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## PROCESS PERFORMANCE MEASUREMENT SUPPORT: A CRITICAL ANALYSIS

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*Keywords: Design Management, Performance Management, Performance Metrics.*

### 1 Introduction

Design development processes, within engineering disciplines, lack the necessary mechanisms in identifying the specific areas where improved design development performance may be obtained. In addition, they lack the means to consider and align the goals and respective performance levels of related development activities with an organisation's overall goals and performance levels. Current research in organisational performance behaviour, formalised through performance frameworks and methodologies, has attempted to identify and focus upon those critical factors which impinge upon a wealth creation system while attempting to, simultaneously, remain representative of organisational functions, processes, people, decisions and goals. Effective process improvements remain conditional upon: the ability to measure the potential performance gains which may result from an improvement initiative; the ability to understand existing process dynamics and in turn understand the subsequent impact of some change to a system/process; and, the ability to identify potential areas for improvement. The objective of this paper is to discuss some of the management techniques, which are purported to support various process performance concerns and perspectives, and present the major factors that remain unsupported in identifying, measuring and understanding design process performance.

### 2 Process Performance

Engineering design development processes involve designers developing product designs that possess the potential to meet the requirements of both prospective customers, and the specific standards delineated through internal and external influences. In addition, designers must be guided and controlled by the needs and strategic intentions of an organisation placed in a local context through the directives and focus of middle management. Design development processes are responsible for not only achieving and delivering the required output, from various internal and external perspectives, but must produce an output or product design that has the potential to be delivered to the customer in the form of a product, through subsequent development stages: at an efficient cost when placed in the context of market price; at an optimum point of market entry to satisfy customers delivery requirements and ahead of market competition; at a level of quality that the customer is at least expectant of while superior to market competitors in the aspects that a market will base its decision to purchase; and, that will support the long term survival of an organisation and the financial health expected by shareholders [1]. Thus, designers and design development managers must acquire, modify and/or generate the information that enables them to manage design

processes/activities and design products that: firstly, align with, and satisfy, the required dimensions of organisational performance and that are congruent with the goals and objectives of the associated product development process functions; and secondly, that will perform in the market place from such dimensions as generated sales to return on investment. Thus, design development activities are forced to consider not only their own output or deliverable, from the alignment of both internal organisational perspectives from strategic level objectives (macro) to design development goals (micro) and the objectives and standards associated with the external organisational environment, but must, in addition, produce a design deliverable that will remain congruent with the objectives and goals of subsequent, and indeed previous, development activities.

The statement that an organisation's core competencies are the building blocks of competitive advantage [2] brings to the fore the second, high level, concern of performance measurement, namely, that of how organisational strategies may be developed based on the strengths and weaknesses of lower level functions and processes [3]. Thus, the formulation of a strategy necessitates the need to understand the many relationships and interactions that may exist internally and externally to an organisation's environment i.e. identifying where major strengths and weaknesses, and opportunities/threats, are likely to arise.

From the discussion certain factors should be supported in order to determine the areas that a process or organisation should be utilising or improving upon (bottom up) and in measuring the levels of performance required to develop and deploy organisational strategies (top down). The following points explicate the fundamental components and requirements that would support in formulating strategies, based on performance levels obtained at a design development process level, and in guiding development activities by placing process specific goals in the context of realising high-level organisational strategies. Thus, the requirements presented refer to the means of getting high-level concerns and objectives down to a process level, and within their context, to feedback the information to an overall organisation level.

**Definition of Goals:** Design Development processes are, for the most part, subject to product requirements in terms of functional and behavioural considerations but lack support in placing these specific requirements or goals in context with organisational strategies and goals. From an improvement point of view the development and definition of goals infers that gaps or sub-optimal results have been identified. Thus, measurements relating to a process's level of performance are required to support in identifying what must be protected or improved upon to satisfy organisational objectives and customer expectations and requirements. High-level strategic goals or objectives need to be decomposed into process specific objectives, providing the ability to relate and align process performance measures with the needs and strategic direction or focus of the organisation, and in turn providing the ability to link company objectives to daily activities and decision making activities [4]. The following points identify why the setting of realistic and informed strategic objectives is required for the success of satisfying those objectives, and to an organisation's overall level of performance.

- *Alignment:* Consideration must be given to how high-level organisational objectives will be viewed at the process level and how they will effect (i.e. contribute or constrain) upon the specific goals and objectives of development functions and visa versa [5].
- *Congruency:* Objectives bring a focus to activities and processes and the sub-optimisation of activities, processes and products may occur as a result of project teams optimising solutions or process outputs to fit with their functionally specific objectives while being counter-productive to the outputs of other departments [6]. Therefore, outlining the goals

for one design development activity should be placed in a wider organisational context to assess its contribution or constraint on other functions achieving their goals.

- *Constraints and Contributors to Success*: The provision of objectives and the determination of how they may be realised aids in highlighting and distinguishing between obstacles that may restrain, or opportunities that may promote, the level of performance obtainable from within the focus of an objective [7] and provide the means to control the number of measures being required. It therefore remains pertinent to the success of outlining and satisfying goals that distinctions are made between constraints and contributors of the levels of performance and the specific dimensions of success.
- *Learning*: Objectives may be detailed that are ambitious, while yet achievable, in terms of their satisfaction but such ambitious ‘stretched’ objectives force personnel to think and analyse the sequence and structure of the process and the way work is carried out. The setting of goals requires that, firstly, the ability to determine what state an organisation, process, etc. is in (i.e. an ‘as is’ understanding) from which goals can be derived and, secondly that the organisation recognises where it wants to go or what aspects it wants to improve upon (developing a ‘to be’ understanding). Consideration should be given, therefore, to ensure that goals outlined are ambitious but that remain within the realms of feasible in terms of process, technology and personnel capabilities.

**Composition of Metrics**: In order to support the realisation of organisational goals, at various levels and considering the alignment, congruency, constraints and contributors of success, the identification and determination of the measures (metrics) that will help in checking the progress being made toward such goals and in determining whether such goals support higher organisational goals must be supported to determine how close you are to a target and how quickly you are moving toward a target [5]. The aim of controlling and defining the measures used at a process level, and maintaining the existence of a cascading effect is to promote a common direction, in terms of obtaining the best return on effort and work, toward common, higher level, objectives while considering the often functionally specific goals which may be beneficial to the function but not to the overall process performance level [8]. Current research in the area of performance measurement advocates the need to balance the mix of measures between high-level organisational dimensions while the identification, and application of appropriate metrics remains to be conducted erratically and intuitively.

**Overall and Sub-level Index**: Providing management and process level personnel with an inter-related and flexible method to specialise and generalise measures throughout an organisation, while maintaining the congruency and alignment of measures, provides the ability to obtain an overall sense of improvement or detriment at various organisational levels and the means to specialise their focus to identify (sub) optimal performance. The ability to generalise from lower levels of an organisation to drive an overall performance index enables: the identification of contributors and retractors of performance; the ability to compare the performance of distinct departments, functions etc.; and, allows management to generalise and specialise their focus or concerns providing the means to control the range of measures in reflecting and supporting organisational strategic viewpoints.

**Relational structures**: The preceding points have all discussed the need to enable the relations between goals, metrics, organisational functions to be identified, quantified and structured. There is thus a need to: firstly, understand how the satisfaction of one goal will impinge upon other organisational goals identifying any conflict between goals; secondly, detail the structure of metrics throughout relevant functions of the organisation to provide focus and to identify the level of progress being made; and lastly, enable performance

measurements to reflect the structure of an organisation and the hierarchy of goals within. In addition, any person involved in an organisation has a perspective on the organisational system and therefore their goals may be different, or refer to distinct but affected or affecting goals. Thus, an organisational wide performance measurement system should relate between measures/metrics, goals/objectives and perspectives/viewpoints. While the identification of the relationships between performance related entities enables more informative decisions to be made, the need to identify their effects, i.e. positive or negative, relative to the perspectives, and the density of interactions are also important in determining the stability of a process and how changes made to improve performance will be received by other functions within an organisational system [9].

The existence today of a plethora of various performance measurement systems has indeed pushed our understanding of the constituent factors of organisational performance and given practitioners a multitude of issues and dimensions of performance to consider. However, at a fundamental level of performance, in determining organisational down to process levels of performance, we need to understand how do such performance measurement approaches, frameworks, formalisms and methodologies perform.

### 3 Performance Measurement Systems

The design and application of performance measurement systems has been, primarily, focussed on providing a means of controlling the development and deployment of strategic directions taken by organisations but in addition provides the means to identify the improvement requirements and the drive behind improvement initiatives [10]. Based on the requirements raised in the preceding section a sample of performance measurement systems have been reviewed (as summarised in Table 1) to determine the depth of support that is provided to those involved within such multiple consideration processes such as design development. For a more comprehensive analysis, including a detailed list of references used, see Haffey [11].

Table 1. Performance Measurement Systems Evaluation Matrix

		Requirements & Evaluation Criteria							
		Definition of Goals	Alignment	Congruency	Constraints & Contributors	Learning	Composition of Metrics	Index Levels	Relational Structures
P.M. Approaches	Balanced Scorecard	Intuitive	No	No	No	No	Intuitive	No	No
	BEM (EFQM)	Intuitive	No	No	No	No	Intuitive	No	No
	Cambridge Model	Intuitive	Intuitive	No	No	No	Intuitive	No	No
	Integrated P.M.	Intuitive	Intuitive	Intuitive	No	No	Intuitive	No	No
	Performance Pyramid	Intuitive	High level	No	No	No	Intuitive	Related	High level

The **Balanced Scorecard** is a framework that considers four organisational perspectives (Financial, Customer, Internal, and Innovation & Learning as shown in Figure 1) that are purported to provide both a balanced representation of, and the perspectives upon which to analyse, an organisation. Within each perspective a list of objectives, and in turn metrics, are defined and clustered allowing an organisation to develop its own specific “Balanced Scorecard”. The framework advocates a balance between financial and non-financial measures and it is purported that the analysis of the measures used will detail the strategy being deployed within an organisation. However, these measures and objectives are derived intuitively, and at user’s discretion, and at such specific and complex levels of consideration concern as to the most appropriate mix or balance of measures being used to support strategic objectives must be expressed. Thus, it lacks the necessary means to determine the right things are considered with the rationale associated with the measures used, such as time based or recognising when a measure becomes obsolete and is no longer required. Based on the requirements outlined previously in Section 2 the Balanced Scorecard provides no support in defining either organisation or process level goals and are therefore restrained in: maintaining the alignment and congruency of measures; identifying constraints to or contributors of success; and, providing the basis upon which to learn, identify and utilise competencies. The lack of support to identify applicable metrics in the context of organisational strategies provides no means of deriving process level sub indices from its four high level perspectives.

The **Business Excellence Model** (BEM), developed by the European Foundation for Quality Management (EFQM) provides practitioners with a framework that considers that the processes used to deliver people satisfaction, customer satisfaction and impact on society are attributable through leadership, controlling and defining organisational policies and strategies, managing people and allocating resources in order to produce excellence in its business results. Figure 2 shows the model, consisting of five *enablers* (what an organisation does i.e. Processes) and four *results* (what an organisation achieves i.e. Outputs or Goals), which is reported to provide the generic criterion that is deemed to assess an organisation’s progress toward excellence. Again the model provides a generic framework from which to intuitively derive the most appropriate goals and measures and lacks the depth to consider the alignment and congruency of goals and metrics and the potential to gain insights and learn from the constraints and contributors of success. The high level generic structure may provide overall indexes within results and enablers but relies on the intuitive extraction of measures to reflect operations at a process level and therefore provides no support in identifying what enablers are concerned with the achievement of results at lower more specific levels.

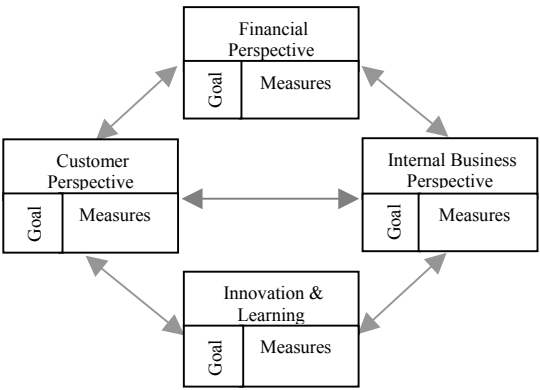


Figure 1. The Balanced Scorecard

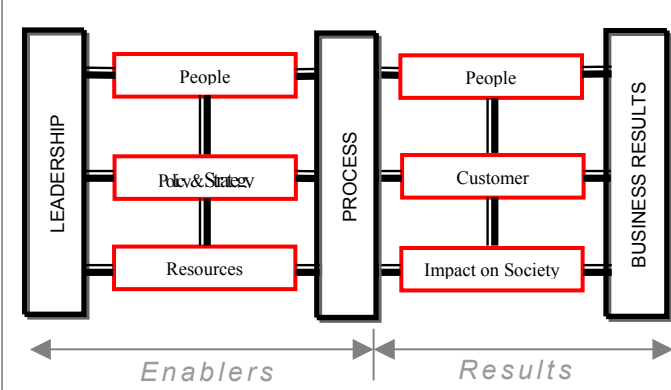


Figure 2. Business Excellence Model

A process which supports organisations in developing a performance measurement system, the **Cambridge Model** as shown in Figure 3, comprises of two, five part, phases that provide the skeletal framework upon which high level measures and concerns are used to derive lower level process level measures. Phase one supports the identification, design and implementation of high level, strategy orientated, performance measures where organisational objectives and their associated or related measures are agreed upon, based on specific product strategies, and embedded into high level organisational decision making activities. Phase two aids in cascading high-level objectives and measures down to the process level based upon the key performance indicators and drivers. The model supports users in navigating through the process of developing and relating goals and measures but again relies on the intuitive extraction of goals and measures and the recognition of how they relate across and through an organisational structure. The model does acknowledge the need to support in identifying the interactions between measures, within isolated organisational levels, but relies on a relational matrix to intuitively explicate their existence.

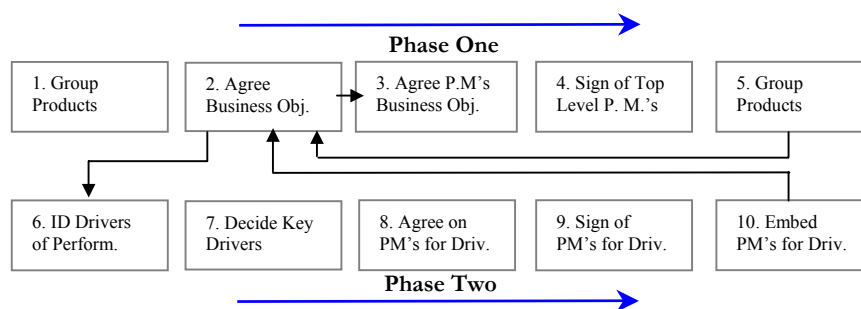


Figure 3. Performance Measurement System – Cambridge Model

A framework put forward by Nanni et al., **Integrated Performance Measurement**, emphasises the explication of relationships between an organisation's strategy, its actions and the utility of performance measures as shown in Figure 4. The framework refers to *integrated* as strategic-driven performance management through the congruency of actions across functional boundaries while in the context of strategic objectives. Their work argues the need for identifying process level goals and measures as derived from organisational strategies while they support the need to structure the goals and measures to align and be congruent within an organisational structure. However the framework proposed falls short of supporting the identification of appropriate goals, measures and their inter-relationships. In addition, they recognise the need to identify the constraints and contributors to success and in turn learn from the strengths and weaknesses of process capabilities. However, the framework lacks the ability to explicate such information.

The **Performance Pyramid** provides a means of deriving operational measures from organisational strategies. The approach outlines four levels within an organisation from the corporate vision, business units and business operating systems down to departments and identifies key, generic, dimensions within each level as outlined in Figure 5. The approach outlines four levels within an organisation from the corporate vision, business units and business operating systems down to departments and identifies key, generic, dimensions within each level. The key objectives reflect key concerns at each level and are related and broken down to lower level, more specific, objectives with the recognition for the measures, related to objectives, to be aggregated back up through an organisation to support the recognition of effort being focused on working toward the satisfaction of objectives. While the approach identifies the key dimensions (high level and related low level), which should be addressed and measured at a process level, it provides little support on how to identify and



integrate the relevant goals and measures. The approach does begin to address the need for the alignment of dimension goals/measures but lacks any depth in understanding their structure, interactions and cause and effect relationships and therefore restrains the potential opportunities to learn.

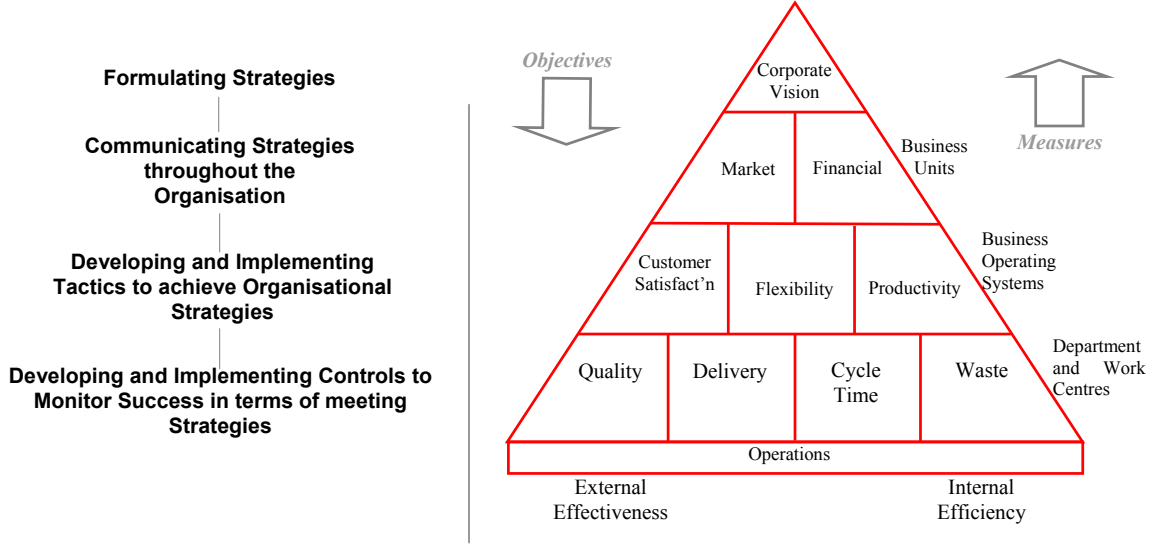


Figure 4. Business Management Cycle

Figure 5. The Performance Pyramid

In summary, system approaches and discussions on performance measurement have all concentrated on strategic objectives and considered high level generic dimensions but lack the contribution of how such performance dimensions can be deployed to a process level while relegating the modelling of processes in terms of ‘as is’ to a secondary requirement. Even at such high level considerations the information required to manage the concentration or reduction in the degree of effort along the dimensions factored in strategic foci is not generated and in some cases equal weightings and considerations within relevant dimensions is prescribed. The utility of performance measurement approaches have been focused upon, at a general level, one of determining the dimensions of performance that will support the focus of effort in realising strategic objectives and in determining organisational health. However, none support, explicitly or based on factual feedback, the mapping of goals needed to analyse and control processes in the context of organisational and process level objectives and thus lack the opportunities to stimulate learning, improve communication and affect behaviour. Work by O’Donnell and Duffy has contributed to the understanding of product development process performance, at a micro level, and provides a means for the alignment and congruency of objectives and measures in addition to providing the basis upon which to explore the relationships between the components of process performance [12 & 13].

#### 4 Conclusion

The ability of organisations to objectively set strategic goals, identifying the path along which such goals may be realised, requires a considerable degree of knowledge of the organisation, the environment within which it operates and the potential source from which major threats and opportunities are likely to arise. The complex nature of a design process requires consideration of the performance required from subsequent process activities in addition to its own and therefore need prescriptive information on the levels of performance both required and attainable. This indeed contributes to the complexity of the design process and emphasises the need to provide prescriptive decision-making information. In order to provide

such prescriptive information the need to support in understanding and learning what has happened, by understanding goal and metric structures and their interactions, and predicting what is about to happen must be recognised. However, based on an evaluation of existing performance measurement approaches a substantial lack of support exists that brings organisational objectives down to a process level and that aids the identification of measures to support the focus of effort toward their satisfaction. Thus, the opportunities to learn from past experiences and to map out and utilise the concept of causality is severely restricted.

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