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BEST PRACTICE ENGINEERING ASSET CULTURES - A PILOT STUDY

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For some time there has been a growing awareness of organizational culture and its impact on the functioning of engineering and maintenance departments. Those wishing to implement contemporary maintenance regimes (e.g. Condition Based Maintenance) are often encouraged to develop “appropriate cultures” to support the new method’s introduction. Unfortunately these same publications often fail to articulate the cultural values required to support the efforts of those behind the implementation. In the broader literature only a limited number of case examples document the cultural values held by engineering asset intensive firms and how they contribute to their success (or failure). Consequently a gap exists in our knowledge of what engineering cultures currently are, and what might constitute a best practice engineering asset culture. We report the findings of a pilot study investigating the perceived ideal characteristics of engineering asset cultures. Engineering managers, consultants and academics (n=47) were surveyed as to what they saw were essential attributes of both engineering cultures and of engineering asset personnel. Valued cultural elements included those orientated around safety and quality and commercial orientations. Valued individual attributes included openness to change, interpersonal skills and contentiousness. The paper concludes with a discussion regarding the development of a best practice cultural framework.

Key Words: Organizational Culture, Engineering Asset Management, Engineering Cultures

While the value and contribution of culture to an organization's success or failure is widely acknowledged, the complex nature of culture and its origins present some challenges for engineering asset managers. In relation to the management of engineering assets the most obvious barrier is the lack of information concerning ideal cultural archetypes for engineering and technical environments. The aim of this paper is to present the findings of a qualitative investigation into what senior managers and engineering personnel consider to be the key attributes of a best practice engineering asset culture. The paper begins by comprehensively defining organization culture before critiquing the current state of the engineering asset cultures literature. The results of a qualitative study investigating the perceived ideal characteristics of a best practice engineering asset culture are then presented and discussed.

1 DEFINING CULTURE

It would be rare to enter into a discussion with any manager or supervisor and not have them agree as to culture’s importance. Ask them to go one step further, to define what they mean by culture and the picture loses clarity. The strength of the culture construct is perhaps its greatest weakness in that while the notion of culture has received a high degree of acceptance within the organizational and popular press, a knowledgeable understanding arguably remains lacking among many. Anecdotally the author has observed that while many recognize the importance of a strong, organizationally aligned culture they also struggle to articulate what constitutes the various components that make up a “good culture”. A commonly used phrase to convey the notion of organizational culture is to say that culture is “the way we do things around here” [1]. While a useful sound-bite, this simplistic treatment of a complex organizational phenomena leads to a failure of understanding as to what organizational culture is and how it can be managed. Therefore it is important to adequately understand how culture is derived, what micro elements combine to produce a “culture” and to recognize the source elements that give culture the capacity in some instances to provide sustainable competitive advantage [2].

Typical definitions describe culture as a set of basic assumptions about the functioning of an organisation shared by the majority of employees that drive their perceptions, attitudes, feelings and behaviours [3]. A more sophisticated treatment of culture describes it as a general pattern of mindsets, beliefs and values that members of the organisation share in common, and which shape the behaviours, practices and other artefacts of the organisation which are easily observable” [4]. Others suggest that cultures develop as a learned, shared response problems experienced by group members over time [3]. As such cultures

are considered to be historically determined and socially constructed, holistic in their scope involving beliefs and behaviour, existing at multiple levels, and manifesting themselves in a wide range of features of organisational life [5,6].

Scholars have addressed the study of culture from three distinct approaches (See Table 1.0 below). Some like Schien [3] offer diagnostic frameworks to help break down and understand the discrete elements of culture. Schien [3] for example suggests that cultures, with increasing levels of complexity can be differentiated by their visible artefacts (logos, uniforms etc.), espoused values and behaviour, and finally the tacit assumptions held by organisational members concerning the way in which their world should operate. Others such as Deal and Kennedy [1] have developed what can be described as generic cultural archetypes, providing a set number of cultural profiles that may be applicable inside any one organisation, regardless of business type, industry or context. According to Deal & Kennedy's model organisations may identify with a "tough-guy, macho culture", or a "work hard, play hard culture" for example. The final approach has to been to develop a set of cultural attributes based around a specific context or target population. Examples of such work can be found in Reason's and Hobb's [7] work on safety cultures and Detert et al.'s [6] work on quality cultures.

Table 1
Approaches to the study of organisational culture

Diagnostic tools	Generic Cultural Archetypes	Specific Cultural Attributes
3 Levels of culture Schien [3]	Charles Handy [9]	Quality Cultures Detert et al.,[6]
	Deal & Kennedy [1]	Safety Cultures Reason [11]
Organisational Culture Profile O'Reilly et al. [8]	Competing Values Model Quinn & Rohrbrah, [10]	Entrepreneurship Cultures McGuire [12]

In a similar approach to the work carried out by Reason and Detert et al. on Safety and Quality respectively, it was considered useful to begin the development of a set of specific cultural attributes relevant to the engineering asset management context. Consequently the next logical step in the process was to review the literature dealing with engineering and technical cultures - this is reviewed briefly below.

2 WHAT DO ENGINEERING AND MAINTENANCE CULTURES LOOK LIKE?

A cursory review of the engineering cultures literature yields few sources of any real use to practicing engineering asset managers and supervisors. Those that do exist are limited in their scope or fail to provide adequate direction as to the desired cultural characteristics or the mechanisms by which organizations may wish to achieve them [13]. For example, Cooke [14] recently bemoaned the lack of attention paid to maintenance workforces despite their potential significant contribution to organizational success. Other limited examples do exist, such as Reiman, Oedewald and Rollenhagen's [15] work in developing a six component model of maintenance engineering culture in nuclear power plants (NPPs). Their model suggests the behavioral demands of anticipating, reacting and monitoring are driven by the three traits of flexibility, methodicalness and learning. While the investigation of maintenance cultures within NPP's is useful and clearly related to engineering asset management, the specific technical and political environment of nuclear plants tends to limit their work within that context. In their review of engineering work Treveleyan & Tilli [13] found a limited, fragmented and occasionally conflicting, literature. Overall they suggest that while accounts of engineering work exist, they tend to be normative in approach and fail to clearly articulate not just what engineers should do, but what they actually do.

The problem appears particularly acute when discussing the adoption and implementation of new maintenance regimes such as TPM, CBM and the like. A regular observation is the monotonous regularity with which practitioners and managers are encouraged to adopt a culture that supports the implementation of new regimes but are given little or no guidance as to what this culture may manifest itself as. The following quotes from two recent publications are offered as examples in which both advocate culture change but fail to provide guidance on the specific nature of that change.

“an overall quality maintenance strategy always calls for culture change, continuous improvement and training...” [16, p352]

“TPM necessitates an examination of corporate values and objectives and for many companies may require a substantial shift in management style to create a new workplace culture” [17, p329]

Professional institutes also appear to struggle with what culture is and how it should be represented within engineering asset intensive organizations. As an example, the Asset Management Council of Australia (AMC) annual excellence awards is one of the few to at least evaluate the culture of high performing engineering organizations. Their definition of culture is as follows “The extent to which all levels of the organization have the knowledge, skills and commitment to achieve the documented AM goals of the organization”.

The criteria used to evaluate this component are listed below:

- How are Asset Management goals deployed at all levels?
- Are these evident to all involved?
- Are the knowledge and skills necessary for achieving AM performance goals known by the enterprise?
- Is there a plan for the provision of AM knowledge and skills?
- Are the roles and responsibilities for those involved in AM clearly defined?
- How is performance of individuals and groups recognized and supported?

At one level the above accurately captures the presence (and to some degree the efficacy) of the communication and performance management tools used to initiate, shape and maintain culture. However, when compared to the culture definitions reviewed earlier it can be seen that the AMC definition and criterion fails to explore the desired shared values, behavioral norms and beliefs present within the organization. As a result it does little to identify the cultural attributes that may drive excellence in engineering practice. Consequently while examples like this are useful starting points, the manner in which they are operationalized limits the construct and struggles to identify the real source of power represented by organizational culture and desired by engineering asset and maintenance managers.

In summary, the disparate and occasional nature of studies devoted to engineering and technical cultures has prevented a unified theoretical approach to the problem of engineering asset cultures. While adequate theoretical definitions of culture exist, there is little empirical data to provide an indication of the “appropriate shared values, behavioral norms and beliefs” that might be of use in an engineering asset context. A suggested reason for the lack of documented examples of engineering asset cultures and the lack of understanding of engineering work in general is the cyclical problem of organizational researchers not understanding engineering, and engineers not conducting organizational research [18]. To this end it was considered important that we begin to understand what engineering asset and maintenance managers considered the essential elements of an engineering asset culture. The next section of the paper outlines in the detail the methods employed to capture such data.

3 METHOD

The sparse nature of the accumulated literature in relation to engineering asset cultures required that a largely inductive approach be undertaken in this study. Qualitative lists of desired attributes were obtained via a self administered questionnaire from the 2007 World Congress on Engineering Asset Management (WCEAM 2007) and ICOMS 2008 (International Conference of Maintenance Systems) conference participants. Participants were provided with two questions designed to explore their perceptions of organizational culture and at a more detailed level, the values, behaviors, attributes and skills required of engineering asset personnel.

“List the most important elements of a high performing engineering asset culture (e.g. Values, attributes, behaviors attitudes)”

“List the most important qualities that high performing engineering asset personnel should possess (e.g. Attitudes, skills, abilities, personalities, mentality)”

This approach allowed us to capture data from those who at a macro level may have found difficulty in articulating what shared values might be of interest in an EA intensive organization. It was felt that most managers and engineering practitioners at the very least have some idea of the requisite behaviors and attributes required from their subordinates and peers. These were used as proxies for the cultural elements that would be considered valuable if universally adopted throughout the group.

NViVo7 was used to conduct the coding and allowed the use of matrix coding to identify the presence of demographically determined response patterns. The exploratory nature of the research dictated a substantive thematic approach to the coding, which involved an iterative process of actively identifying patterns, coding them into meaningful categories in the responses

that would allow the grouping of responses into logical groupings. These logical groupings were then reviewed again to see whether they could be broken down further into more detailed meaningful categories.

The analysis of the data occurred in three overlapping and iterative phases. One a preliminary phase during which each returned survey was initially reviewed for reoccurring phrases, statements or concepts - this identified that for example, “technical skills and competence” was likely to be a common theme. Two, using Nvivo7 a process of open or substantive coding was undertaken where like concepts were clustered into broad, meaningful categories [19]. Initially this involved differentiating between responses that were located at an individual, group or organizational level. A secondary round of coding was then conducted within each category to identify sub-themes within each main category. For example a review of the comments relating to “groups & teams” indicated two dominant sub themes of group communication and group co-operation. Three, the final phase of the analysis involved a process similar to axial coding whereby the various categories were reviewed in light of their relationship to other categories, as drivers, antecedents or mediating factors or as those that could be legitimately classified as elements capable of being shared values, behavioral norms and beliefs. Finally Nvivo7’s matrix coding functionality was used to determine whether response patterns could be identified by participant demographics, particularly relating to industry.

3.1 Demographics:

47 participants responded to the survey administered at the 2007 World Congress on Engineering Asset Management and the ICOMS2008 Asset Management Conference. Demographic data was collected in three areas, Industry, Qualifications and Position, these are presented below in Table 2.

Table 2
Participant Demographics

Category	Variable	% of Respondents
INDUSTRY	Manufacturing	21%
	Power Generation / Utilities	17%
	Defence	13%
	Transport / Logistics	9%
	3rd Party Provider / Contractor	19%
	Extraction industries (oil, mining, gas)	21%
QUALIFICATIONS	Trade Certificate	6%
	Undergraduate Degree	43%
	Post-Graduate Degree	47%
JOB ROLE	Management	56%
	Academic	9%
	Consultant	6%
	Engineering / Technical role	29%

4 RESULTS

As can be seen from Table 3.0 below the nature of the questions asked and the diverse manner in which individuals interpret the issue of culture produced a diverse range of responses. The thematic analysis resulted in 22 specific elements that were unable to be distilled into additional useful categories. The results from each round of coding are presented in Table 3.0 below along with the frequency of responses by participants. The results of the analysis are presented in two sections, one relating to the specific individual attributes nominated by participants and the other relating to the broader, cultural profiles that were also referred to by the participants.

4.1 Key Desired Individual Qualities

The question requiring participants to indicate “the most important qualities that high performing engineering asset personnel should possess” yielded numerous attitudinal, psychological and personality traits that were offered up as essential elements of EA cultures. Six elements in particular are felt to be worth discussing briefly based on the frequency with which they were recorded.

Openness to change & flexibility: Typical phrases and words used in this category included “*open minded*” “*flexible*” “*ability to change*” and “*able to deal with ambiguity*”. The importance placed on this element is possibly reflective of the degree of change required by contemporary organizations in the current competitive environment. It may also reflect the changing nature of maintenance and engineering operations, looking for skills that allow them to adapt to new technologies, staff shortages and the need to adopt sophisticated contemporary maintenance regimes such as condition and reliability based maintenance.

Contentiousness: Long recognized as a strong predictor of job success [20] it is no surprise perhaps that elements related to contentiousness are highly valued by engineering managers. Example phrases included “*precision and attention to detail*”, “*discipline*”, “*diligent*” and “*tenacity in achieving results*”. Quality cultures in particular typically cite this attribute as one valued in a culture seeking to achieve quality outcomes [21].

Technical & engineering skills: Given the highly specialized and technical nature of the work carried out the value placed on this element was to be expected. Regrettably many participants failed to identify precisely the kind of technical skills they required, using phrases such as “*technical competence*” “*engineering skills*” and “*engineering experience*”. However it is highly possible that the exact skills are not important, rather what is being suggested is that a culture valuing all and any engineering skills is what is required. Such a culture would drive organizational initiatives and resources for continued upgrades of technical and engineering capability. While referred to less frequently there is an indication that at least a proportion of respondents considered training as fundamental in achieving a workforce that recognizes and realizes the value of technical and engineering skills.

Collaboration: The engineering asset context is one that is permeated with numerous social, hierarchical and professional groups that ideally are highly inter-dependant in the execution of their roles. However the presence of what Van Maanen & Barley [22] call occupational communities (e.g. Operators; Maintainers; Engineers) along with the traditional demarcations between trades (e.g. Electrical; Plumbing; Mechanical) can hinder the establishment of an environment conducive to the degree of co-operation required for effective engineering asset management. As such it appears that a culture able to overcome these naturally occurring barriers to collaboration are highly valued and considered essential for engineering asset management success. Examples of the phrases that collectively represent a desire for high levels of collaboration included “*respect for colleagues*” “*working collaboratively*” “*inclusive with colleagues*” “*work with others for a common goal*” and “*ability to work with others from all levels*”.

Communication: Communication is the second of three elements relating to the interaction between engineering and technical personnel, rather than individual attributes. Similar to the reasons underpinning the importance of collaboration, the nature of the engineering asset context relies heavily on the presence of effective communication practices. However the participant responses indicated an awareness of the value represented by good communication beyond the more salient implications relating to safety for example. Instead, areas such as knowledge transfer were acknowledged as key outcomes of cultures driving effective communication practice. Example responses included “*willingness to share information*” “*clear and open communication*” “*free and open reporting*” and “*share knowledge and information*”.

Interpersonal skills: The importance placed on “interpersonal skills” highlights the increasing awareness among senior engineering management as to the critical nature of the human element in engineering success. As has been discussed in relation to the factors of “*collaboration*” and “*communication*” the response frequency of these elements reflects the idea that the effective management of engineering assets in a technical environment relies heavily on the ability of its workforce to work together in an integrated fashion despite differences in educational, trade, functional and even on occasion geographical locations. Typical responses included under the broad heading of interpersonal skills were items such as “*respect for colleagues*”, “*supportive of others*”, “*social skills*” and “*ability to work with people at all levels*”.

Table 3

Engineering asset cultural attributes - Participant responses

1st Round	2nd Round	3rd Round	Frequency
Individual Elements	Attitudes / Attributes	Awareness	12
		Continuous learning	4
		Openness to change & flexibility	24
		Pride in work	4
		Misc personality & psychological traits (See Appendix A.)	31
	Behaviors	Compliance	6
		Contentiousness	20
		Innovative	17
		Performance related	11
	Specific Skills & Knowledge	Decision making capability	16
		Information & data management	3
		Interpersonal skills	20
		Project management skills	19
		Technical & engineering skills	31
	Group Elements	Communication	
Co-operation & collaboration		23	
Organizational Elements	Training		1
	Cultural Traits	Customer focused	8
		HR focused	11
		Ownership & Empowerment	17
		Quality & continuous improvement	22
		Safety & Environmental focus	24
		Business & Commercial focus	23

4.2 Engineering Culture Profiles

A key aim of this study was to determine whether those currently operating in the engineering asset management context were able to identify a range of attitudes, behaviors and values that collectively represent a source of competitive advantage and contribute to the superior functioning and management of engineering assets (in simple terms, an engineering asset culture).

In total six cultural profiles emerged as examples of the kind of shared values that were considered integral to engineering asset management success (see Table 3.0). These included - Business & commercial orientation; HR focused; Safety & environmentally focused; Quality & continuous improvement; Ownership & empowerment, and customer focused. Five of the seventeen of the individual and group elements identified by participants were nominated by between 40% and 60% of the sample. The three that stood out as being most frequently referred to (44 - 48%) were the profiles associated with safety cultures, those with a strong commercial and business focus and those concerned with quality and continuous improvement. These are discussed briefly below.

Safety: Perhaps unsurprisingly given the nature and the typically high risks involved in working with engineering assets, elements relating to safety were consistently mentioned. Broader elements relating to environmental and sustainability were also identified by a small number of participants. Examples of typical responses included “*safety first*” “*safety should be ingrained*” and “*safety driven*”. There were also a number of elements put forward that those familiar with the safety culture literature would identify as key components of a safety culture such as a “*no-blame attitude*”, a “*culture of independent investigation*” and “*free and open reporting*”.

Strategic & Business focus: The strong endorsement for the need for engineering asset cultures to incorporate a strong business and commercial orientation by some participants is possibly reflective of the broader shift away from a parochial approach to the maintenance and operation of engineering assets to the broader, more inclusive whole of life approach that the emerging field of engineering asset management represents. It may also be reflective of an increasingly competitive market place where all aspects of the business are under increasing pressure to contribute to the organization's survival. As such, in order to operate effectively engineering and technical personnel are now required to understand the commercial (not just the technical) context within which they operate. The fact that this component was strongly represented by respondents in the Power Generation and Manufacturing industries (39% and 22% respectively) in this category would perhaps lend some support to this idea. Example respondent contributions included statements such as “*all employees see the survival and improvement of the business as critical*”, “*cost aware*”, “*understanding the core business*”, “*strategic focus*”, “*commercial focus*” and “*engaged with parties external to their organization*”.

Quality & Continuous improvement: A significant number of cultural elements desired by participants were consistent with those associated with quality or continuous improvement cultures. Respondents operating within the Power Generation industry were heavily represented in this category, providing 32% of the responses in this category. Quality as a business practice has a long involvement with engineering asset contexts, originating in the car manufacturing arena. In addition, both its methods and intended outcomes are consistent with many of the aims desired by engineering asset managers. Contemporary maintenance regimes such as Total Productive maintenance (TPM) are heavily underpinned by quality principles. Important to note is that the cultural profile of “*asset ownership and empowerment*”, while less frequently referred to (34%) is considered a key element of both quality and TPM cultures [17, 21]. It appears that the responses in this study confirm the continuing close association between quality and the effective operation and management of engineering assets. Typical responses included “*striving for quality*” “*continuous improvement culture*” and “*always improve*” as well as less obvious aspects of a quality culture such as “*prepared to challenge the status quo*”, “*data driven culture*” and “*appropriate measurement and feedback systems*”.

Further analysis identified that a sizable proportion of the additional individual group and cultural elements identified in Table 3.0 were recognized sub-elements of the three cultural profiles discussed above. A concept map of this is provided above in Figure 1.0. Placement of the individual and group elements within the relevant sphere was informed by an extensive literature review of cultures relevant to engineering asset contexts (see [23] for further details). Overall, all but three elements (Innovation, openness to change, interpersonal skills) were consistent with the cultural profiles of Safety; Strategic orientation; and Quality in one form or another. Aspects such as interpersonal skills can be seen to be relevant across all three profiles. The fact that a large majority of the individual and group elements are consistent with the three most frequently identified cultural profiles is important as it indicates a wider acceptance of these three cultural profiles than the straight frequency measures of 44%-48% response rates would initially indicate.

A review of the concept map would suggest a greater emphasis on cultural elements consistent with quality and continuous improvement cultures. However there are high degrees of overlap that suggest the potential for a core set of core values - e.g. Cultures based around the values of Ownership & empowerment; Data driven decision making; Communication; Team orientation; and Training. Further research with a larger, potentially more representative sample may provide further guidance on this area. Another point of interest is that respondents from the Power Generation and Manufacturing industries appeared to place a stronger emphasis on quality and business orientations than the other demographic profiles. The limited

sample in this study requires further work be undertaken to identify whether the nature of the industry and commercial operation of the business determines to some degree the cultural priorities of engineering asset intensive organizations.

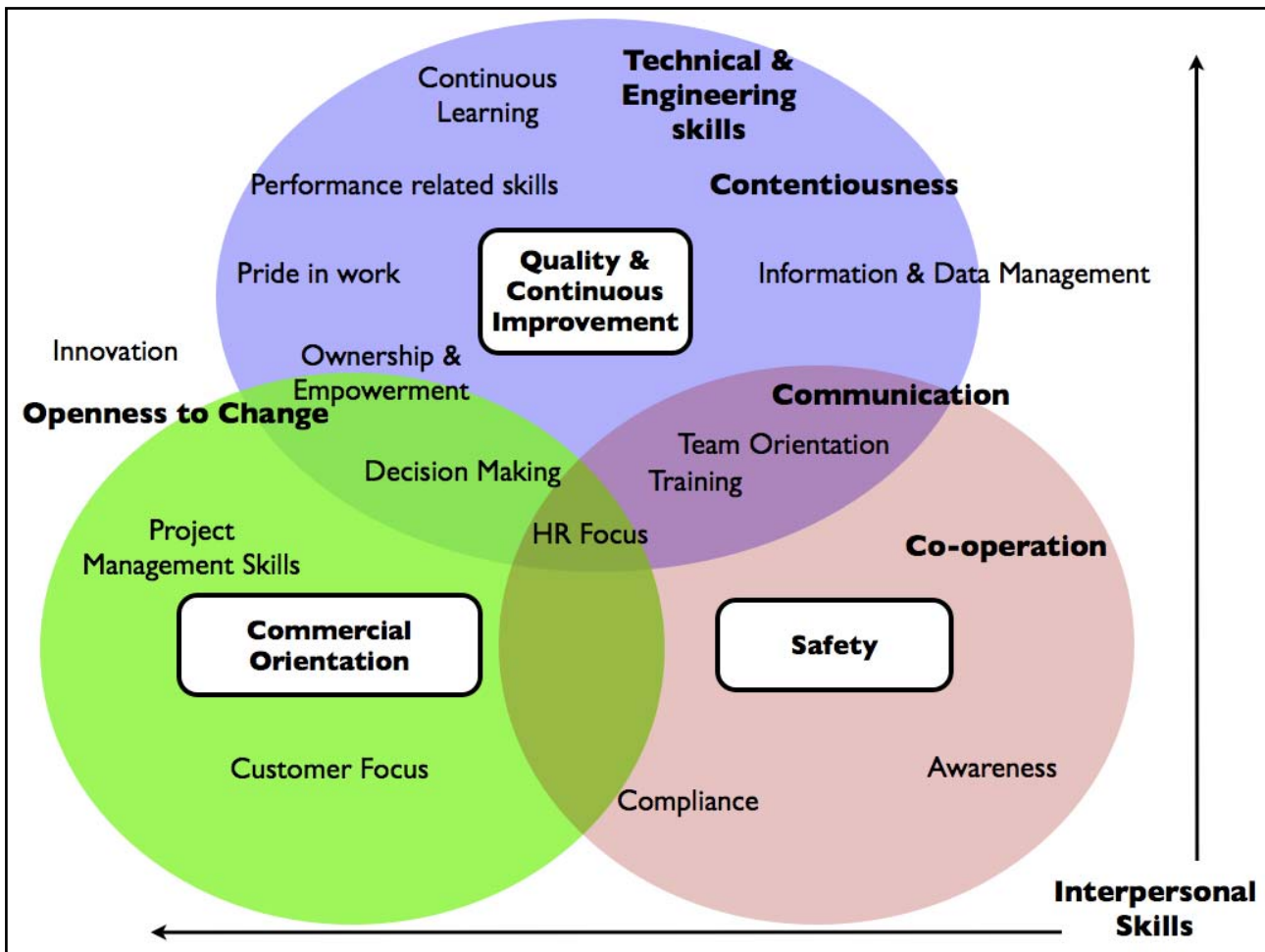


Figure 1.0 Concept map of best practice Engineering Asset Management cultural elements

5 DISCUSSION

The aim of this study was to begin understanding what engineering managers, academics and consultants considered essential elements of a “best practice” engineering asset culture. A brief review of the literature indicated a paucity of information relating to the desired characteristics of an engineering asset culture. Further, documentation relating to the emerging field of engineering asset management (EAM) and contemporary maintenance regimes such as CBM and RCM was identified as advocating the critical nature of “appropriate supporting cultures”, but failing to offer any specific guidance on the matter.

The study involved the surveying of engineering managers, senior engineers, academics and consultants (n=47) as to what they considered to be the essential elements of a “best practice engineering asset culture”. In particular the author was interested to see whether the respondents would provide an overlapping, common set of ideal attitudes, values and behaviors that would represent the building blocks of a “best practice” engineering asset culture. As such this study intended to provide a useful starting point for engineering asset managers and researchers when considering the ideal components of an engineering asset culture. The results of the study offer three key learnings in the study of organizational cultures in engineering asset management contexts.

In the first instance the results indicated that no one single cultural profile was shared by the participant sample. Instead, three distinct but inter-related cultural profiles were identified - those relating to safety, business orientation and quality. Further, the results indicate that an “ideal” engineering asset culture may be an amalgam or hybrid model, incorporating a number of elements relating to safety, performance and quality cultures. In practical terms this is useful in that there are a number of established cultural profiles based around these elements that can give engineering asset managers immediate

insight into the key characteristics of each culture. The presence of the established models also provides researchers a strong empirical base and diagnostic tools to further the research in this area.

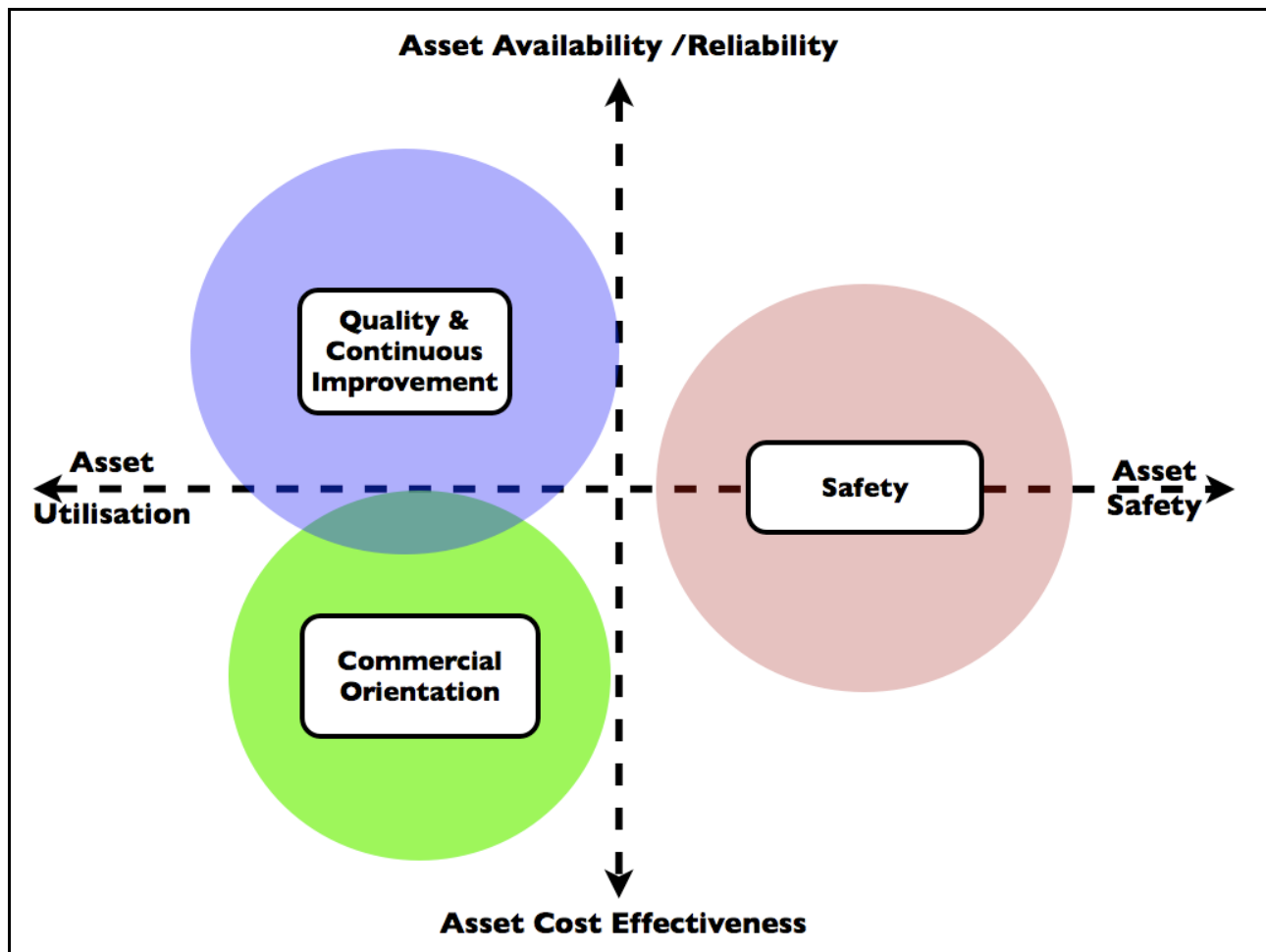


Figure 2.0 Engineering Asset Cultures and Engineering Asset Priorities

In the second instance the results reported that industries such as manufacturing and power generation placed a greater emphasis on cultural values relating to Quality and Commercial Orientation. This would suggest that while engineering cultures may share some commonalities across industries, business strategy and industry type may determine the degree of emphasis placed on any one of the three cultural profiles. It is possible that while engineering contexts may have commonalities in their cultural requirements, contextual influences may place different emphases on critical elements depending on the nature of the organization, strategic goals and broader industry classification [23]. Figure 2.0 above demonstrates this in simple terms by plotting the three profiles of safety, quality and commercial orientation over the key functional outcomes of engineering asset management (asset reliability, utilization, cost effectiveness, reliability and availability). Using this simple diagram it can be seen that organizations in high risk / high consequence industries (e.g. nuclear plants; petro-chemical facilities) with a greater emphasis on asset safety will place a greater premium on values relating safety culture. Conversely those organizations with an increased commercial demands and lower risk assets (e.g. manufacturing, telecommunications) may place a greater emphasis on cultural values consistent with a commercial and/or quality focus.

It is possible however that these priorities may shift around a “core” set of cultural values that are universal across engineering asset contexts. The study identified a 22 of attitudinal and value based elements considered by participants as having a positive contribution to the management of engineering asset intensive organizations. Six of these (openness to change; contentiousness; technical skill; communication; co-operation; interpersonal skills) were nominated by 40-50% of the participants with no identified demographic bias. This in itself stimulates a broader discussion around the appropriateness of these attributes and whether collectively they collectively constitute a set of 3 “engineering asset core values”. Previous work [23] has identified the potential for a single set of “core values” emerging from overlapping elements of more clearly defined cultural profiles such as safety and performance cultures. The results of this pilot study indicate a number of specific

elements that engineering managers and researchers may wish to consider as the basis for future research into the area of engineering asset cultures.

6 LIMITATIONS & FUTURE DIRECTIONS

As a pilot study this study represents an important step forward in understanding the essential cultural attributes of a high performing engineering asset organization. However there are a number of limitations needing addressed by future work looking to build on the results reported here. The first and most obvious is the limited sample in the study. While the participant profile equally represented engineers, academics and consultants, future samples should aim for a broader representation of industries and occupations. This will assist for example, in determining with greater accuracy whether industry or hierarchical level determines a particular desired cultural profile. The survey also failed to capture data on the value attributed to each element, forcing the researchers to use frequency as a measure of relative importance. While a useful proxy for a pilot study, further work needs to be carried out to determine the relative value of the elements recorded here and the degree to which factors such as organizational size, industry, organizational strategy and asset type(s) result in different perceived values attributed to various cultural attributes. Finally the nature of the data set prevented the researcher to directly link the nominated attributes with performance measures - as such there is no empirical support for the suggestion that these preferred elements will actually result in higher performing engineering asset intensive organizations. While empirical evidence already exists linking Safety cultures and TPM initiatives to performance outcomes, future research should examine whether the presence of a set of engineering “core values” translates into effective management of engineering assets.

In terms of moving the question of engineering asset cultures forward beyond this current study the results reported here raise a number of important questions:

- Should organizations develop a “hybrid” culture of all three profiles?
- Can organizations successfully develop a “hybrid” culture of all three profiles?
- Is there a set of “core values” drawn from the overlapping elements of all three cultural profiles that are universally applicable across organizations?
- Is the desired cultural profile based around the axes of asset reliability/availability; asset cost effectiveness; asset utilization; and asset safety? In short, does the nature of the asset and the organization it serves dictate the desired cultural profile?

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Appendix A. *List of personality traits nominated by participants*

Misc. Personality &	Frequency	Industry Demographic
Integrity	4	
Honesty	3	
Enthusiastic	2	
Patient	2	
“Positive attitude” and mentality	2	
Open minded	1	
Humility	1	
Selflessness	1	
Achievement focused	1	
Self-motivated	2	
Pro-active attitude	1	
Independent of thought & action	1	
Persistence	1	
Thoroughness	1	
Responsive	1	
Dynamic	1	
dedication	1	
Commitment	1	
Empathy	1	
energy	1	
Approachable	1	
Trust	1	
Respect	1	
Professionalism	1	
Pragmatic	1	
Strong-willed	1	
Maturity	1	
Risk-taking	1	