The functions of visual management

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Abstract:
Visual Management has been evolving and effectively employed in some manufacturing and service organisations for a long time. In order to facilitate a cross-industrial learning process and to advance in detailed research the understanding of how the Visual Management concept may serve in an organisation is necessary. The aim of this paper is to identify Visual Management functions and the theoretical base for the construction industry. A detailed literature review and an analysis of the findings were performed accordingly. The necessity of a holistic approach in order to make more use of the Visual Management process and some research opportunities were identified.

Keywords:
Background, Functions, Visual Management

1. Visual Management

In the organisational world Visual Management is a management system that attempts to improve organisational performance through connecting and aligning organisational vision, core values, goals and culture with other management systems, work processes, workplace elements, and stakeholders, by means of stimuli, which directly address one or more of the five human senses (sight, hearing, feeling, smell and taste) (Liff and Posey, 2004). These stimuli communicate quality information (necessary, relevant, correct, immediate, easy-to-understand and stimulating), which helps people make sense of the organisational context at a glance by merely looking around (Greif, 1991). It is a management approach that utilises either one or more of information giving, signalling, limiting or guaranteeing (mistake-proofing/ poka-yoke) visual devices

to communicate with “doers”, so that places become self-explanatory, self-ordering, self-regulating and self-improving (Galsworth, 1997).

A motorway analogy can be used to understand the concept a little better. On a motorway traffic lanes are designated and separated from each other by painted lines and these lines even manage drivers’ passing each other. Rumble strips alert drivers against possible dangers by causing tactile vibrations and audible rumblings. Speed bumps are carefully integrated on and are successful in limiting speed. Traffic policemen can be easily recognised at a glance by their distinctive uniforms, badges, the livery used to signal the presence of their cars and drivers are directed to their destinations by some information giving traffic signals and signs. A motorway is visually structured, so that as a place, it highly manages itself. This is specifically what Visual Management tries to do in a construction context.

One clear point from the literature is the lack of common terminology in this field. Some used terms, that refer to more or less the same concept, are Visual Management (Imai, 1997; Liff and Posey, 2004; Drew et al., 2004; Denis and Shook, 2007; Liker and Hoseus, 2008), visual workplace (Greif, 1991; Hirano, 1996; Galsworth, 1997; Galsworth, 2005), visual control (Schonberger, 1986; Ohno, 1988; Liker, 2004; Shingo, 1989; Mann, 2005), visual factory (Bilalis et al., 2002; Aik, 2005), shop floor management (Suzaki, 1993), visual tools (Parry and Turner, 2006) and visual communication (Mestre et al., 1999). According to Standard and Davis (1999), misuse of the terms is a common practice. Moreover, the degrading and narrowing of Visual Management to some housekeeping, production or quality control methodologies can also be seen.

1.1. Historical Background

Visual Management and correspondingly, data visualisation, has a rich historical background. Ca 2500 B.C., The Egyptian Royal Cubit was extensively used in construction projects and other related areas as the visual measuring standard (Corry, 2002). Ca. 600 B.C., the Chinese General Sun Tzu used gongs, flags, and signal fires for communication and management of his army (Wren, 1994). Around 1800 -1813, Robert Owen used the Silent Monitor as a display for moral evaluation of behaviour on the shop floor (Donnachie and Hewitt, 1993).

In 1917 the Gantt Chart, devised by Henry Gantt in 1910, was applied in Frankford Arsenal for visual control of production (Morris, 1994). In 1920 Charles Edward Knoeppel established the link between industrial efficiency and the graphical methods through visual control devices (Knoeppel, 1920). In 1932 Allan H Mogensen advocated process charting (mapping) and operator involvement for work simplification, underlining the person doing a job knows

more about it than anyone else, and therefore is the best one suited to improve it (Mogensen, 1932). Around 1935 the just-in-time thinking, of which Visual Management comprises an important portion (Liker, 2004), was roughly embodied in 10-centimeter-thick manuals by the founder of the Toyota Motor Corporation Kiichiro Toyoda himself (Hino, 2006). In 1937 standard, highly visual work sheets were employed, showing cycle time, work sequence, standard inventory, in the Toyoda Auto Loom (Ohno, 1988).

From the mid 1940s till the 1970s a development of Visual Management practices within the Toyota production system can be observed. In the late 1940s, manuals and standard operation procedures were posted above work stations so that supervisors could see if the workers were following the standard operations at a glance (Fujimoto. 1999). In 1953 Toyota applied the kanban production control and synchronisation system in its main machine shop (Ohno, 1988). In the same year, the Ishikawa (Cause and effect or Fishbone) diagram was employed by Kaoru Ishikawa for the first time. He also advocated that 95% of quality-related problems can be resolved with the seven basic visual tools (flowcharts, check sheets, Pareto diagrams, cause and effect diagrams, histograms, scatter diagrams, and control charts). In the mid 1950s several aspects of workplace structuring, visual control and housekeeping, what we know today as 5S (sort, set in order, sweep, standardize and sustain) implementations started to develop in Japan (Fabrizio and Tapping, 2006). The early version of the housekeeping methodology was 3S and then it became 4S in Toyota (Ohno, 1988). Osada (1991) refined and developed the concept of 5S in the early 1980s.A rough periodic maturity summary of 5S in Japan can be: 1950-1955,2S ; 1956-1972, 4S; 1973 -1980, 5S and 1981 -199, 6S; including safety as the 6^{th} S (Gapp et al, 2008). In 1957 the basic andon (light board) quality control system was initiated in Toyota (Ohno, 1988). In 1961 Shigeo Shingo applied the first poka-yoke (mistake-proofing) device in the Yamada Electric plant (Shingo, 1986). In 1977 Sugimori et al (1977), the Toyota managers, and Ashburn (1977) published the first papers in the English language on the Toyota Production System. These first papers also explained some aspects of Visual Management, like the kanban production control. Motivated by the successful Japanese economic development and competitive advantage various papers and books explaining the Toyota production system, Japanese management practices and the role of Visual Management have been published or translated from Japanese into English.

2. The Functions of Visual Management

A literature review was performed to identify functions of Visual Management. The details of the review resulted in a taxonomy of the functions identified from different resources and they are illustrated in Table 1:

Table 1: The Functions of Visual Management

Function	Definition	Alternative Practice
Transparency	The ability of a production process (or its parts) to communicate with people (Formoso et al., 2002).	Information held in people's minds and on the shelves.
Discipline	Making a habit of properly maintaining correct procedures (Hirano, 1995).	Warning, scolding, inflicting punishments, dismissing etc.
Continuous Improvement	An organisation-wide process of focused and sustained incremental innovation (Bessant and Francis, 1999).	Static organisations or big improvement leaps through considerable investment.
Job Facilitation	Conscious attempt to physically and/or mentally ease people's efforts on routine, already known tasks by offering various visual aids*.	Expecting people to perform well at their jobs without providing them any aids.
On-the-Job Training	Learning from experience (Mincer, 1962) or integrating working with learning (Sumner et al., 1999).	Conventional training practices or offering no training.
Creating Shared Ownership	A feeling of possessiveness and being psychologically tied to an object (material or immaterial) (Pierce et al., 2001).	Management dictation for change efforts, vision and culture creation.
Management by Facts	Use of facts and data based on statistics (Gunasekaran et al., 1998)	Management by subjective judgement or vague terms.
Simplification	Constant efforts on monitoring, processing, visualizing and distributing system wide information for individuals and teams*,	Expecting people to monitor, process and understand the complex system wide information on their own.
Unification	Partly removing the four main boundaries (vertical, horizontal, external and geographic) and creating empathy within an organisation through effective information sharing*.	Fragmentation or "this is not my job" behaviour

* The definition made by the authors.

The elaboration of the identified functions for a better understanding of their possible contributions to an organisation is necessary and presented in the following.

2.1. Transparency

Transparency can be defined as the ability of a production process (or its parts) to communicate with people (Formoso et al., 2002). This is achieved by making the main process flows visible and comprehensible from start to finish, through organisational and physical means, measurements, and public display of information (Koskela, 2002). Transparency involves a separation of the network of information and the hierarchical structure of order giving, in other an increase in self-control, which in classical organisation theory are identical (Greif, 1991). The goal is thus to substitute self-control for formal control and related information gathering. Transparency facilitates management-by-sight, which requires understanding of the workplace at a glance by the superior. Therefore, transparency serves information for both the manager and the worker. Contrary to the Taylorist/ Fordist system, in which control is purely disciplinary, extrinsic and thus, inefficient and causing the workers to create shadowy areas, in which they adapt to work on their own rhythms, the Toyota Production system, with reduced stocks and visual elements, creates transparency that stimulates people to move outside the bureaucratic confines of particular job responsibilities within the principles and the necessities of the production system (Forza, 1996).

Basically transparent organisational entities radiate information. Some aspects of transparency such as the goal of delegation of decision making from higher organisational levels to lower ones and increasing information availability for individuals at lower organisational levels coincide well with the fundamental requirements of the organisational empowerment practice (Bowen and Lawler, 1992; Suzaki, 1993; Galsworth, 2005). According to Spreitzer (1995), access to more information (especially about the mission and performance) and sense of self control (locus of control) facilitate physiological empowerment. Empowerment as a job characteristic affects, according to Hackman and Oldham's (1976) Job Characteristics Model, experienced responsibility which is an important part of higher work satisfaction, internal motivation and performance. Transparency can be an information oriented tool for the flexibility and leanness ethos of the modern organisation, in which the distinctive organisational power structure and order-giving blurs and persuasion and negotiation come into question (Kanter, 1989).

Moser and Santos (2002) summarise the practical impacts of transparency in a work environment as follows: the simplification and greater coherence in decision making, the stimulation of informal contacts throughout different hierarchical levels, the contribution to introduction of decentralisation policies, the assistance to broaden employees participation and the autonomy in management, more effective (overlapping) distribution of responsibilities, an increase in employee morale, more effectiveness of production scheduling, the

simplification of production control systems, rapid comprehension (by making problems apparent) and response to problems (a controlled speed in decision making and responsiveness), increase in the motivation of workers for improvement and visibility of errors. Flexibility, versatility and mobility within work teams can be also included (Greif, 1991). A correct message giving visibility that helps people construct mental models and provides the feedback of their actions are the essentials of user centred design as well (Norman, 1998).

One of the concerns here can be semiotics or the study of symbols and how they convey meaning. The details of this issue are out of the scope of this paper. Perceived meaning that is conveyed by visual signals is related to the society and the culture, in which the communication is situated (Ware, 2004). Additionally communication of some information in certain fashions can be against the dominant culture in an organisation or in a society.

2.2. Discipline

Visual Management reflects people's adherence to the expectations of processes by transforming the abstract concept of discipline into directly observable concrete practices (Mann, 2005). This is achieved by influencing, directing, limiting or guaranteeing people`s behaviours (Galsworth, 1997). Discipline can be defined as "making a habit of properly maintaining correct procedures (Hirano, 1995)." Anyone, even a newly hired, inexperienced employee, should be able to distinguish between normal and abnormal conditions at a glance and start taking the correct steps, developing a intuitive, habitual correctness, without being dependent on another entity.

Discipline refers to a term that widely ranges from putting a subtle organisational pressure on people (influencing) through various visual elements (Liff and Posey, 2004) to extensive standardization of outcomes through poka-yoke (mistake proofing - guaranteeing) devices (Shingo, 1986; Galsworth, 1997). By visually opening and regularly updating the individual/team performance results of a work station through making them available to everyone, management not only reflects an organisational reality, but also conveys some deeper messages to people: we watch your efforts on the issues that we value regularly and we are aware of your actual performances. These two messages put a subtle pressure, which, in most cases, leads to improving poor performances, trying harder than usual or sustaining the desired behaviour (Liff and Posey, 2004). Many of visual devices send these kinds of deeper messages that tell people the organisational expectations and the valued behaviours. These messages can be modified by changing their senses, feelings, intentions or tones (Morgan, 1992).

Discipline addresses waste minimisation. In part, Visual Management tries to eliminate the asked/unasked six basic questions (the what, the where, the who, the how, the how many and the when) that can potentially turn into waste of some sort (Galsworth, 2005). In part, it influences or standardises outcomes for an increase in adherence to the organisational goals. Discipline over the workplace identities (space, tools and equipments, material and machinery), personnel, production, quality and process have been realised through visual elements. In terms of workplace design and management, to impose discipline Norman (1998)'s proposal of exploiting physical, logical, mental or cultural constraints can be used in practice.

A rough, linear comparison of the different levels of discipline, namely influencing, directing, limiting and guaranteeing, on similar parameters (indicated in the boxes) can be seen in Figure 1. The comparison for the first two parameters in the figure, namely consistency/ standardisation of the outcome and human control was adapted from Galsworth (1997). The arrows on the figure show the direction of an increase or a decrease of the discipline levels by the terms indicated in the boxes. For example, consistency/ standardisation of the outcome in the first box increase moving from influencing (a lower outcome) to guaranteeing (a higher outcome).

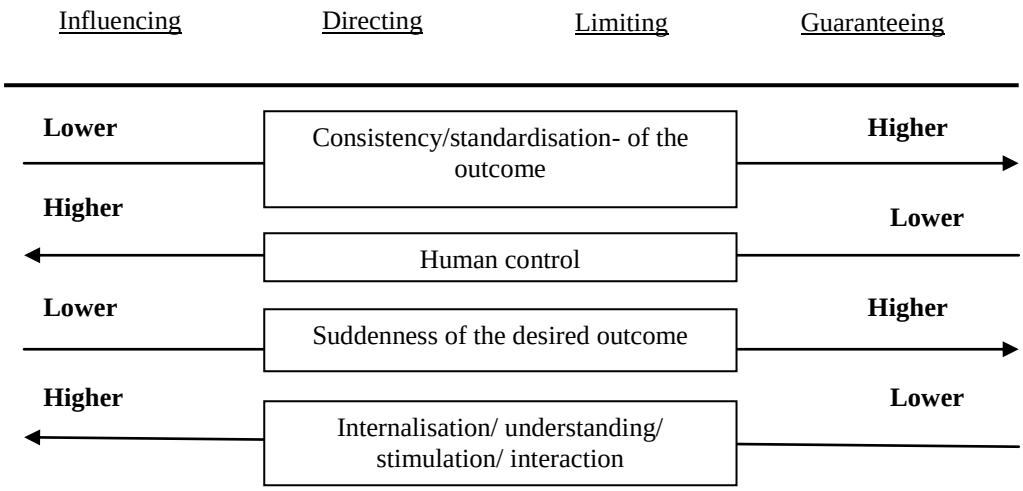

Fig. 1: Different Types of Visual Discipline

2.3. Continuous Improvement

Continuous improvement (or kaizen in the lean terminology) is a highly dynamic capability and can be defined as "an organisation-wide process of focused and sustained incremental innovation (Bessant and Francis, 1999)." Visual Management serves as a base for continuous improvement (Suzaki, 1993; Imai,

1997), and perhaps more importantly stimulates employee involvement to manage and improve quality (Grief, 1991; Schonberger, 1992; Flynn et al., 1994). High bureaucracy in organisations brings (especially in repetitive tasks- e.g. mass production assembly) detailed rules, manuals and standards, distinct hierarchical levels, substantial staff, and positively discipline, efficiency and timeliness. Yet it may cause (If coercive), rigidity/ less innovation, alienation/ low employee involvement, and low commitment (Adler, 1999). Visual Management makes organisational listening visual with high ability to respond to people's ideas. Thus, Visual Management influences not only adherence to the organisational standards through discipline, it also helps people observe the deviations from the standards easily (visibility – transparency). The standards are improved with modifications and some altered standards are created as an outcome (Grief, 1991).

In summary, visual tools are employed to see the problem (through transparency and discipline), to communicate suggestions (e.g. the idea board) (Mann, 2005), to understand and apply basic problem solving techniques (e.g. the seven basic tools for problem solving), to communicate the problem solving process and results to other people (e.g. the A3-storyboard from The Lean Manufacturing Advisor, 2005) and to praise the involvement effort (e.g. the superstar boards) (Liff and Posey, 2004).

2.4. Job Facilitation

Job facilitation can be defined as a conscious attempt to physically and/or mentally ease people's efforts on routine, already known tasks by offering various visual aids. Visual Management facilitates routine job tasks for people by offering a quick, correct and holistic understanding of their job requirements (Greif, 1991; Suzaki, 1993; Galsworth 1997). When the amount of information required to complete a task pushes the capacity of working memory, it must be made available in the physical world through visual displays (Norman, 1998). Human understanding consists of preconscious and conscious forms and visual graphical information processing is involuntary, like breathing (Rohrer, 2000). The right brain which processes visual information, creating mental images, is capable of working faster, sometimes in the form of emotional reactions (Barry, 2005). Moreover, repeated stimuli, with their frequent patterns, create the templates that people use to map and anticipate the reality (Barry, 2005).

Job facilitation can be researched and understood under the bigger subject of human factors and ergonomics in industrial engineering and systems design. Human factors is a discipline that investigates "human behavioural, cognitive, and physical abilities and limitations in order to understand how individuals and teams will interact with products and systems (Resnick, 2006)." Human factors

include cognition (how users will perceive the information that they receive during system use, how this information will be processed, and the nature of the resulting behaviour and decisions of users), behaviour (people behave on the basis of experiences and beliefs that transcend the system, including factors such as corporate culture, personal goals, and past experience), performance (the speed and accuracy with which the task is completed) and reliability (an understanding of human failure modes, the root causes of human error, and the performance and contextual factors that affect error probability and severity dimensions) (Resnick, 2006). If done correctly, visual communication through visual aids can eliminate many of the structural drawbacks that linguistic communication may possess (Racine, 2002). Answering, reminding, warning, summarising, or in other words, job facilitating visual aids are one of the essential parts of Visual Management.

2.5. On-the-Job Training

On-the-Job training includes learning from experience (Mincer, 1962). Integrating working with learning is a competitive imperative for organisations (Sumner et al., 1999). Information in the environment enables on the job training, which is an effective way of learning, as it is integrated in actual work and helps employees learn by practical experience. Thus, on-the-job learning is a tool for acquiring tacit knowledge through sharing experience (Choo, 1996). It is a cost effective, less work disruptive, encouraging, and easy to assess (for supervisors) organisational learning practice that employs Visual Management (Aik, 2005). Visual elements provide the media and format for capturing and articulating tacit knowledge, which becomes explicit once articulated, to the people in an organisation. Although information in the environment eases mental load and assists employees greatly, information embedded in the head offers a deeper understanding, and a more efficient and effective work effort (Norman, 1998). The collection of information in the head forms a person's experiences. Additionally, information in the head enables creative approach (Norman, 1998), which supports continuous improvement to one's work tasks. Visual elements may be designed so that people can absorb information in the environment more easily and more quickly to change it into information in the head, which is a more refined and versatile type of information.

2.6. Creating Shared Ownership

Psychological ownership can be defined as a feeling of possessiveness and being psychologically tied to an object (material or immaterial) (Pierce et al., 2001). Visual Management is used to create and designate territories and work teams (Grief, 1991 and Suzaki, 1993). One other function of Visual Management is image creation for stakeholders (Liff and Posey, 2004). It is particularly effective

in creating a desirable organizational impression on potential/existing employees, customers and other shareholders.

When a potential employee steps into a Visual Management organisation, the vivid atmosphere populated with visual aids for employees marks positive impressions and a sense of support for him/her. Effectively designed and visually displayed "employee praises" convey the message of a caring, supporting and encouraging organisational atmosphere (Liff and Posey, 2004). Successful employees are congratulated by catchy visual means, displayed openly to other people (Grief, 1991; Suzaki, 1993; Liff and Posey, 2004). They are rewarded through financial/non-financial prizes. Likewise customer focus and priority are visually underlined around the organisation. Employees understand who they work for and the importance of their jobs for customers at a glance. Customer satisfaction metrics are publicly displayed. The connection between the employees and the customers are always sustained through visual means. The customers are invited into the organisation and get the feeling that they are at the focal point. A supporting organisation is a caring organisation in which employees may feel obliged to respond with increased effort, citizenship behaviours and loyalty (Cropanzano et al., 1997).

Visual elements are extensively used for internal marketing efforts and change management practices to convey a desired message, to persuade people and to alter the perception for creating ownerships (Davis, 2001; Ahmad and Rafiq, 2002). According to Mestre et al (1999), visual elements can be utilised to signal group membership, to acquaint members with organisational vision and culture, to maintain organisational vision, to alert members change in the work environment, to manage human relations, to provide avenues for expression and to transform the organisational paradigm. Visual elements that are used for business communication enable the effective transmission of the reality as well. They can be used to clarify, simplify, emphasise, summarise, reinforce, unify, attract people to and impress people by the reality (Bovee and Thill, 2005).

Along with other organisational parameters, these messages act as a reflection of the culture of an organisation, which serves as a template for individuals' work and management fashions. Visual Management can expectedly help to instil an open and sharing work culture among the people in an organisation (Galswort, 2005).

2.7. Management by Facts

Management by facts is based on the use of facts and data based on statistics (Gunasekaran et al., 1998). Visual Management is partially about opening the objective organisational reality to the relevant people through the flow of

information (Grief, 1991; Liff and Posey, 2004; Galsworth, 2005; Mann, 2005). This reality is free from personal bias and/or subjective experience or understanding of individuals. Openness, or willingness to share ideas and information willingly, frankly and accurately, is a condition for obtaining employees' trust in management (Clark and Payne, 1997; Lewicki et al., 1998). The pure reality helps managers overcome the negative side of organisational politics associated with the misuse of power, secrecy and considered as a barrier to democratisation by many (Butcher and Clarke, 2002). In situations where employees perceive the organisational reality as politicised, they may remain silent, mislead managers by telling them what they want to hear, new employees quickly learn the effects of politics from the others and act accordingly, people may feel inequitable or distrustful against each other, a distinctive selfishness may appear, employees deliberately reduce their efforts and some people deeply immerse themselves into their tasks, avoiding their environments to a greater extent(Witt et al., 2002).

Visual Management helps to eliminate information monopolies at different layers, and provoke people to face their own performance realities (Grief, 1991; Liff and Posey, 2004; Galsworth, 2005). Employees who lack other forms of power and control may use information and knowledge as a form of control and a defence mechanism (Brown and Woodland, 1999). When the individual and the group performance metrics are displayed numerically in a work station, it is so clear who is contributing enough, who has improved, who is doing worse and whose performance is on a decline that it is impossible for a manager or work colleagues to unjustly favour or cover a poorly performing employee. If a hand tool has not been placed on a visually designated area, it means the hand tool was not taken enough care of the person who is responsible for it. Facing the reality expectedly pushes the employees and management to face the issues for themselves first and to concentrate on their own efforts rather than searching for or finding an external identity to blame. Visual Management, therefore, helps upper management persuade people that the management practices in an organisation are just and working with the organisational reality.

2.8. Simplification

The management of information in dynamic and complex environments sometimes goes beyond the efforts and abilities of individuals. Organisations mainly use strategic information to make decisions, to make sense of changes and developments in their external environments and to generate new knowledge through organisational learning (Choo, 1996). While cascading strategic information from upper organisational levels to lower levels, a mechanism for monitoring, processing and presenting the vast amount of information for people to make sense is necessary. Information deficiencies or information overflows

may simply lead to poor performance, waste, distress, conflicts, misunderstandings, discord and so on. Especially for decision making processes, simplification of the strategic information is necessary (Choo, 1996; Bierly III et al., 2000). According to Tegarden (1999), visualization of data exploits human visual system in order to extract information from data, provides a focused overview of complex data sets, identifies structure, patterns, trends, anomalies and relationships in a data set and assists in identifying the areas of "interest." Information visualization is frequently the optimal way for human capabilities (Tufte, 2001). According to cognitive fit theory, decision making performance improves when the task and information presentation format match (Vessey, 1991).

Visual Management, as a system, keeps an organisation focused on monitoring, filtering, simplifying and effectively presenting quality information, which is necessary, relevant, correct, immediate, stimulating and located as close to the relevant place as possible or integrated in the workplace, process, machinery, tool, inventory etc. In this way, an information field, from which people can pull information whenever they feel a need (does not push information), is created (Grief, 1991). This information presents a simplified, structured and condensed reflection of the organisational realities in the complex environment for people to utilise especially in their day-to-day transactions. Therefore, Visual Management is an information management tool. Examples are abundant in this sense: visualized customer satisfaction metrics, supplier related information, information corresponding to various aspects of organisational environment and supply chain, information related to different departments, teams and workstations within an organisation (Grief, 1991; Suzaki, 1993).

Visual displays constantly serve as reminders and function as knowledge transferred or integrated into the environment as proposed by Norman (1998) for user-centred design. Provided that the visual elements are sustained and updated on a regular basis, they function as a feedback mechanism for the people in an organisation, which is another feature underlined by Norman (1998) for user-centred design. User-centred design can be defined as a design approach that puts the intended user at the centre of its design by taking the user's human (physiological, cognitive etc.) and functional needs as the reference points.

2.9. Unification

Organisations are constituted by interconnected socio-technical departments, with various layers. One of the managerial issues is to establish synchronisation and harmony (shared understanding) between these layers. People may illusively think that they work in an isolated manner solely according to the departmental values and conditions to which they belong. In an organisation, the vertical

boundaries (the boundaries between layers), the horizontal boundaries (the boundaries between functional units), the external boundaries (the boundaries between the organisation and the outside world) and the geographic boundaries (the boundaries between different organisational units located in different geographic areas) can partly diminish with information sharing and dialogue creation (Ashkenas et al., 1995). Creating a "boundaryless" organisation, where people act openly without status or functional loyalty and look for ideas from anywhere, is a major concern, especially in knowledge management efforts (Rastogi, 2000). A knowledge originating environment, where people can sympathise and empathise with others removing the barriers is fundamental for knowledge creation (Nonaka and Konno, 1998). Moreover, removal of boundaries between tasks for information sharing, learning and knowledge is proposed by the socio-technical job design theory (Holman et al., 2005). When the border between tasks and organisational groups diminish, multiple task handling or job enlargement for employees can be easier (Hirano,1995: Galsworth, 1997). A machine operator, for instance, can both operate the machine and participate in the maintenance of the same machine effectively.

Creating a feeling of interest and concern, in other words, care will expectedly give a rise to mutual trust, active empathy, access to help, lenience in judgement and prevent the "this is not my job" behaviour (von Krogh, 1998). Sharing of quality information and opening it to the rest in an organisation with various multi-directional communication channels and media will facilitate empathy and timely and correct understanding of the needs and expectations of other people (Grief, 1991; Galsworth, 2005, Liff and Possey, 2004). Managers will more clearly see the strengths and the weaknesses of their subordinates. Subordinates will understand the expectations and the priorities of their managers better. Horizontally, people working in various departments will gain a wider view of the organisation through effectively perceiving the direct impact and the strong connection of their efforts to other departmental units (Grief, 1991; Liff and Possey, 2004). Therefore, Visual Management functions as a unifier, assisting to wipe off the detrimental effects of fragmentation and organisational boundaries. It increases people's sensitivities to their environments.

3. Conclusion

According to the identified functions in this paper, Visual Management can serve a broad range of functions for an organisation. The different use of the terminology in this field, of course, can be directly related to the authors' perception of and approach to the issue. The general understanding of Visual Management seems mainly concentrated on its transparency and/or discipline functions, particularly in the lean production literature. A complete understanding of the term is necessary for the unified exploitation of these functions. The Visual

Management functions identified in this paper should also be in accordance with the socio-technical structure and other managerial practices of an organisation. Visual Management and its applications might be researched for design, construction and management of different facilities (e.g. healthcare facilities, schools, commercial facilities etc.), based on the theoretical aspects identified in this paper. A cross-industrial learning effort that identifies what has been utilized as Visual Management in different industries seems necessary for a broader understanding of the issue. A complete visual management framework covering the identified functions might be developed for construction organisations. Research in this area possibly requires rigorous field observation of organisations from different industries with case studies or various action-research efforts as Visual Management is a highly practical approach with numerous visual solutions for different management practices. The identification of the specific needs of construction and management of facilities that can be met by Visual Management and implementation of various visual tools might be needed.

The identified functions seem inter-related and interacting and some of them appear to be at a more macro or organisation-wide level like management by facts, simplification and unification. The inter-relations between the outlined functions and how other organisational features can alter these functions might be researched. An exploration of possible new functions or some modifications on the identified functions might be necessary. The relationship between Visual Management and other managerial practices and how Visual Management can possibly support or hinder different managerial efforts in an organisation need to be understood more clearly. A detailed classification and identification of various Visual Management tools may be useful. The utilisation of Visual Management in computer mediated work possibly makes another promising research area.

References

Adler, P S (1999), 'Building Better Bureaucracies', Academy of Management Executive, 13(4), pp. 36-47.

Ahmed, P K & Rafiq, M (2002), Internal Marketing: Tools and Concepts for Customer-focused Management, Butterworth-Heinemann, London.

Aik, C T (2005), 'The Synergies of the Learning Organization, Visual Factory Management, and On-the-Job Training', Performance Improvement, 44(7), pp. 15-20.

Ashburn, A (1977), 'Toyota's Famous Ohno System', American Machinist, 21(7), pp. 120–123.

Ashkenas, R N, Ulrich, D, Jick, T & Kerr, S (1995), The Boundaryless Organization: Breaking the Chains of Organizational Structure, Jossey Bass, San Francisco.

Barry, A M (2005), Perception Theory, K Smith, Moriarty S, Barbatsis G and Kenney K, Handbook of Visual Communication: Theory, Methods, and Media, Lawrence Erlbaum, London.

Bessant, J & Francis, D (1999), 'Developing Strategic Continuous Improvement Capability', International Journal of Operations and Production Management, 19(11), pp. 1106-1119.

Bilalis, N, Scroubelos, G, Antoniadis, A, Emiris, D & Koulouriotis, D (2002), 'Visual Factory: Basic Principles and the `Zoning' Approach', International Journal of Production Research, 40(15), pp. 3575-3588.

Bovee, C L & Thill, J V (2005), Business Communication Today, 8th Ed., Pearson/Prentice Hall, Upper Saddle River.

Bowen, D E & Lawler, E E (1992), 'The Empowerment of Service Workers: What, Why, How, and When.' Sloan Management Review, 33(3), pp. 31-39.

Brown, R B & Woodland, M J (1999), 'Managing Knowledge Wisely: A Case Study in Organizational Behavior', Journal of Applied Management Studies, 8(2), pp. 175-198.

Butcher, D & Clarke, M (2002), 'Organizational Politics: The Cornerstone for Organizational Democracy', Organizational Dynamics, 31(1), pp. 35-46.

Choo, C W (1996), 'The Knowing Organization: How Organizations Use Information to Construct Meaning, Create Knowledge and Make Decisions', International Journal of Information Management, 16(5), pp. 329-340.

Clark, M C & Payne, R L (1997), 'The Nature and Structure of Workers' Trust in Management', Journal of Organizational Behavior, 18(3), pp. 205-224

Corry, A K (2002), Engineering and Production, 2nd Ed., I McNeil, An Encyclopaedia of the History of Technology, Routledge, London.

Cropanzano, R, Howes, J C, Grandey, A A & Toth, P (1997), 'The Relationship of Organizational Politics and Support to Work Behaviors, Attitudes, and Stress', Journal of Organizational Behavior, 18(2), pp. 159 - 180.

Davis, T R V 2001, 'Integrating Internal Marketing with Participative Management', Management Decision, 39(2), pp. 121-130.

Dennis, P & Shook, J (2007), Lean Production Simplified, 2nd Ed., Productivity Press, Portland.

Donnachie, I & Hewitt, G (1993), Historic New Lanark: The Dale and Owen Industrial Community Since 1785, 2nd Ed., Edinburgh University Press, Edinburgh.

Drew, J, McCallum, B & Roggenhofer, S (2004), Journey to Lean: Making Operational Change Stick, Palgrave Macmillan, New York.

Fabrizio, T & Tapping, D (2006), 5S for the Office: Organizing the Workplace to Eliminate Waste, Productivity Press, New York.

Flynn, B B, Schroeder, R G & Sakakibara, S (1994), 'A Framework for Quality Management Research and an Associated Measurement Instrument', Journal of Operations Management, 11(4), pp. 339-366.

Formoso, C T, Santos, A d & Powell, J (2002), 'An Exploratory Study on the Applicability of Process Transparency in Construction Sites', Journal of Construction Research, 3(1), pp. 35-54.

Forza, C (1996), 'Work Organization in Lean Production and Traditional Plants', International Journal of Operations and Production Management, 16(2), pp. 42-62.

Fujimoto, T (1999), The Evolution of a Manufacturing System at Toyota, Oxford University Press, Oxford.

Galsworth, G D (1997), Visual Systems: Harnessing the Power of Visual Workplace, AMACOM, New York.

Galsworth, G D (2005), Visual Workplace: Visual Thinking, Visual-Lean Enterprise Press, Portland.

Gapp, R, Fisher, R & Kobayashi, K (2008), 'Implementing 5S within a Japanese context: An Integrated Management System', Management Decision, 46(4), pp. 565 - 579.

Greif, M (1991), The Visual Factory: Building Participation through Shared Information, Productivity Press, Portland.

Gunasekaran, A, Goyal, S K, Martikainen, T & Yli-Olli, P (1998), 'Total quality management: A New Perspective for Improving Quality and Productivity', International Journal of Quality and Reliability Management, 15(8/9), pp. 947-968.

Hanckman, J & Oldham, G (1976), 'Motivation through the Design of Work: Test of a Theory', Organizational Behavior and Human Performance, 16(2), pp. 250-279.

Hino, S (2006), Inside the Mind of Toyota: Management Principles for Enduring Growth, Productivity Press, New York.

Hirano, H (1995), 5 Pillars of the Visual Workplace: The Sourcebook for 5S Implementation, Productivity Press, Portland.

Holman, D, Wood, S, Wall, T D & Howard, A (2005). Introduction to the Essentials of the New Workplace. The Essentials of the New Workplace: A Guide to the Human Impact of Modern Working Practices. (Eds.) D Holman, Wall T D, Clegg C W, Sparrow P and Howard A. Wiley, Chichester,

Bierly III, P E, Kessler, E H & Christensen, E W (2000), 'Organizational Learning, Knowledge and Wisdom', Journal of Organizational Change Management 13(6), pp. 595-618.

Imai, M (1997), Gemba Kaizen: A Commonsense, Low-Cost Approach to Management, McGraw-Hill, London.

Kanter, R M (1989), 'The New Managerial Work', Harvard Business Review, 67(6), pp. 85-92.

Knoeppel`, C E (1920), Graphic Production Control, Engineering Magazine, New York.

Koskela, L (1992), Application of the New Production Philosophy to Construction, Department of Civil Engineering, Stanford University.

Lewicki, R J, MacAllister, D J & Bies, R J (1998), 'Trust and Distrust: New Relationships and Realities', Academy of Management Review, 23(3), pp. 438-458.

Liff, S & Posey, P A (2004), Seeing is Believing: How the New Art of Visual Management Can Boost Performance Throughout Your Organization, AMACOM, New York.
Liker, J K (2004), The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer, McGraw-Hill, New York.
Liker, J K & Hoseus, M (2008), Toyota Culture: The Heartand Soul of the Toyota Way, McGraw-Hill, New York.
Mann, D (2005), Creating a Lean Culture: Tools to Sustain Lean Conversion, Productivity Press, New York.
Mestre, M, Stainer, A, and, L S & Strom, B (1999), 'Visual communications - the Japanese experience', Corporate Communications: An International Journal, 5(1), pp. 34-41.
Mincer, J (1962), 'On-the-Job Training: Costs, Returns, and Some Implications', The Journal of Political Economy, 70(5 (part 2)), pp. 50-79.
Mogensen, A H (1932), Common Sense Applied to Motion and Time Study, McGraw-Hill, New York.
Morgan, J (1992), See What I Mean?: An Introduction to Visual Communication, Edward Arnold, London.
Morris, P W G (1994), The Management of Projects, Thomas Telford, London.
Moser, L & Santos, A D (2003), Exploring the Role of Visual Controls on Mobile Cell Manufacturing: A Case Study on Drywall Technology, In Proceedings of the 11th IGLC Conference, Blacksburg, Virginia,
Nonaka, I & Konno, N (1998), 'The Concept of 'Ba': Building a Foundation for Knowledge Creation', California Management Review, 40(3), pp. 40-54.
Norman, D A (1998), The Design of Everyday Things, MIT Press, London.
Ohno, T (1988), Toyota Production System: Beyond Large-Scale Production, Productivity Press, Portland.
Osoda, T (1991), The 5-S: Five Keys to a Total Quality Environment, Asian Productivity Organisation, Tokyo.
Parry, G C & Turner, C E (2006), 'Application of Lean Visual Process Management Tools', Production Planning and Control, 17(1), pp. 77-86.
Pierce, J L, Kostova, T & Dirks, K T (2001), 'Toward a Theory of Psychological Ownership in Organizations', The Academy of Management Review, 26(2), pp. 298-310
Racine, N (2002), Visual Communication: Understanding Maps, Charts, Diagrams, and Schematics, LearningExpress, New York.
Rastogi, P N (2000), 'Knowledge Management and Intellectual Capital – The New Virtuous Reality of Competitiveness ', Human Systems Management, 19(1), pp. 39-48.
Resnick, M (2006). Human Factors, Handbook of Industrial and Systems Engineering. (Eds.)A B Badiru, Taylor & Francis CRC Press, Boca Raton, FL,
Rohrer, M W 2000, Seeing is Believing: The Importance of Visualization in Manufacturing Simulation, In Proceedings of the Winter Simulation Conference, Orlando, USA
Schonberger, R J (1986), World Class Manufacturing, Free Press, New York.

Schonberger, R J (1992), 'Total Quality Management Cuts a Broad Swath - through Manufacturing and Beyond', Organizational Dynamics, 20(4), pp. 16-28.

Shingo, S (1986), Zero Quality Control: Source Inspection and the Poka-Yoke System, Productivity Press, Portland

Shingo, S (1989), A Study of the Toyota Production System from An Industrial Engineering Viewpoint, Productivity Press, Portland.

Spreitzer, G M (1995), 'Psychological Empowerment in the Workplace: Dimensions, Measurement and Validation', Academy of Management Journal, 38(5), pp. 1442-1465.

Standard, C & Davis, D (1999), Running Today's Factory: A Proven Strategy for Lean Manufacturing, Hanser Gardner Publications, Cincinatti.

Sugimori, Y K, Kusunoki, K, Cho, F & Uchikawa, S (1977), 'Toyota Production System and Kanban System: Materialization of Just-in-Time and Respect-for-Human System', International Journal of Production Research, 15(6), pp. 553 – 564.

Sumner, T, Domingue, J, Zdrahal, Z, Millican, A & Murray, J (1999), Moving from On-the-job Training towards Organisational Learning, In Proceedings of the KAW'99 12th Workshop on Knowledge Acquisition, Modelling and Management, Alberta, Canada,

Suzaki, K (1993), The New Shop Floor Management: Empowering People for Continuous Improvement, The Free Press, New York.

Tegarden, D P (1999), 'Business Information Visualization', Communications of AIS, 1(4), pp. 1-37.

The Lean Manufacturing Advisor (2005), 'Storyboards Teach Workers the Process', 7(4), September.

Tufte, E R (2001), The Visual Display of Quantitative Information, Graphics Press, Chesire, USA

Vessey, I (1991), 'Cognitive Fit: A Theory-Based Analysis of the Graphs Versus Tables Literature', Decision Sciences, 22(2), pp. 219-240.

Von Krogh, G (1998), 'Care in Knowledge Creation', California Management Review, 40(3), pp. 134-153.

Ware, C (2004), Information Visualization: Perception for Design, 2nd Ed., Morgan Kaufmann, San Francisco.

Witt, L A, Kacmar, K M, Carlson, D S & Zivnuska, S (2002), 'Interactive Effects of Personality and Organizational Politics on Contextual Performance', Journal of Organizational Behavior, 23(8), pp. 911 - 926.

Wren, D A (1994), The Evolution of Management Thought, 4th Ed., Wiley, New York.