



A Role-Based Design Performance Measurement Matrix for Improving Design Performance

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This paper describes an investigation of a role-based Design Performance Measurement (DPM) matrix that incorporates design performance measures with three design team role-players: the top design manager, the middle design manager and the designer. Based on the author's previous research, a DPM matrix combining 25 criteria was developed to support DPM operation during a design process. A questionnaire survey was conducted to establish if different design team members would have diverse perceptions of the importance of 25 DPM criteria for the three types of design team roles. As a result, a role-based DPM matrix was developed, which demonstrated that the 'clear team goal' criterion should be regarded as the most important measure for the assessment of top design manager; the 'problem solving', 'delivering to the brief', 'managing mistakes', 'build high morale within team', 'monitor team performance' and 'define design responsibilities' for the middle design manager; the 'high quality product design' and 'adding perceived value to the design work' for the designer. Furthermore, a role-based DPM matrix application was developed that enables the role-based DPM matrix to be flexibly implemented in different design projects by matching a project's features from three perspective: a design project strategies-based perspective, a stage-based design objectives perspective, and from a design staff role-based perspective.

INTRODUCTION

Design management is increasingly regarded as an important concept in the design industry, emphasizing the need for certain managerial activities and skills to optimize the design process and improve design performance (Chiva & Alegre, 2009). With the rapid growth of

global competition, design process is becoming more and more complex, due largely to cross-functional team collaboration, dynamic design processes, and unpredictable design outcomes (Shen et al, 2008; Brookes and Backhaus, 1998). Due to such complexity, many design management studies concentrated on supporting and improving design efficiency and effectiveness during a design process (Naveh 2005; Hull, 2004; Hertenstein et al, 2001). Among these studies, many researchers have stressed the potential benefits of appraisal in design project performance, such as motivating design staff to achieve a positive business outcome, supporting decision-making, fostering organisational learning and continuous improvement (Chiesa et al, 2009; Busseri & Palmer, 2000). Furthermore, the significance of appropriate design performance measures in the success of design projects has been particularly highlighted (Carbonell-Foulquié et al, 2004). Therefore, a number of Design Performance Measurement (DPM) criteria have been identified and investigated from diverse perspectives to support DPM operation (Moultrie et al, 2007). Although the contributions of the identified DPM criteria studies are notable, few of them have considered the influence of team-roles on performance measurement criteria design. A great deal of research has emphasised the importance of role theory in project management, and suggests that the features of team-roles should be utilized as the basis for job descriptions, as well as for specifying project expectations, performance requirements, and measurement (Van Dyne et al, 1995; Ilgen & Hollenbeck, 1992). Despite this recognition of the importance of team-roles, and the fact that employees choose to perform multiple roles in their design teams, research has continued to measure design performance as if only single roles apply. As a result, by relying on the evaluation of only those work behaviours defined by an organisation as relating to a specific job, performance systems may exhibit deficiencies (Welbourne et al, 1998). Bourne et al (2000) point out that, to correct this measurement error, performance management systems need to account for multiple roles at work. Thus, there is a significant need to incorporate the concept of the team-role into a theory of DPM, so as to improve the accuracy of design performance results.

RESEARCH AIM

The study presented in this paper, based on the authors' previous research (Yin et al, 2011). It focused on the impact of diverse design team-roles on the design of DPM criteria. More specifically, in our previous research, a DPM matrix (Table 1) was established for key performance criteria, and this can be used for measuring design performance during a design process. 25 DPM criteria, which address five DPM indicators (efficiency, effectiveness, collaboration, management skill, and innovation) have been highlighted as the most critical factors for design performance measurement. Following the indicated suggestions of a possible significant impact from team-roles on DPM operation, the present study aims to develop a role-based DPM matrix, which can support design managers in improving the accuracy of performance measurement outcomes, by linking DPM criteria with three identifiable team-roles in a design team: those of the top manager, the middle manager, and the designer. These three roles were selected because they were broadly agreed to be the

essential components of design project teams, both in the design industry and in academia (Prasad, 1996; Bullinger et al, 1994). In this study, design was interpreted as an integrated product design and development process, which involves many participants from different disciplines and requires team members with varied knowledge and experience to work together (Adopt from Girard & Robin, 2006). In practice, the research concentrated on measuring and improving design performance from a project-level perspective.

Table 1: Design Performance Measurement Matrix

	Most Important → Less Important				
Efficiency	Decision-making efficiency	Problem solving	Personal motivation	Ability to work undertake pressure	R&D process well planned
Effectiveness	Delivering to the brief	Personally responsible/work ownership	Understand design rationale	Fast and detailed feedback	Managing mistakes
Collaboration	Clear team goal/objectives	Information sharing	Communication quality	Cross-functional collaboration	Shared problem-solving
Management Skill	Decision making	Define/fully understand role/s and responsibilities	Build high morale within team	Conflict management	Monitor/evaluate team performance
Innovation	Competitive advantage	Select the right creativity concept to implementation	Products lead to future opportunities	High quality product design	Perceived value

LITERATURE REVIEW

Design performance measurement

In the design management research field, many researchers have emphasised the potential benefits of DPM on design projects and concentrated on improving design performance by operating performance measurement activities (Mallick et al., 2005; Bryant et al., 2004; Huang et al., 2003). Implementing appropriate performance measurement has many advantages, such as motivating people, supporting decision-making, fostering organisational learning and continuous improvement (Neely et al, 2005). Additionally, performance measurement can be operated to influence project staff's behaviour to achieve a positive business outcome. For these reasons, many companies have spent considerable time and resources redesigning and implementing performance measurement positively to reflect their current environment and strategies (Kennerley & Neely, 2003).

With the intention of developing a successful DPM method, many researchers have focused on investigations of DPM criteria, because well-defined criteria ensure an understanding of the intent and expectations of design tasks, and increase the quality of team communication in the design process (Hart et al, 2003; Suomala & Jokioinen, 2001). These studies can be divided into two categories: product-focused DPM criteria; and project-focused DPM criteria (O'Donnell and Duffy, 2002). The former concentrate on exploring key factors of success and failure in New Product Development (NPD) and essential DPM criteria, such as market share, investment return rate, and customer feedback (Loch et al, 1996); and the latter focus on an investigation of efficiency and effectiveness-based, planning-based and product life-cycle duration-based measurement (Buganza & Verganti, 2006; Kušar, 2004; Salter & Torbett, 2003; Nachum, 1999). Although the contributions of these existing DPM criteria studies are notable, few of them have considered the influence of team-roles on design performance measurement.

Design team roles

Role theory has been well discussed in psychology, social psychology, sociology, organization behaviour, and human resource management research fields (Willcocks, 2006; Welbourne et al, 1998). Related researchers from these various fields have concluded that roles play an important part in social structure, and roles have been recognized as central to understanding and appraising employee behaviour in organizations (Partington & Harris, 1999; Fondas & Stewart, 1994). Especially in the performance measurement research area, a great deal of research has highlighted the influence of role theory on performance measurement operation. For instance, Welbourne et al (1998) have emphasized that an important contribution of role theory to performance management was its ability to provide direction for avoiding measurement errors in performance appraisal tools. Consequently, role theory recommends that the design of performance measurement criteria should consider differences in organizational requirements of specific job-roles (Blenkinsop & Maddison, 2007).

In a design project team, there are three essential team roles: the top design manager, the middle design manager and the designer (Prasad, 1998). These roles have various responsibilities and work focuses during a design project development process. Cooper & Press (1995) summarised the key duties of these three design team roles from multiple perspectives such as strategy; policy; programmes and procedures; people; structure; culture; and climate. For example, top design managers are responsible for providing direction, in terms of the programmes to be followed, in order to achieve strategic goals. The middle design manager's responsibilities involve setting design objectives for corporate communications, product and environments, having them approved by senior management, then developing strategies for achieving those objectives. Finally, designers at the design activity level can contribute to the project by setting up all procedures related to management control of design jobs, understanding the design needs of consumers, enabling the development of design objectives and strategies that are relevant and flexible, and responding

to changes in the market place and in design trends. These variations in responsibility between the three design team-roles make it very clear that their design performance should be measured against their team-role responsibilities and based on customized DPM criteria rather than generic and uniform measures. Therefore, this study aims to explore a role-based DPM criteria matrix that can match different design team-role responsibilities in turn, to produce more precise DPM results. Practically, based on our previously develop DPM matrix, this study explored 1) if there is a need to differentiate the importance of the 25 DPM criteria for different DPM users, and 2) relationships between the three design team roles and the 25 DPM criteria.

METHODOLOGY

In order to explore the identified research questions, a questionnaire survey was conducted with design managers and designers from industry. More specifically, 30 questions were designed to explore participants' opinions about the importance of 25 DPM criteria for each of the three design team roles. Four close-ended questions were designed to understand participants' background, 25 ranking questions were designed to classify the priorities of 25 DPM criteria for the three role players, and one open-ended question was designed to collect participant's suggestions and comments for this study. In addition, in the 25 close-ended classification questions, the participants were asked to rank the importance of the 25 DPM criteria with 1, 2, and 3 for the three design project team role players, where 1 denoted less important and 3 very important. A pilot study was then conducted with four participants to test and improve the questionnaire design. After the pilot study, the questionnaire survey was conducted via email, using contact details from web-based design company and research institute directories. 200 invitation emails were sent out, and 40 valid feedbacks were received, which comprised 14 from designers, 13 from middle design managers, and 13 from top design managers.

Among the 40 participants, 52.50% were working in design consultancies, and 47.50% were working in product design companies when they answered the questionnaire survey. Additionally, 40% of them focused on industrial design, 20% respondents concentrated on design management, 17.50% focused on design strategy, 15% focused on design research and the other 7.50% concentrated on engineering design.

FINDINGS

Based on the results of the questionnaire survey, Table 2 summarises feedback from the participants. Table 3 simplifies Table 2 in order to highlight the key results.

Table 2 DPM results from different design project role players

DPM items	Criteria		Respondents	Individual Designer		Middle DM		Top DM	
				Mean	Std. D	Mean	Std. D	Mean	Std. D
Efficiency (E)	E ₁	Ability to work undertake pressure	Individual staff	2.36	.842	2.07	.475	1.57	.938
			Middle DM	2.08	.954	1.77	.599	2.15	.899
			Top DM	2.13	.725	2.23	.725	1.54	.877
	E ₂	Decision-making efficiency	Individual staff	1.36	.633	2.00	.555	2.64	.745
			Middle DM	1.46	.877	1.92	.277	2.62	.768
			Top DM	2.16	.947	1.92	.494	2.03	.870
	E ₃	Personal motivation	Individual staff	2.07	.997	2.14	.363	1.79	.975
			Middle DM	1.92	.862	2.38	.650	1.69	.855
			Top DM	2.08	.862	2.15	.689	1.77	.927
	E ₄	Problem solving	Individual staff	2.07	.917	2.43	.646	1.50	.650
			Middle DM	1.77	.725	2.46	.660	1.77	.927
			Top DM	2.08	1.038	2.15	.555	1.77	.823
	E ₅	R&D process well planned	Individual staff	1.71	.726	2.50	.650	1.79	.893
			Middle DM	1.62	.961	2.08	.494	2.31	.855
			Top DM	1.69	.630	2.00	.927	2.23	.913
Effectiveness (EE)	EE ₁	Delivering to the design brief	Individual staff	2.14	.949	2.29	.469	1.57	.852
			Middle DM	2.08	.760	2.46	.660	1.46	.776
			Top DM	2.15	.801	2.31	.751	1.54	.776
	EE ₂	Fast and detailed feedback	Individual staff	2.33	.646	2.43	.514	1.14	.535
			Middle DM	2.08	.862	2.38	.650	1.54	.776
			Top DM	2.23	.832	2.00	.707	1.77	.927
	EE ₃	Managing mistakes	Individual staff	1.21	.579	2.71	.469	2.07	.616
			Middle DM	1.54	.776	2.46	.660	2.00	.816
			Top DM	1.69	.947	2.23	.599	2.08	.862
	EE ₄	Personally responsible/ work ownership	Individual staff	1.93	.917	1.86	.535	2.21	.975
			Middle DM	2.00	.913	2.31	.439	1.92	1.038
			Top DM	2.08	1.038	2.23	.439	1.69	.855
	EE ₅	Understand design rationale	Individual staff	1.71	.914	2.29	.469	2.00	.961
			Middle DM	2.15	.899	2.00	.577	1.85	.987
			Top DM	1.92	.862	2.00	.862	2.08	.816
Collaboration (C)	C ₁	Clear team goal/objective	Individual staff	1.36	.745	2.21	.426	2.43	.852
			Middle DM	1.62	.650	2.00	.650	2.38	1.000
			Top DM	1.54	.776	2.00	.519	2.46	.913
	C ₂	Communication quality	Individual staff	1.71	.726	2.57	.514	1.71	.914
			Middle DM	1.54	.660	2.54	.660	1.92	.862
			Top DM	2.31	.899	1.85	.630	1.85	.899
	C ₃	Cross-functional collaboration	Individual staff	1.57	.852	2.50	.650	1.93	.730
			Middle DM	1.77	.725	2.62	.768	1.62	.650
			Top DM	2.23	.725	1.38	.650	2.38	.768
	C ₄	Information sharing	Individual staff	1.64	.745	2.36	.497	2.00	1.038
			Middle DM	2.38	.768	2.23	.599	1.38	.768
			Top DM	2.38	.768	2.23	.725	1.38	.650
	C ₅	Shared problem-solving	Individual staff	1.71	.914	2.50	.519	1.79	.802
			Middle DM	1.77	.832	2.23	.599	2.00	1.000
			Top DM	2.38	.870	2.08	.641	1.54	.776
Management Skill (M)	M ₁	Build high morale within team	Individual staff	1.43	.646	2.64	.497	1.93	.829
			Middle DM	1.62	.768	2.38	.650	2.00	.913
			Top DM	1.54	.776	2.54	.660	1.92	.760
	M ₂	Conflict management	Individual staff	1.43	.646	2.36	.497	2.21	.975
			Middle DM	1.69	.855	2.31	.630	2.00	.913
			Top DM	2.46	.832	1.77	.660	1.77	.832
	M ₃	Decision making	Individual staff	1.29	.611	2.50	.519	2.21	.802
			Middle DM	1.38	.650	2.15	.519	2.46	.899
			Top DM	2.31	1.013	1.92	.494	1.77	.855
	M ₄	Define/fully understand role/s and responsibilities	Individual staff	1.93	.730	2.43	.646	1.64	.929
			Middle DM	1.54	.877	2.46	.519	2.00	.816
			Top DM	1.77	.832	2.38	.650	1.85	.899
	M ₅	Monitor/evaluate team performance	Individual staff	1.14	.363	2.36	.497	2.50	.760
			Middle DM	1.38	.768	2.46	.519	2.15	.801
			Top DM	1.69	.947	2.38	.506	1.92	.862
Innovation (I)	I ₁	Competitive advantage	Individual staff	2.07	.929	2.36	.616	1.57	.756
			Middle DM	2.08	.954	2.15	.376	1.77	1.013
			Top DM	1.92	.801	1.92	.760	2.15	.954
	I ₂	High quality product design	Individual staff	2.14	.949	2.00	.555	1.86	.949
			Middle DM	2.32	.870	1.62	.480	2.08	.954
			Top DM	2.62	.650	2.31	.480	1.08	.277
	I ₃	Perceived value	Individual staff	2.36	.842	1.86	.663	1.93	.917
			Middle DM	2.08	.954	2.00	.577	1.92	.954
			Top DM	2.23	.913	2.00	.725	1.77	.832
	I ₄	Products lead to future opportunities	Individual staff	1.21	.426	2.07	.616	2.71	.611
			Middle DM	1.46	.776	2.08	.494	2.46	.877
			Top DM	2.31	.725	1.92	.760	1.77	.947
	I ₅	Select the right creativity concept to implementation	Individual staff	1.86	.949	2.21	.426	1.93	.997
			Middle DM	1.31	.751	2.15	.376	2.54	.776
			Top DM	1.62	.650	2.08	.855	2.31	.862

As shown in Table 3, the three design team role players shared some common opinions. For example, they thought that *delivering to the design brief* was more important for the middle design manager in comparison with the other two roles. In contrast, they also had opposing opinions. For instance, the top design managers believed that *ability to work under pressure*

was more important to the middle design managers, but the middle design managers thought it should be more essential for the top design managers. Moreover, the individual designers considered this DPM criterion was more important for them. The sections below present the details of their common and opposite opinions.

Table 3 Different perspectives for a role-based DPM matrix

DPM items	Criteria		Individual designer	Middle manager	Top Manager
Efficiency (E)	E ₁	Ability to work undertake pressure	I	T	M
	E ₂	Decision-making efficiency	T		I M
	E ₃	Personal motivation		I M T	
	E ₄	Problem solving		IMT	
	E ₅	R&D process well planned		I	MT
Effectiveness (EE)	EE ₁	Delivering to the design brief		IMT	
	EE ₂	Fast and detailed feedback	T	IM	
	EE ₃	Managing mistakes		IMT	
	EE ₄	Personally responsible/work ownership		MT	I
	EE ₅	Understand design rationale	M	I	T
Collaboration (C)	C ₁	Clear team goal/objective			IMT
	C ₂	Communication quality	T	IM	
	C ₃	Cross-functional collaboration		IM	T
	C ₄	Information sharing	MT	I	
	C ₅	Shared problem-solving	T	IM	
Management Skill (M)	M ₁	Build high morale within team		IMT	
	M ₂	Conflict management	T	IM	
	M ₃	Decision making	T	I	M
	M ₄	Define/fully understand role/s and responsibilities		IMT	
	M ₅	Monitor/evaluate team performance		IMT	
Innovation (I)	I ₁	Competitive advantage		I	MT
	I ₂	High quality product design	IMT		
	I ₃	Perceived value	IMT		
	I ₄	Products lead to future opportunities	T		IM
	I ₅	Select the right creativity concept to implementation		I	MT

I=data from Individual designer, M= data from Middle manager, T= data from Top manager

Convergent opinions

As shown in Table 4, ten DPM criteria received the common opinions. Firstly, ‘Clear team goal/objective’ was selected specifically for top design managers because they usually took charge of a macro level of strategic management. More specifically, the top design managers are key decision-makers for project strategies and objectives, and their major responsibility is to orient teams towards common strategic objectives which could be achieved by having clearing team goal/objectives. In addition, top managers could clearly indicate team goals so

that NPD cycle time could be reduced and the team members' emotional reaction could be improved. Secondly, seven DPM criteria were identified for the middle design managers probably because they play a very crucial link between top design managers and individual designers. In addition, their responsibilities become more important as the complexity of the design projects increased. Moreover, the middle design managers, who are responsible for improving everyday tasks and supervising individual designers, play the most important part in design development and have a big impact on final design performance. Thus, the middle managers' responsibilities are not replaceable by top design managers or individual designers, and the middle design managers are expected to satisfy both top managers and individual designers. Consequently, they should have high-quality skills in problem-solving, managing mistakes, monitoring/evaluating team performance, and so on. Ultimately, individual designers are those who effectively design the products, create and add design value to the products. Thus, their innovation performance has an important influence on final product design performance.

Table 4. The important DPM criteria with common opinions

Design Team Role Player	Same opinions of the important DPM criteria
Top Design Manager	Clear team goal/objective
Middle Design Manager	Personal motivation, Problem solving, Delivering to the brief, Managing mistakes, Build high morale within team, Monitor/evaluate team performance, and Define/fully understand role/s and responsibilities
Individual Designer	High quality product design, Perceived value

Divergent Opinions

The diversity of these results indicates that the three design team role players had different opinions about the relative importance of DPM criteria and the three design team roles. It seems that experience in different roles raised different expectations of the other roles. For example, the top design managers believed that the ability to work under pressure was more important for the middle design managers, but the middle design managers considered it should be more important for the top design managers. This result implies that the middle design managers should have a high ability to work under pressure as they always work with a high level of responsibility. Conversely, the middle design managers believed that the top design managers were under higher pressure than them. Figure 1 presents various expectations from different design team role players. And the list below summarised key conflicting opinions from the three design role players.

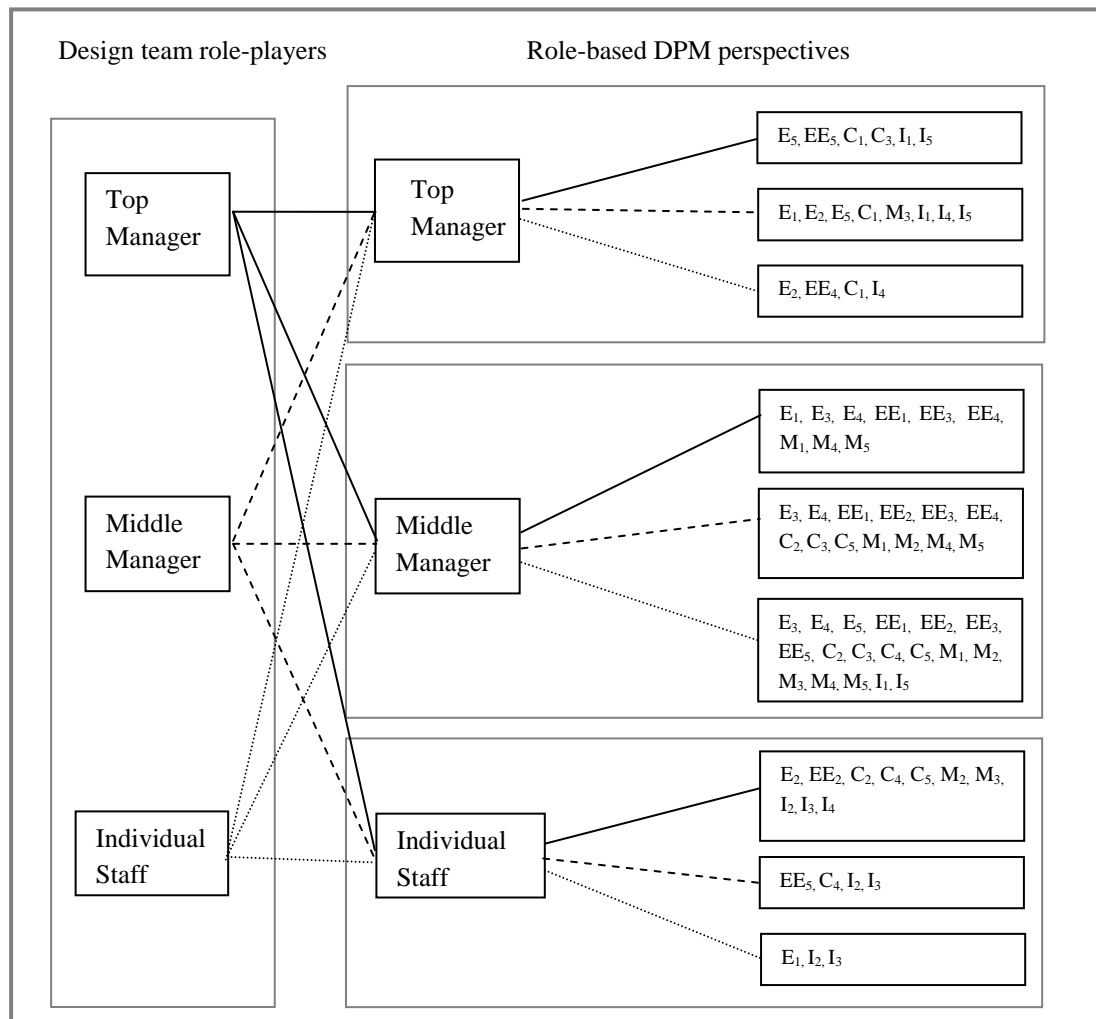


Figure 1. A role-based DPM matrix

- Efficiency performance- E₁: Ability to work under pressure
 - Top design managers thought E₁ was more important to middle design managers when compared with individual designers and top design managers
 - Middle design managers regarded E₁ was more important to top design managers when compared with individual designers and middle design managers
 - Individual designers thought E₁ was more important to them when compared with top and middle design managers
- Effectiveness performance - EE₅: Understand design rationale
 - Top design managers thought EE₅ was more important to top design managers when compared with individual designers and top design managers
 - Middle design managers thought EE₅ was more important to individual designers when compared with middle design managers and top design managers

- Individual designers thought EE_5 was more important to middle design managers when compared with individual designers and top design managers
- Management skill performance - M_3 : Decision making
 - Top design managers thought M_3 was more important to individual designers when compared with middle design managers and top design managers
 - Middle design managers thought M_3 was more important to top design managers when compared with individual designers and middle design managers
 - Individual designers thought M_3 was more important to middle design managers when compared with individual designers and top design managers

DISCUSSION ON ROLE-BASED DPM MATRIX APPLICATION MODEL

Based on the results of the questionnaire survey, it has been demonstrated that design team members do have diverse apprehensions of the 25 DPM criteria for the three design team role-players. Several convergent and divergent opinions referring to the significance of the criteria for the three design roles were summarised. These results offer design team members a better understanding of how their responsibilities have been perceived from within other roles, and may help to avoid potential communication conflicts and improve team collaboration. The matrix will support design managers in setting up role-specific DPM criteria for the top design manager, the middle manager and the designer, which could enable DPM operations to be linked to diverse design team role features, so as to produce more precise DPM results, with which to lead design performance.

A review of the literature indicates that many studies have pointed out that failure to link project strategy in this way is a recognised barrier to the success of the performance measurement tool (Bourne et al, 2002). One of the major challenges that has been discussed was defining a set of measures that were clearly linked to the operational strategies of the project (Reilly et al, 2002). Neely et al (1997) suggest how to link DPM operations with a project's strategy from three levels: the set of criteria and performance measurement as a system; the relationship between the performance measurement system and its operational environment; and the individual performance measures. They also indicate the key to building up a successful DPM matrix is the assurance of a link between strategic objectives and performance criteria used at each level. Because complexity and uncertainty often feature in a design process, project strategies might need to be modified in the middle of the development process. Thus, if a DPM matrix could not be upgraded to match changes of project strategy, problems in project development could arise (Staw, 1981). A successful DPM matrix should be able to offer sufficient flexibility to match dynamic project strategies. Accordingly, based on the developed role-based DPM matrix and the foregoing recommendations, a role-based DPM matrix application model (Figure 2) was developed which addresses the application of the role-based DPM matrix at a design project system

level, by involving design project strategies; at an operational environment level, by accounting for the dynamic feature of the design process; and at an individual level, by considering each design staff member's role and responsibility.

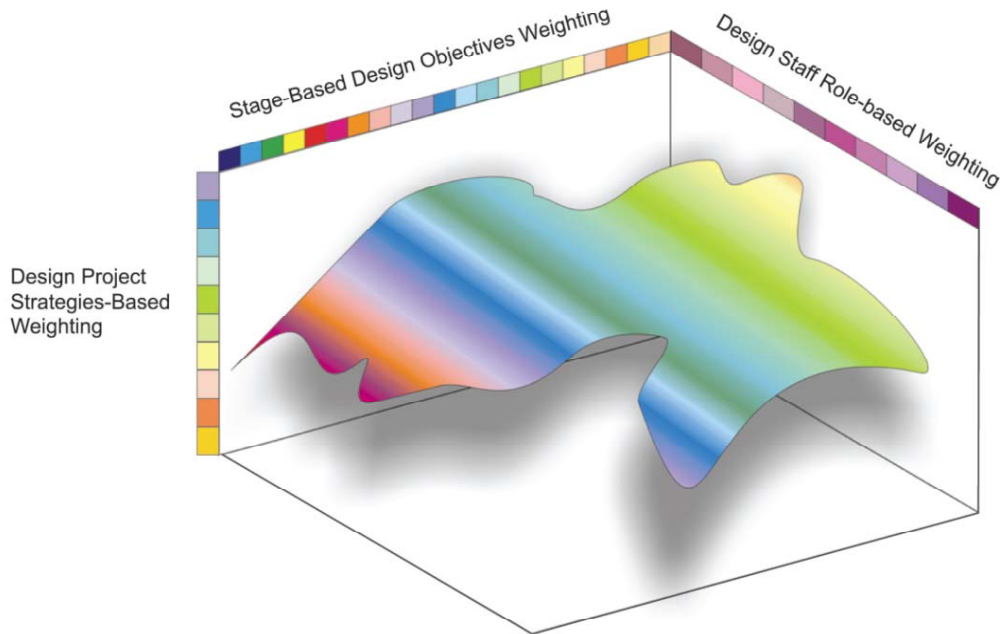


Figure 2. Role-based DPM matrix application model

CONCLUSIONS

In summary, a role-based DPM matrix was developed which incorporated DPM criteria into the hierarchical design team structure. In addition, it was found that *clear team goal/objective* is the most important DPM criterion for top design managers; *problem solving, delivering to the brief, and building high morale within team* for middle design managers; and *high quality product design and perceived design value* for individual designers. Furthermore, a role-based DPM matrix application model was developed to enable the role-based DPM matrix to be flexibly implemented in different design projects by matching a project's features from a design project strategies-based perspective (project system level), from a stage-based design objectives perspective (operation environment level), and from a design staff role-based perspective (individual level). The matrix and the application model will support design managers operating a role-based DPM implementation that can produce accurate DPM results, and in turn maximise support for improving design performance.

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