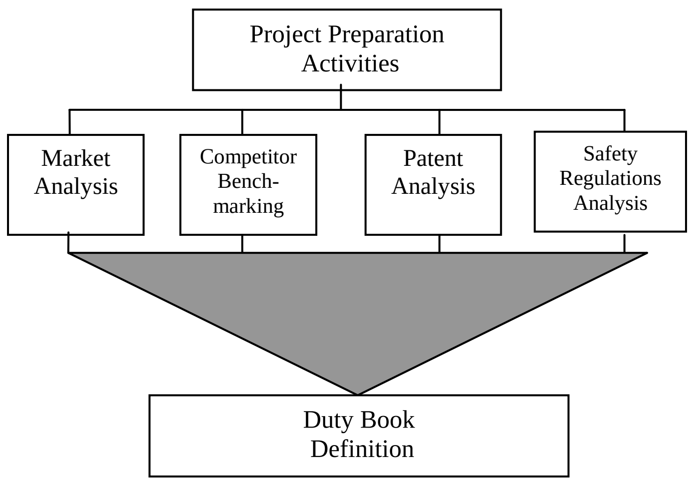

Figure 3: Project preparation activities

PROJECT PREPARATION ACTIVITIES

In order to define a market and customer oriented duty book for the new product program; intensive world wide preparation activities must be organized:

Market Analysis

In all key markets like China, Japan, the Far East, Europe, USA and Canada; intensive market research has to be completed. Seat test reports of all important test laboratories and journals were analyzed just to learn what the specific airline as a user would expect in regard to:

- technical functions
- safety functions
- comfort functions
- weight and price

which they would be willing to pay for the product.

International Benchmarking of all Competitors

All available products of the different competitors will be deeply analyzed by comparing items like:

- technical functions and solutions
- safety functions and solutions
- comfort functions and solutions
- weight
- sales price
- sales organization
- Unique Selling Points

The best technical, safety and comfort solutions of each competitor are especially analyzed and compared in an evaluation matrix, so that all possible synergy effects can be learned and used later on during the creativity phase.

International Patent Analysis

In all key markets the patents of all competitors are collected and studied. This is done to:

- know the details about all patent protected solutions
- get synergy effects for the creative phase
- prevent the development of solutions already protected by other manufacturers and to prevent possible patent claim problems later on

Analysis of Safety and other Aircraft specific Regulations and Standards

The world wide performed analysis of the safety regulations, requirements and test conditions show that there are quite very different and very special requirements in the key markets.

The knowledge of these differences however is substantial as one of the main basic factors for the definition of market and customer oriented duty books.

Customer Specific Requirements

The success of any new product program in the selected key markets can definitely only be achieved, if all specific requirements are being met and offered specifically to the end users.

DUTY BOOK DEFINITION

On the basis of the results of the project preparation activities described above, the duty book of a Product Program can be defined by the project team.

In the duty book the following main chapters were determined:

1. Basic product requirements
   1.1 primary functions
   1.2 Unique Selling Points (USPS)-functions
2. Customer specific requirements and standards
3. Aircraft manufacturer specific Requirements and standards
4. Product structure and material
5. Handling and comfort requirements
6. Design
7. Operating conditions
8. Comfort functions
9. Maintenance requirements
10. Safety criteria
11. Recycling
12. Packaging
13. Corrosion and toxicology
14. Instruction manual
15. Target market distribution price
16. Warranty

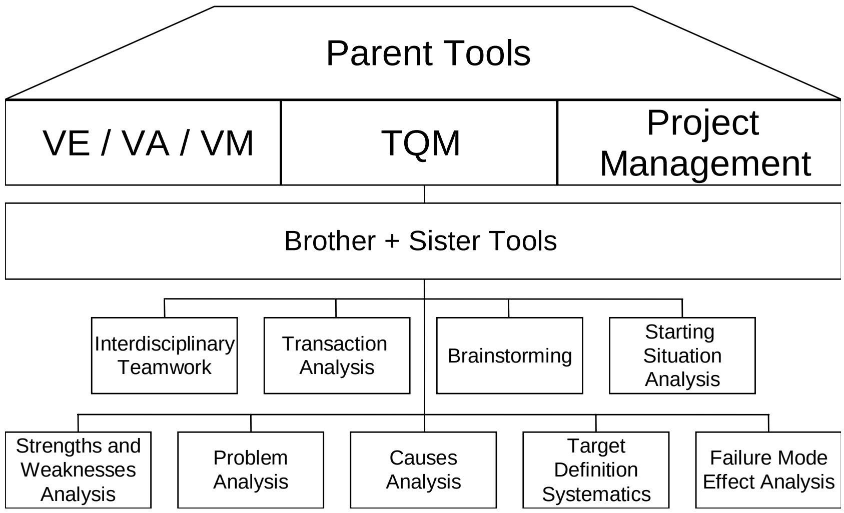

Figure 4: Value Management Tool Kit

VALUE ENGINEERING AND OTHER SOPHISTICATED MANAGEMENT TOOLS

Parent, brother and sister tools are being applied in a close combination according to the specific requirements and targets of each global or national project.

CREATIVITY TECHNIQUES

It is important to know that different Creativity Techniques should be applied systematically during the development and implementation of a project, such as:

- Classical Brainstorming
- Morphology
- Synectics

The implementation especially of the more sophisticated creativity techniques "Morphology" and "Synectics" make it finally possible to create ideas and solutions which guarantee new products and components.

Also we would like to point out that the consequent application of

FMEA – FAILURE MODE EFFECT ANALYSIS

Makes sure, that all thinkable possible problem- and defect-areas will be identified. On this basis solutions must be developed and implemented to prevent such problems completely.

Mile Stone Plan

Normally the Time to Market for a product like for example a seat actuator is assumed to be 24-30 months. By a consequent and systematic application of Project Management and the use of all sophisticated PM Tools/Techniques the TTM can be reduced on the average by 50% and sometimes even more (based on more than 7.000 projects completed).

Besides this Master Mile Stone Plan, detailed Activity Time Schedules have to be prepared and systematically actualized at least once a month. This must be done not only for the internal activities but also for jobs which the key suppliers have to complete.

The consequent continuous control check of the master Mile Stone Plan as well as the detailed Activity Time Schedules created the best basis for meeting all time targets by immediate corrective actions, if necessary.

FMEA – Failure Mode Effect Analysis

FMEA is a best proven systematic method to

- detect failure possibilities
- define failure reasons
- evaluate failure risks and effects
- develop solutions to prevent / eliminate these failures and their effects

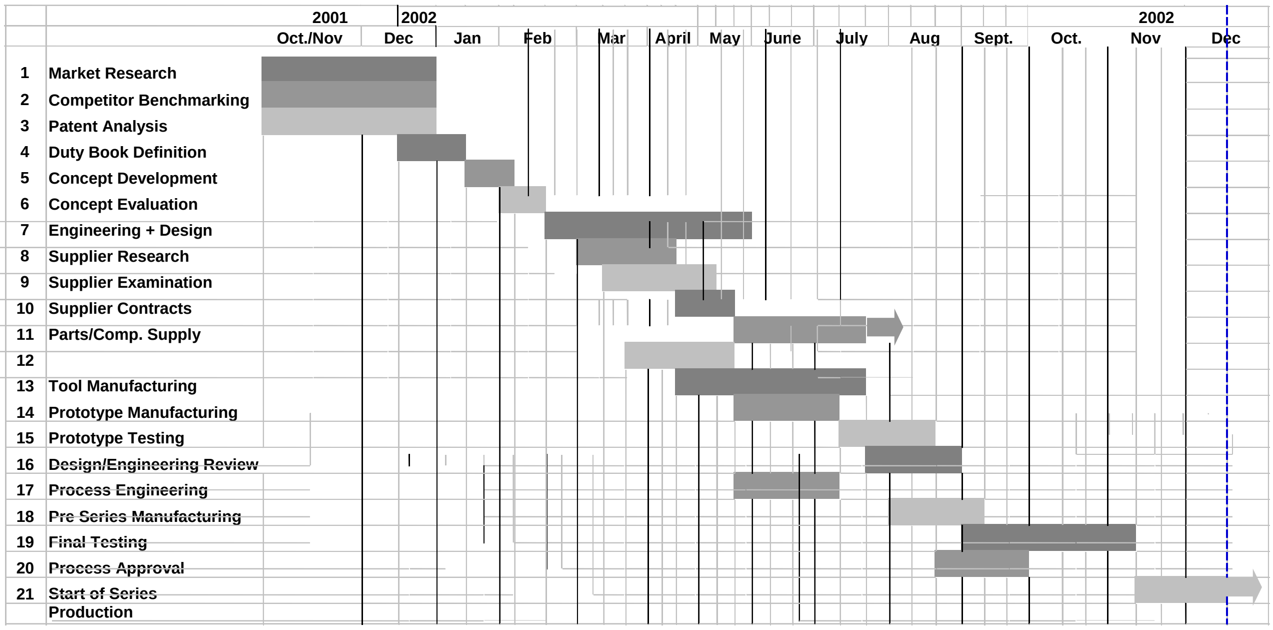

Figure 5: Master mile stone plan aircraft

BASIC FMEA FORM

FMEA No. System-FMEA Product

Product:			Date:
System Element: Function:			Department:

Pos.	Possible Failure Consequences	S	Possible Failures	Possible Failure Causes	Prevention Solutions	A	Detection Solutions	E	RF	R / D

A = Possibility of Appearance
S = Significance of Consequences
E = Probability of Discovery

R = Responsibility
D = Date
RF = Risk Factor

Attention: If the RF > 125 corrective actions must be developed and implemented.

Figure 6: Basic FMEA form

The FMEA is a continuous process completed in different steps throughout the different phases of a development project.

- Info Phase "Data Research FMEA"
- Function + Target Definition Phase "Duty Book FMEA"
- Engineering + Design Phase "Design FMEA"
- Supplier Definition Phase "Supplier FMEA"
- Manufacturing Phase "Manufacturing and Processing
- Implementation Control Phase "Implementation FMEA"

This very well structured FMEA Procedure makes sure, that the new product performs all required functions from the very first moment on. Unnecessary additional costly and time consuming development and manufacturing loops will be avoided. This is one of the main reasons that the TTM can be reduced by approximately 50 %.

INTENSIVE KEY SUPPLIER INTEGRATION

A very important component of each development project, no matter of which kind, is the integration of the pre-selected key suppliers into the project as early as possible. It is of course clear that any supplier must be analysed and chosen very carefully.

The integration of key suppliers as part of a consequent Project Management includes a sophisticated Quality Process Control Program.

One very important lesson learned was that in any project the systematic and well organized integration of key suppliers into a project team may be of substantial importance for the success of a new product or service.

Project Description

Targets: **1. Main Functions and Components**
2. Cost
3. Weight

Main Functions	Components	Cost Target	Status of (Date)						Weight Target	Status of (Date)					
			1	2	3	4	5	6		1	2	3	4	5	6
I.	I. 1. 2. 3. 4.														
II.	II. 1. 2. 3. 4.														

Figure 7: Project control sheet

Zero Defects

Besides VE and the other sophisticated Management Tools, especially TQM should be trained with the suppliers in order to make sure, that they understand the quality requirements and policy. On this basis all parts and deliveries will be available exactly just in time (JIT) and with Zero Defects.

Marketing Strategy

The marketing strategy as well as the world wide operative marketing tools and measures have been developed by the VE-Project Steering Team as well.

Each key market requires different approaches, and also the distribution channels are quite different in Europe, USA, China and Japan.

SUMMARY

Using sophisticated PM Tools and Techniques offers the best potentials to achieve high and challenging targets like:

- innovation
- sophisticated solutions
- achievement of all function requirements
- zero defects, PPM
- reduction of TTM by 50% and more
- low weight
- low manufacturing cost
- profit as well as short pay back periods
- full customer satisfaction

REFERENCES:

Project Management and Pm Tools/Techniques; seminar handbook, 4th edition 2002

Drastic Enhancement of Companies' Competitiveness and Profit by the consequent Application of VE/VM as a Key Management Tool, Presentation during International conference of Hong Kong Institute of Value Management in May 1999

APQP – Advanced Product Quality Planning – a sophisticated way for value Management to add Value to Products and to create wealth for companies, Presentation during International conference of Hong Kong institute of value management in November 2000

Setting corporate Guidelines for VE in new Product development, presentation during XV Invest international conference in Mumbai / India in November 1998

FMEA – Failure Mode Effect Analysis, a key tool of Value Engineering to guarantee total function performance, prevent cost, achieve profit and Time to Market (TTM) targets, Presentation during 32nd SAVE international conference in October 1999

Development of a Safety child seat for cars by applying VE and other sophisticated management tools; Presentation During CEL International Conference IN Calgary in may 1999

Successful application of VE in the early design stage, Presentation during save international conference in San Antonio, USA in June 1999

Enhancement of the product design and development activities by applying the VE techniques and energizing the Value Methodology – a Success Story achieved in China, presentation during SAVE international conference in Reno, Nevada in June 2000

Value engineering techniques, applied team psychology and qs 9000 of the automotive industry - a combination to expand the value society horizons, Presentation during SAVE international Conference in Fort Lauderdale, Florida, USA in may 2001

Value engineering in the very early design stage – creating innovations of car mirror actuators and preventing development, engineering and manufacturing cost simultaneously; presentation during International VE Conference in Tokyo, Japan 2001

Project management – an excellent tool to reduce time to market by 50% for the aircraft industry, Aircraft interiors conference. Hamburg, Germany – April 2002

Budget planning and control for company wide VE / VM activities guarantees remarkable continuous and growing profit margins, presentation during international conference in Tokyo, Japan 2002

A LOGICAL VALUE MANAGEMENT TECHNIQUE: FUNCTION IDENTIFICATION

Dr. Mei-yung Leung
Councillor, HKIVM

A free seminar on "A Logical Value Management Technique: Function Identification" was jointly organised by HKIVM, CityU and The Institute of Maintenance and Building Management (HK Branch)" in the City University of Hong Kong on 25th July 2007. Our Council Members Dr. Mei-yung Leung, introduced the concept, history and function identification techniques of VM in this seminar A group of some 50 people attended the workshop.

About the speakers

Dr. Mei-yung Leung BSc(Hons) UK, BRS Rome, PhD HK, MCIOB, MAIB, MHKIS, MRICS, CVS, MHKIVM

Dr. Leung is currently an Assistant Professor, Department of Building and Construction, City University of Hong Kong. She is a Chartered Quantity Surveyor by profession. She is also a Certified Value Specialist of the SAVE International: The value society in U.S.A. and Qualified Facilitator (List A) of HKIVM. She acted as a Qualified Facilitator for numbers of VM Workshops and as a Principle Investigator for numerous external and internal funding research projects.

(From Left to Right)
Representative of HKICW;
Chairman of IMBM (HK Branch), Mr. Davis Tsang;
Vice-Chairman of IMBM (HK Branch), Mr. Tang, Chi-wang;
Speaker, Dr. Leung, Mei-yung;
Representative of CIAT (HK Centre);
Representative of ICW (HK Branch);
Representative of HKIPM;

Group presentation

Group discussion

Group discussion

Group discussion

HKIVM news and events

- 24 April 2007, A luncheon seminar named “Making VM Work when Time is Short” was held in Hong Kong Club. The speaker, Mr. K.H. Fok from Evans and Peck (Hong Kong), is an experienced Value Management Facilitator (HKIVM List A Facilitator) and he has worked on various types of civil engineering projects and foundation projects for over 20 years.
- 25 July 2007, A free seminar named "A Logical Value Management Technique: Function Identification" by Dr. Dr. Mei-yung Leung was jointly organised by HKIVM, CityU and The Institute of Maintenance and Building Management (HK Branch)" in the City University of Hong Kong. This seminar was attended by over 50 construction professionals.

APPLICATION FOR MEMBERSHIP OF THE HKIVM

If you are interested in knowing or joining the Hong Kong Institute of Value Management (HKIVM), please download the membership application form from the Institute's website http://www.hkivm.com.hk. Alternatively, please fill in the reply slip below and return it to the membership secretary of HKIVM.

Membership requirements are as follows:

Member (MHKIVM) — This classification is available to individuals who can demonstrate an acceptable level of knowledge and experience in the field of Value Management. For admission, details on the Application Form are to be completed and copy of CV outlining professional employment, experiences and value management background enclosed. **Value Management Background** incorporating details of VM training and courses in VM process, application and techniques, number of studies, types of studies, role in process, days and dates should be stated clearly in the CV.

Associate Member — The Associate Member classification is available to any individual who can demonstrate interest in the objectives of HKIVM, but may not have had sufficient Value Management experience to qualify as a Member.

✂ -

REQUEST OF THE HKIVM MEMBERSHIP APPLICATION FORM

To: Training, Accreditation and Membership
Dr. Mei-yung Leung
Department of Building and Construction
City University of Hong Kong
Tat Chee Avenue, Kowloon, Hong Kong
Tel. (852) 2788 7142, Fax (852) 2788 7612
Email: mei@hkivm.com.hk

Please send an application form for membership to the undersigned:

Full Name: ____________________

Company: ____________________ Position: ____________________

Address: ____________________

Email: ____________________

Tel: ____________________ Fax: ____________________

Date ____________________ Signature: ____________________