

Visual management and communications boards, empirically testing design principles

Peter Gardner

School of Business and Economics, Loughborough University

Dr Nicola Bateman nab34@le.ac.uk

School of Business University of Leicester

Abstract

This paper considers the use of visual management in operational settings, particularly focusing on the design of communication boards. Implementation in industry has mostly been practice lead with limited research providing theory-based guidelines on how to use or design communication boards. This research paper contributes to theory by exploring how operational teams use these boards. It empirically assesses team problem-solving by conducting a series of 15 experimental trials to test different formats. The research concludes the most important factor is the placement of the relative elements of the board as this supports team decision-making by inference support and discourse management.

Keywords: Visual, Lean, PDCA

Introduction and literature

The use of visual management in operational settings has been increasing in recent years with communications boards being a particular focus. The design of these boards has mostly been practice lead with company examples being available in the literature (Galsworth, 2017) but there is limited research providing theory based guidelines on how to use or design communication boards. This has started to be addressed by research such as Bateman, Philp, and Warrender, (2016) and Beynon-Davies and Lederman, (2017). This research adds to this body of work by conducting a series of experimental trials to test different formats.

This paper explores how operational teams use these boards by assessing how easily the teams are able to problem-solve and the extent to which the format of the board supports or hinders this process. Communication boards are defined as “large format (boards) about 1.5m by 2.5m with several different elements that have operational and strategic data displayed” (Rich, Bateman et al. 2006). These types of boards are commonly used by operational teams to direct their work through team briefings and

problem solving. They are strongly identified with a lean approach (Liker 2004) because of their visual nature and support for problem solving, PDCA in particular. Their use to support teams in this process is advocated by Bateman and Lethbridge (2014). This research has focused on paper based examples because these are commonly used, but we acknowledge the use of white boards which are likely to be very similar to paper versions and digital boards for example smart-boards and touch screens.

More fundamental approaches to the analysis of visual images is provided by Barthes (1977) who makes the point that images can have multiple messages or many meanings; polysemy. This determines that visual communications can be interpreted in different ways, so to ensure the message communicated is the one received, one needs to be convinced that the visualisation is effective. The visualisation should form a coherent whole and the design should consider understanding and interpretation of the content and ultimately group decision making.

Tufte's work (2009) is widely acknowledged in the field of data representation. His minimalist approaches for visualising quantitative information, and his eleven guidelines for graphical excellence, were an influence in the construction of the experimental design of this research. The guidelines include ideas of data density, chartjunk and graphical elegance.

Bresciani, Blackwell and Eppler (2008) provide a framework that provides insight into visual tools that are used in business applications and in this research it used to aid the analysis between team members using visual tools. From this framework, inference support, directed focus, and discourse management were of particular interest. The definitions by Bresciani et al. p5 are as follows:

Inference support: The extent to which new insights are generated as a result of the constraints of the visualization form.

Directed focus: The extent to which the diagram draws attention to one or more items.

Discourse management: The control over the discussion and work flow.

This research tests two of the visual management principles used in a case study by Bateman et al. (2016) specifically;

1. That of using the right graphical tool – in this case comparing line graphs with tables of numerical data
2. Using a board layout that reflects the flow of discussion – in this research different layouts are compared and how teams use them is analysed.

Deriving from this, and wider visual management literature, the following research questions were posed:

RQ1. What effect does the way the graphical elements are placed on the communications board have on how the team use the data for decision making?

RQ2. What effect does the type of graphical representation have on team decision making?

RQ3. How does the use of status indicators in the visualisation affect the use of data within the decision making process?

Methodology

This research was conducted using a problem solving exercise, in the form of a specifically designed and tested business game, with 15 groups of 3-5 members, a total

of 46 people. The problem solving exercise was conducted in an operating business environment where each group was asked to solve a business problem within 20 minutes. The data to solve the problem was presented in one of three visual formats (Figure 1), thus there were five trials of each format. The three visual formats were designed based on:

1. Data in graphs
2. Data in tables with numerical data
3. Data in tables with numerical data and status indicators (red, amber, green)

The data for all three formats was structured into four balanced scorecard perspectives (Kaplan and Norton 1992). Each group were then asked to reflect on the problem solving activity. The process of problem solving was audio and video recorded for analysis.



Figure 1: Three formats tables, tables with status indicators and graphs

The problem solving exercise was based on a scenario of a supermarket and each team was asked to answer business game questions 1 to 5 (shown in Table 1). The game questions are designed to explore how the team of participants use data and to require the team to develop inferences from data in different parts of the display. This is summarised in Table 1 where the relationship between the game questions is related to what the participants need to do to answer the question and then this is related to the relevant research question.

Table 1: links between game design and research questions

| Business Game Question | To Solve the Question. | Link to Research Question |
|--|--|--|
| 1. Why is there a rise in waste? | Participants to search across two perspectives of the business game, internal and finance, find the relevant data, and make a judgement based upon interpreting the data. | RQ1 - graphical elements placement RQ2 - type of graphical representation |
| 2. When was the 20% reduction in staff achieved? | Requires the calculation of when the number of full time equivalent staff had been reduced by twenty percent from a starting value of one hundred. This was from read from a single source in the people perspective on the business game visualisation. | RQ1 - graphical elements placement RQ2 - type of graphical representation RQ3 use of status indicators |
| 3. What were the operating costs for March August and November? | Values could be read directly from the business game visualisation in a single position in one business game perspective finance. | RQ1 - graphical elements placement RQ2 - type of graphical representation |
| 4. What month saw the biggest month to month rise in jobs affecting food storage? | Comparison of values from a single position in the internal perspective on the business game visualisation to determine the biggest month to month rise in jobs affecting food storage. | RQ1 - graphical elements placement RQ2 - type of graphical representation RQ3 use of status indicators |
| 5. What impact did the customer service training have on the trend of customer complaints? | Requires looking at the investment in customer service training in the people perspective and identifying the trend in customer complaints in the customer perspective. | RQ1 - graphical elements placement RQ2 - type of graphical representation RQ3 use of status indicators |

After the game the team are encouraged to reflect on the problem solving process and are asked reflective debrief questions:

1. How easy was it for you to answer the game questions?
2. How did you reach a decision to answer the questions?
3. What were the problems or issues you had with the visual data?
4. What would you do with the visual display and its layout to make it easier to answer the questions?

The purpose of the reflective debrief questions was to gather an insight as to how the teams made decisions to answer the five business game questions, why the teams answered the questions in a specific way, and to draw out difficulties, or ease of use, for the different business game visual formats. The open debrief questions allowed for the group participants to explore aspects not covered directly by the debrief questions, and not stifling emergent or abstract ideas from individual participants.

The analysis was conducted using thematic analysis of the audio recordings, times taken for problem solving, and specially developed “gesture diagrams” constructed from the video recordings. The gesture diagrams were developed to show how the teams interacted over time with data displays (Figure 3).

Results

The trials were conducted across 15 groups and all but one group were able to complete the business game in the allocated time. The teams were able to understand the game and were observed to engage with the data; treating it as if it were a real situation in a company. The teams found the game questions sufficiently challenging and thoroughly interrogated the data to find the answers to the game questions. Figure 2 shows the time each of the fifteen groups took to complete the entire business game.

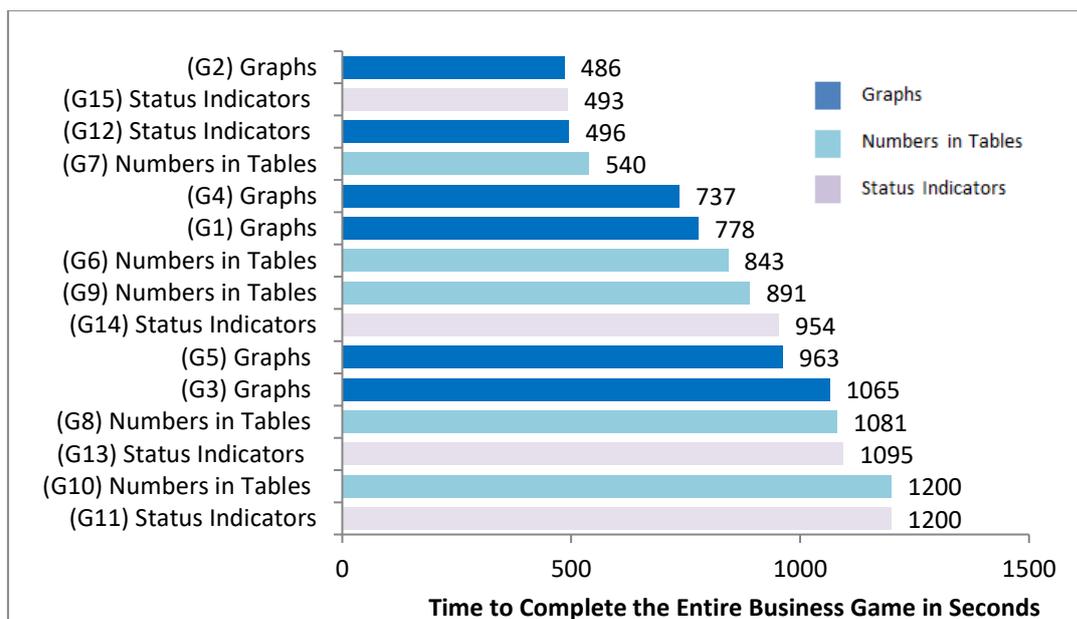


Figure 2: Time taken by each group to complete the business game

Considering research question 1 “*What effect does the way the graphical elements are placed on the communications board have on how the team use the data for decision making?*”. The design of the game questions and placement of the data in the three different business game formats meant the participants had to use data from different parts of the visual display to find answers. This is shown in a gesture diagram Figure 3 which shows the hand indications made by team members as they point to different parts of the display (different members shown in different colour) in answering business game question one. The time the gesture is made is shown on the diagram. The gestures for business game question one are divided over two diagrams for clarity.

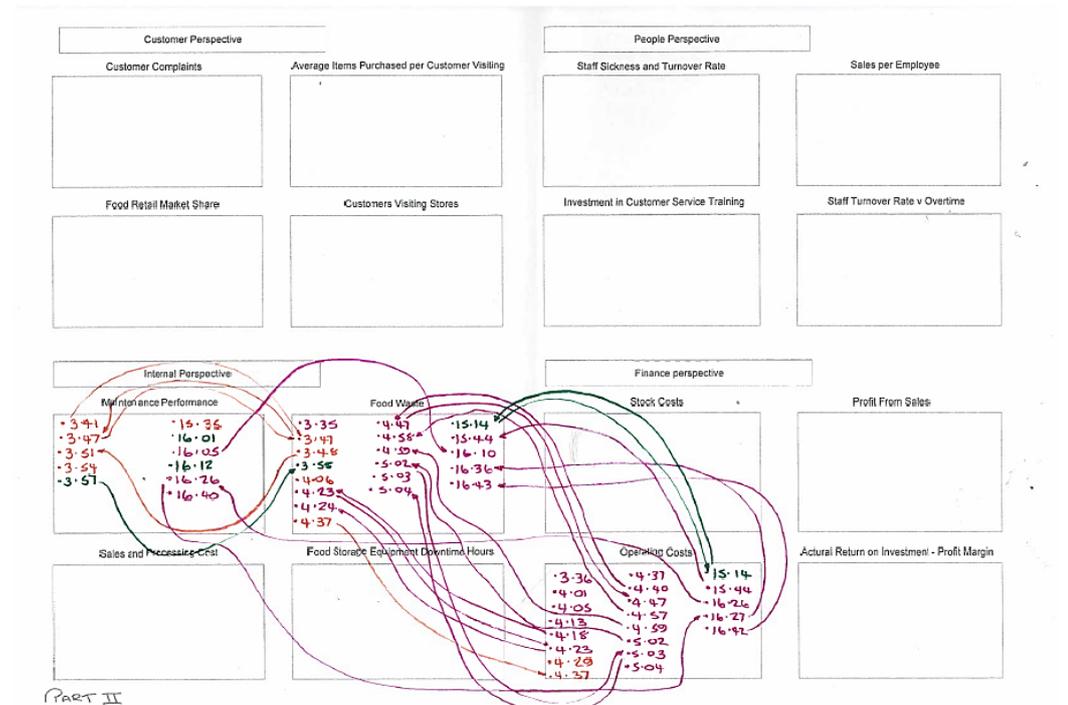
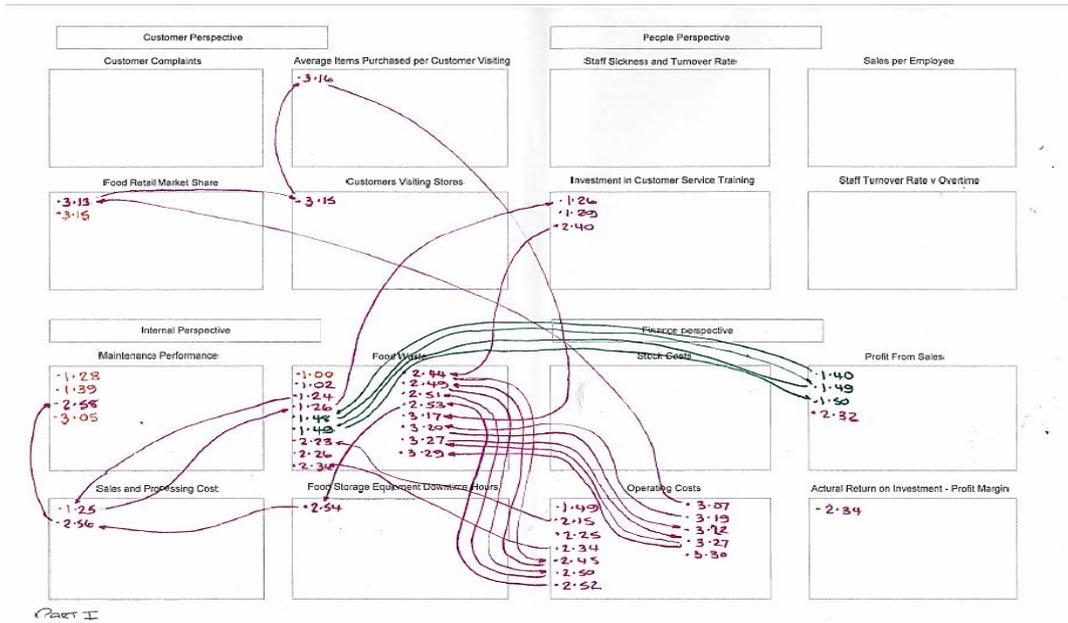


Figure 3: Gesture diagram for question 1 group 11 (parts 1 and 2) (status indicators layout)

After the completion of the business game, participants were encouraged to comment on the problem solving process by the debrief questions. Participants highlighted how the relative placement of elements of the display could support their problem solving

“..where actually this goes up here it actually related to here- so it would have been nicer if you had the possibility of looking at having it side by side,” Group 3 Business game visualisation type graphs participant A September 2016. Proximity of data likely to be compared is valued as expressed by

“So the investment in training is almost completely opposite side to customer complaints so you searching for the information as opposed to it being together.” Group

12 Business game visualisation type tabular format with status indicators participant A April 2017.

In terms of RQ 2 “*What effect does the type of graphical representation have on team decision making?*”. The time taken to complete the game does not show support for any particular format (Figure 2) which would indicate no specific preference for either figures of graph. This is also supported by the contrasting comments of the participants who express a range of responses towards each visual format. Some support the use of graphs,

“I’d choose one graph like err either a line graph or a bar graph for all of them just think it would probably make it easier to understand.”

Group 1, Business Game Visualisation Type Graphs, Participant A July 2016

“Plotting things as graphs errm and visually err is a lot easier to see so what was the largest jump is that was in a graph would be a lot easier to see the steps so right well that happened.”

Group 7, Business Game Visualisation Type Numbers, Participant C August 2016

“I think graphs would obviously be more you’d probably be able to spot it straight away.”

Group 12, Business Game Visualisation Type Status Indicators Correct, Participant A April 2017

This is countered by participants who favour data in tables “*Some of the correlations that were being investigated I would I personally would expect to see presented err in tabular form where you’re having to cross reference that’s just a personal opinion.*”

Group 15, Business Game Visualisation Type Status Indicators Correct, Participant A April 2018

“It’s useful to have the raw data in case you want to go through I’ve seen various dashboards where you get like an infographic of something and everything is in a different type of pie chart and you can never compare the two and you can never get back to the real data which is really frustrating.” Group 10, Business Game Visualisation Type Numbers, Participant A, November

“Line diagrams I personally find a bit harder to read as well that’s just that’s just probably my personal reference.” Group 2, Business Game Visualisation Type Graphs, Participant B, September 2016.

With some participants concerned that the use of graphs to tell a particular story *If your presenting that data to others you’ve got a certain agenda your trying to push that might be a visual graph might make it more in your favour.*

Group 13, Business Game Visualisation Type Indicators Correct, Participant A April 2017

Even for the most complex game question 1 there is no dominant visual format, as

Figure 4 shows no particular format was completely consistently more easily than other formats.

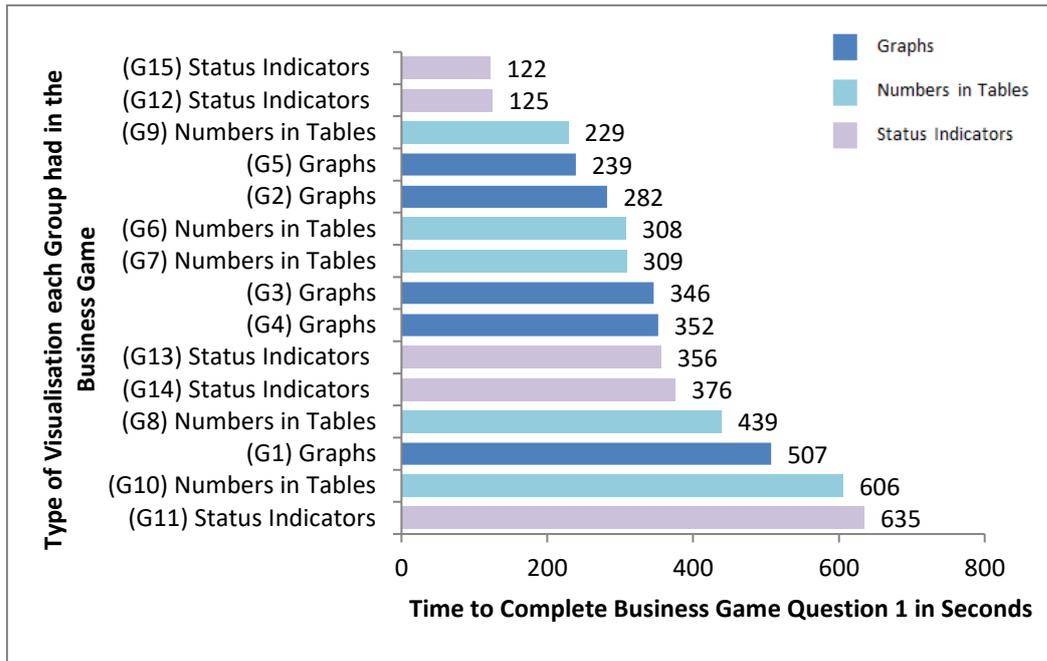


Figure 4: time to complete game question 1

Considering the final research question 3 “How does the use of status indicators in the visualisation affect the use of data within the decision making process?” The timing data shown in figures 3 and 4 does not indicate that status indicators provided any particular advantage for teams provided with this additional data. This was supported by comments from participants who were generally ambivalent.

“Personally I didn’t look at them.” Group 13, Business Game Visualisation Type Status Indicators Correct, Participant B April 2017

“It didn’t really do much for me”. Group 18, Business Game Visualisation Type Numbers in tables with status indicators, Participant B, April 2017

some participants negative “I didn’t like them.” Group 20, Business Game Visualisation Type Numbers in tables with status indicators participant A, April 2017

and some supportive “It points you in the right thing.” Group 17, Business Game Visualisation Type Numbers in tables with status indicators, Participant A, April 2017.

It was clear that the teams also wanted to understand their meaning;

“You don’t know what it represents” Group 12, Business Game Visualisation Type Status Indicators, Participant A April 2017

and “What I would add to that is the fact that the status indicator doesn’t actually or isn’t actually defined.” Group 14, Business Game Visualisation Type Status Indicators, Participant B April 2017

“We can then see why where the red then the yellow and the green come from from that some of the others are not explicit in covered by the background information so in that sense its begging a bit of a question as to what you know what is the underlying significance.” Group 15, Business Game Visualisation Type Status Indicators, Participant C April 2017.

Overall it may be that status indicators are just not that significant in this setting as one participant expressed in a discussion about status indicators

“Yeah they, they did I think, but the, but the figures themselves were more important than the red amber green I must say.” Group 17, Business Game Visualisation Type Numbers in tables with status indicators, Participant A, April 2017

Conclusion

The collection and analysis of research data posed several interesting challenges. The constructed problem solving exercise, the business game, and debrief questions provided a valuable vehicle for gaining insight into what is an important and valuable visual tool, communication boards. The engagement of the participants in the problem solving was clearly observable, and the open exchange during the debrief questioning providing rich, interesting and frank commentary. Some of which is presented here but for reasons of brevity within the scope of this paper it cannot be reproduced in full here.

The paper concludes that the most important factor is the placement of the relative visual elements of the board to allow inference support and discourse management (Bresciani, Blackwell and Eppler 2008) and we have termed this as “flow” (RQ1). Where data from a range of sources was needed to answer the business game questions, the more important the flow becomes. This was born out within the groups completing the business game. Where there was only one point of data needed to answer a business game question then the flow became less important and there was little or no searching for data correlations.

Contrasting the two formats (graphs and tables) does not provide a strong preference for one format over other, (RQ2) however, there is some weaker evidence that people tend prefer the format with which they are more familiar in their professional lives.

The use of status indicators is widespread in industry and the service sector, used as an ‘at a glance’ indicator of performance or project status. In this type of situation status indicators are not supported by the evidence. Status indicators may be useful for business meetings where people need to review a wide range of data such as whole site meetings (RQ3).

Both Tufte (2009) and Barthes (1977) identified that there are skills needed by the constructors of visualisations, and further to this Tufte (2009) concludes that complex ideas should be communicated with clarity, precision and efficiency. The conclusions from this research will be able to direct practitioners to design communications boards with the idea of flow to enable discourse management and data insight as paramount in their design.

References

- Barthes, R. (1977) a. *Image - Music – Text*, Hill and Wang: New York.
- Bateman, N. A. and Lethbridge, S. (2014) *Managing Operations and Team Visually*, (ed.) Bell E, Warren S, Schroeder, The Routledge Companion to the Visual Organisation, Abingdon: Routledge.
- Bateman, N., Philp, L. and Warrender, H., (2016). Visual management and shop floor teams—development, implementation and use. *International Journal of Production Research*, 54(24), pp.7345-7358.
- Bresciani S, Blackwell AF, Eppler M. A (2008) Collaborative Dimensions Framework: Understanding the mediating role of conceptual visualizations in collaborative knowledge work. *Proceedings of the 41st*

annual Hawaii international conference on system sciences (HICSS 2008) 2008 Jan 7 (pp. 364-364). IEEE.

Beynon-Davies, P. and Lederman, R., (2017). Making sense of visual management through affordance theory. *Production Planning & Control*, 28(2), pp.142-157.

Galsworth, G.D., (2017). *Visual Workplace Visual Thinking: Creating Enterprise Excellence Through the Technologies of the Visual Workplace*. Productivity Press.

Kaplan, R.S.; Norton, D.P. (1992). The balance scorecard – measures that drive performance. *Harvard Business Review*, 70 (1), 71-79

Liker, J.K. (2004). *The Toyota Way: 14 Management Principles from the World's Greatest Manufacturer*. McGraw- Hill

Rich, N., Bateman, N., Esain, A., Massey, L. and Samuel, D., (2006). *Lean evolution: lessons from the workplace*. Cambridge University Press.

Tufte, E. R. (2009) *The Visual Display of Quantitative Information, Second Edition*, Cheshire Connecticut: Graphic Press,