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Communicating with Diagrams: How Intuitive and Cross-cultural are Business Graphics?

Results of Image Sorting Experiments with Strategy Students in the United Kingdom and China

by

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ABSTRACT

This article reports on the results of an intercultural card sorting experiment with 104 students in Beijing and Cambridge to identify similarities and differences in the interpretation of visual business communication formats. The results show that English and Chinese strategy students differ dramatically in terms of their similarity and grouping decisions of business diagrams. The results indicate that managers who employ business graphics for their communication should pay attention to their target groups and visual formats to avoid misinterpretation in different cultural regions. The article is a contribution to visual approaches to communication management and highlights their limitations and risks.

1. INTRODUCTION

Managers in the global business community frequently employ standardized graphic formats in their various business communication contexts, ranging from team meetings, strategy workshops, internal reports, employee newsletters or management presentations, to annual reports (Meyer, 1997; Jarvenpaa and Dickens, 1988; Galloway, 1994; Smelcer and Carmel, 1997; Hodgkinson et al., 2004). These graphic formats serve a variety of purposes – from representing financial results, to analyzing industry developments and forces, to outlining future options or prioritizing business activities. Typical examples of such business graphic formats for internal and external communication are pie charts, bar charts, management matrices, flow charts, or visual metaphors such as an iceberg or a temple. Managers may assume that these graphic formats are intuitively understood by employees across different levels of qualification and experience and across cultural boundaries and may consequently risk to be misunderstood or to create confusion if their charts cannot be interpreted properly by their staff or clients. Managers working in Asia as well as in Europe may also assume that they know how to choose the best graphic representation format for the content which they need to communicate, regardless of their target groups in both regions. They may choose their visual communication formats without the necessary empirical information on how these methods are actually understood and interpreted by employees and clients in Asia and Europe.

In order to contribute to the emergence of a global visual business language (Horn 1998) that can be understood by managers in both Europe and Asia and thus facilitate intercultural business communication, we have to analyze which visual formats are easily understandable and which are not, which graphic formats are well known and which are less widely known. This can also be useful in devising teaching strategies on business visualization by highlighting possible misinterpretations and by educating business students about methods that are less popular (and by explaining their application contexts). As visual communication can be especially useful in intercultural business contexts, one has to analyze which business graphics are perceived in similar ways and which provoke different interpretations across cultures (such as the European versus the Asian context).

A feasible research method for this purpose is the *picture sorting* procedure (Rugg & George, 2005) that is described in the methods section below, as it allows researchers to access the perception and judgements of managers and students. Picture sorting as an empirical research method also helps to achieve another, closely related goal: It can assist in the creation

of a user-based classification of management-related visual formats. Through picture sorting results one can analyze the underlying characteristics as a basis for the subsequent development of comprehensible, sound and useful classifications (Ranking, 1990). In this paper, we view visual methods as standardized, rule- or procedure-based, diagrammatic (i.e., abstract) graphic depictions that can be used to represent information that is relevant for managerial decision making. By combining (through cluster analysis) the groupings of such methods of Chinese and English students we can generate a classification of such methods that may be more accessible to both cultural groups. There are numerous benefits that can be achieved through such a classification: First, it can provide a descriptive overview of the business graphics domain (Bailey, 1994: 12) and it can function as an inventory or repository (ibid.: 13). In this way, a classification can also become a problem solving heuristic. A classification reduces the complexity inherent in choosing a visualization format for a particular application context. As a further benefit, a classification helps to recognize the (perceived or effective) similarities and differences among different visualization techniques. It helps to compare different types along pertinent criteria. A classification, according to Bailey (1994) is the ordering of entities into groups or classes on the basis of their similarity. Classifications minimize within-group variance and maximize between-group variance (Bowker & Star, 1999). If a classification is derived empirically, i.e., ex-post through cluster analysis as in this paper, one can refer to this classification as a *taxonomy* (ibid.). In the rest of this paper, we describe how such a taxonomy was created through a picture card sorting task completed by students and what we can learn from this for communication management in Asia and Europe.

2. METHODS

To test the assumption that standard business diagrams may provoke different kinds of interpretations and different levels of familiarity, we have conducted two image sorting experiments with students in Britain and China. In these experiments we have asked a total of 104 individuals to group a set of thirty typical business visualization thumbnails into groups based on their perceived similarity. We have aggregated, analyzed, and compared the resulting classifications through multi-dimensional scaling methods and cluster analysis (Borg & Groenen, 2005). We have opted for a card sorting approach, as this technique reveals the individual and collective similarity judgements among business visualizations which can be useful indicators on the interpretation of such charts. By analyzing the groups that students create to classify business diagrams, we can infer how they perceive and interpret such diagrams and consequently how British and Chinese students differ in those interpretations.

In the remainder of this method section we describe the demographics of the participants as well as the sorting task that we have asked them to perform.

2.1 Demographics

The two card sorting experiments were conducted in September and December of 2006 in Cambridge and Beijing respectively.

Of the 65 participants in Beijing, 29 were men, while 36 were women. All were in their third year of undergraduate business studies and participating in the course on Strategic Management at the Central University of Finance and Economics (CUFE).

The card sorting experiment conducted in the United Kingdom was held at the University of Cambridge. The participants consisted of 37 students in the fourth year of studies in the program of manufacturing management. Seven were female, while 30 were male.

The card sorting instructions and time given to both students were identical. While the explanations given to the students in Cambridge were offered in English, they were given in Chinese to the students in Beijing. Chinese students completed the entire exercise in Chinese, while the Cambridge students proceeded in English.

2.2 Task Description

In order to elicit the classification attributes and salient features of diagrams that can be used in management, we have conducted two all in one, open picture card sorting experiments (Rugg & George, 2005: 97; Borg & Groenen, 2005: 113) where we have asked 67 business students from the Central University of Finance and Economics in Beijing, China, as well as 37 fourth year engineering and manufacturing management students from Cambridge University (UK) to group thirty (4 cm by 5 cm) black and white cards (see figure 1 and table 1) into groups based on their perceived similarity. The cards were given to each participant in an envelope. Each envelope contained the card set in a randomized order to prevent a sequence bias. The students were given 35 minutes to complete the picture sorting task. They were asked to label each resulting group by writing a label on each envelope that contained a grouped set. Unlike Lohse et al. (1994) we did not present any prior criteria, questions, or rating scales to the participants in order not to bias their responses through previous frames or anchors introduced by the researchers. We also tried to homogenize the sample and reduce misleading de-

tails by drawing all cards in the same (hand-drawn) style and by embedding the same generic content in all formats (represented through capitalized letters such as A, B, C, D., etc.). The following thirty visual formats were selected for the card sorting task.

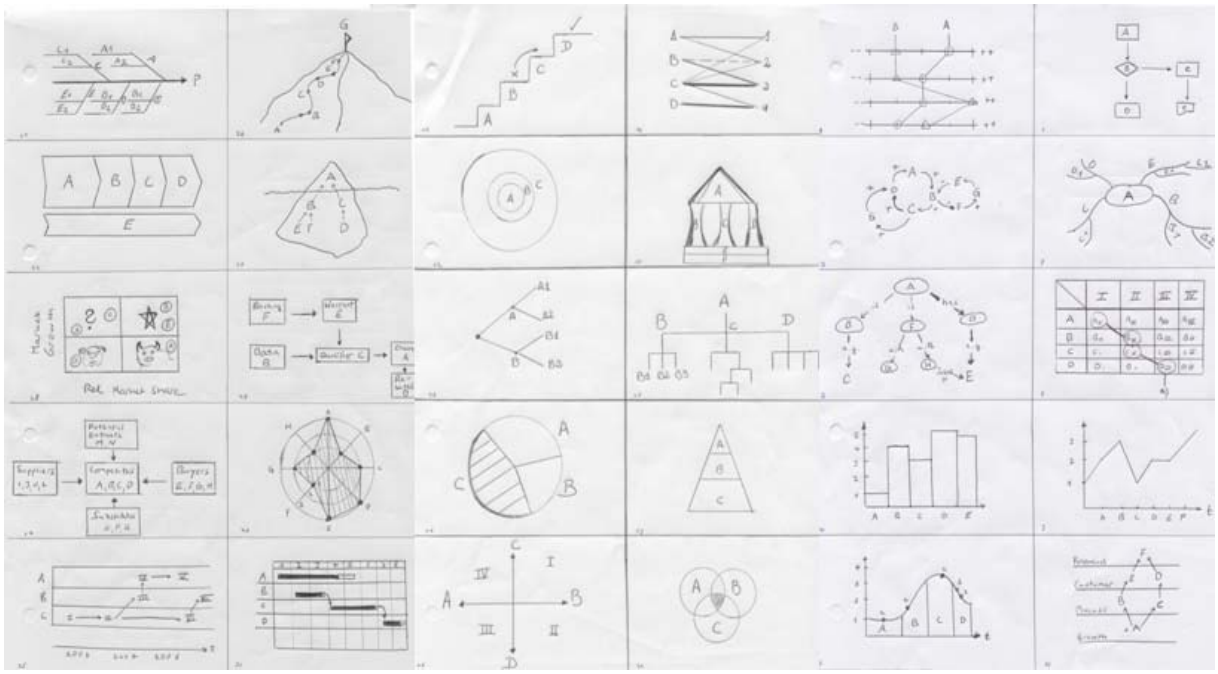

Figure 1: Thumbnails of the 30 picture cards for the card sorting task

1. Fishbone diagram
2. Porter's value chain
3. The BCG portfolio matrix
4. Porter's five forces diagram
5. Technology roadmap
6. Trail diagram
7. Iceberg diagram
8. Toulmin diagram
9. Radar chart
10. Gantt chart
11. Steps diagram
12. Concentric circles diagram
13. Decision tree
14. Pie chart
15. Cartesian coordinates
16. Connectance diagram
17. Temple diagram
18. Org chart / tree
19. Pyramid
20. Venn diagram
21. Profile chart
22. Loop (or system) diagram
23. Concept map
24. Bar chart
25. Life cycle diagram
26. Flow chart
27. Mind map
28. Morphological box
29. Line chart
30. Strategy map (BSC)

Table 1: A selection of 30 visualization-based methods (ordered by vertical column in figure 1)

These thirty formats were chosen because they have been used in management media, such as magazines (e.g., the Harvard Business Review), in management books (such as Huff 1990) or on management resource websites that contain directories of typical management methods (such as www.valuebasedmanagement.net). The collection was also compiled so that the diversity of managerial visualization methods would be reflected adequately in the selection. The collection thus includes quantitative, and qualitative, generic and specific, conceptual and metaphoric, structural and procedural/temporal formats.

Having explained the rationale, context, and procedure used in the card sort experiment, we turn to the main results in the next section.

3. RESULTS

The obtained results from the card sorting exercises can be structured into four sections: results regarding differences among the *participants* and resulting outliers, results regarding the employed grouping *labels*, results regarding the emergent overall *groups* (the derived taxonomy of diagrams), and results regarding the *differences* among the two groups.

3.1. Results regarding outliers

We have analyzed the 104 participants through multidimensional scaling (Borg and Groenen 2005) in order to find outliers. This has enabled us to identify students that have grouped the 30 cards in radically different ways than the rest of the participants. As the following figure illustrates, there are two such outliers among the 104 students, one from the English group and one from the Chinese group. The subsequent calculations were thus carried out with the remaining 102 students, excluding the two outliers CAM-71_9M and 64M (who were both males, as indicated in the figure below through the M letter).

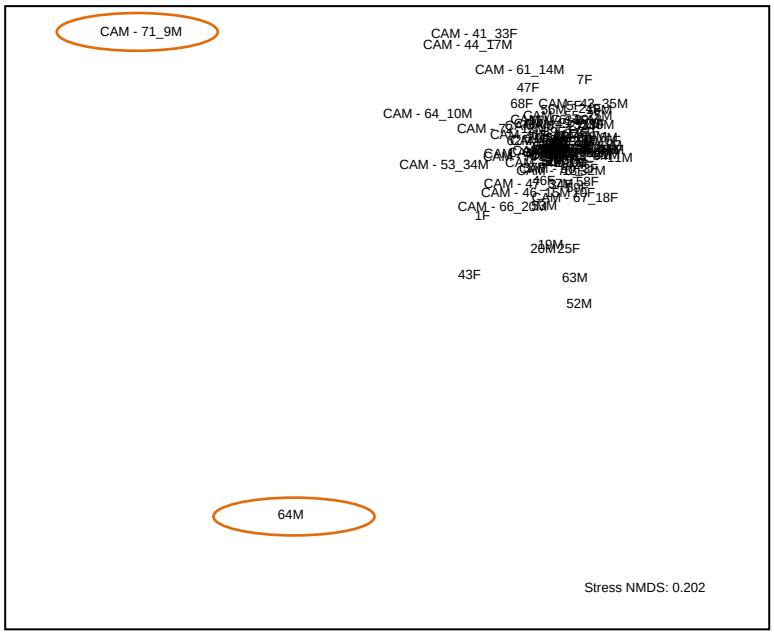

Figure 2: Differences among the participants and the resulting two outliers eliminated from the sample

3.2. Results regarding group labels

The average number of categories into which the 30 methods were grouped was 7.7 for the Beijing students and 6.5 for the Cambridge students. This is not a surprising finding as seven is often reported as a convenient size for building groups or classifying phenomena. The number of categories created varied, however, from as little as 4 groups to as many as 16 groups into which the thirty cards were sorted. More informative than the amount of groups that were created are their names. In the following two tables we have compiled the group labels that were used most frequently by both student groups. The comparison of the two group labels reveals that the British students used a mixture of functional (such as 'decision', 'growth', or 'strategy') and format-based labels (such as 'tree', '2D', 'hierarchy'). Although the Chinese students have used much more functional or domain related labels (they tried to use labels from their strategy course), their groupings are in fact much more based on common *shapes* than common *purpose*. The most frequently used labels in the group from Cambridge were those distinguishing *process* from *hierarchic* charts, namely 'flow charts' and 'tree charts'. In the Beijing group the most frequently used group labels were 'analysis of strategic environment', 'strategy', 'relationships', and 'organizational structure/hierarchy'.

3≤ n ≤5	6≤ n≤ 10	n>10
2D charts	Charts	Flow charts
Area based charts	Decision diagrams	Tree charts
Growth charts	Time diagrams	
Hierarchy charts		
Interrelationships charts		
Line/linear charts		
Xyz charts		
Mathematical charts		
Organizational charts		
Strategy diagrams		
Statistical diagrams		

Table 2: Summary of most frequently used group labels by the 37 Cambridge students

6≤n≤10	11≤n≤20	n ≥20
Strategy layers	Strategy evaluation	Analysis of strategic environments (internal and external)
Different ways to objectives	Strategy control and strategy implementation	Strategy
Business development	Influencing factors	Relationships
Matrix	Market shares	Organizational / corporate structure or hierarchy
Firm's competitiveness	Life cycle	
Evolution	Product related	
Coordinate or coordinate axis, quadrants		
Decision making		
Process or trend		
Trees or branches		
Value chain		

Table 3: Summary of most frequently used group labels by the CUFE students

From these two tables, we can detect three types of classification attributes used by the students: those by ***function*** of a chart, those by the graphic ***format***, and those by the application ***domain*** of a visual format. Functional group examples are such labels as: decision making, classification, comparison, matching, planning, strategy, evaluate. While graphic format group examples are 2d, circle chart, flow chart, hierarchy, process, relationship, sectorial, spatial, static, tree. Domain-related group labels finally are for example: strategy, statistical diagrams, decision diagrams.

From these analyses one overall finding emerges: most students *do not use a single classification principle* to categorize graphic business formats, but rather mix different logical schemes in building or labelling groups of visual formats. While the British students remained close to what they saw and invented highly descriptive names, the Chinese students replicated and applied concepts that they had heard in class and tried to match these with the charts that they had to label and sort. As a surprising result, very few students in either group (a few more in the Cambridge group than in the Beijing group) applied the logic that is typically found in the literature on classifying business diagrams (Ranking, 1990; Lohse et al., 1994; Blackwell & Engelhardt, 2002). Many researched-based classifications distinguish, for example, among *quantitative* and *qualitative* diagrams or among *generic* (such as pie charts or mind maps) and *content-specific* (‘pre-labeled’ such as Five Forces, the Strategy Map or the BCG matrix) diagrams (Fischer et al. 2002). This latter distinction was *not* made by even a single student. This indicates that the distinctions that visualization researchers draw may not be as intuitive or intercultural as previously thought and that diagram purposes and similarities may be interpreted in quite idiosyncratic ways. Nevertheless certain patterns have emerged from the groupings of the diagrams that are discussed in the next sub-section.

3.3. Results regarding emergent groups

One of the objectives of conducting the business visualization card sort experiments in China and the United Kingdom was to combine the results to create a grouping that would be accessible to both groups and that highlights commonalities among the two student groups. In this section, we thus present the results of the picture sorting exercise in terms of the groups that resulted from the average cluster analysis performed with the Prodax statistical data analysis and visualization tool (www.prodax.ch), as well as the resulting groups from a multidimensional scaling analysis and rendering, transforming the similarity ratings into a Euclidian distance model (Borg & Groenen, 2005: 411). By applying average cluster analysis to an ag-

gregated similarity matrix (of all 102 respondents) – which rates the similarity scores of all thirty diagrams – we have generated a dendrogram that classifies all 30 cards hierarchically. The further to the left the forking of a line, the more people have put the linked diagrams into the same group.

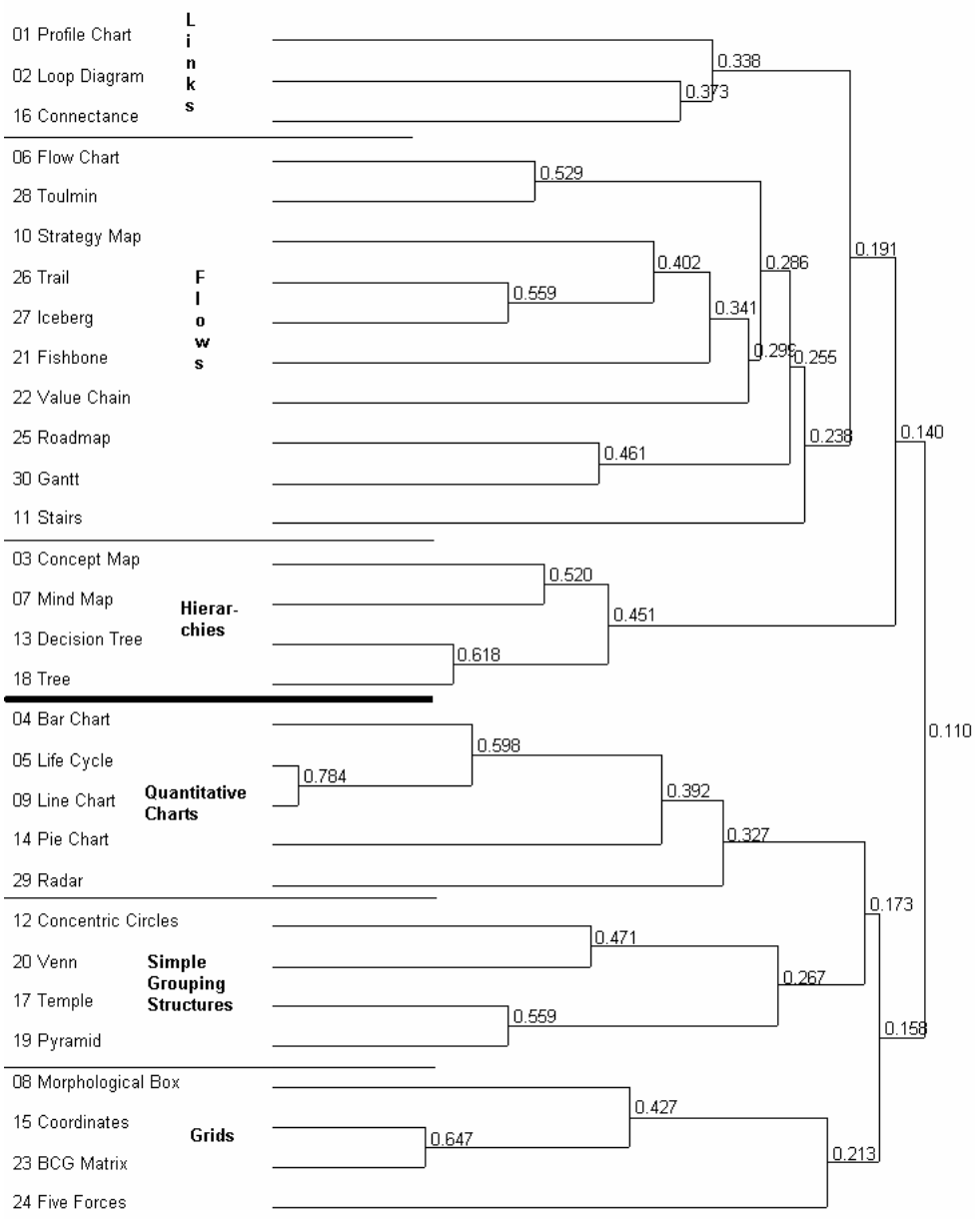

Figure 3: Combined groups of the 102 English and Chinese students

As the figure above illustrates, six groups divided into two categories have emerged from the aggregation through average cluster analysis performed on the 102 card sorts, they are:

1. Graphics emphasizing relations:

a) Links: Multiple relations (causal, rating, connections)

b) Flows: Sequential relations (steps, events)

c) Hierarchies: Hierarchic relations (main concept / sub-concepts)

2. Graphic emphasizing sets:

a) Charts: quantitative sets (along x-axes, pie segments)

b) Shapes: sets based on simple structures or shapes (pyramid, Venn)

c) Grids: tabular/rectangular sets (table, matrix, coordinates, framework)

While the hierarchic grouping represented in the above figure emerged from the aggregated groupings, the labels have been retro-attributed by us in order to make sense of these emergent groups.

We can represent the aggregated similarity scores of all diagrams also in a Euclidian distance model and thus assess which methods were perceived as similar or distinct by the overall rating of both groups. The three dimensional rendering of the aggregated similarity judgements shows that bar charts and line charts, as well as life cycle charts were perceived as very similar (charts group). It also shows that hierarchic formats such as trees, decision trees, concept and mind maps, as well as fish bones are perceived as very similar by the two student classes. Sequential diagrams (flow group), such as flow charts, roadmaps and value chains or stairs, are also perceived as similar but – and this becomes apparent in this rendering of the grouping decisions – to a lesser degree.

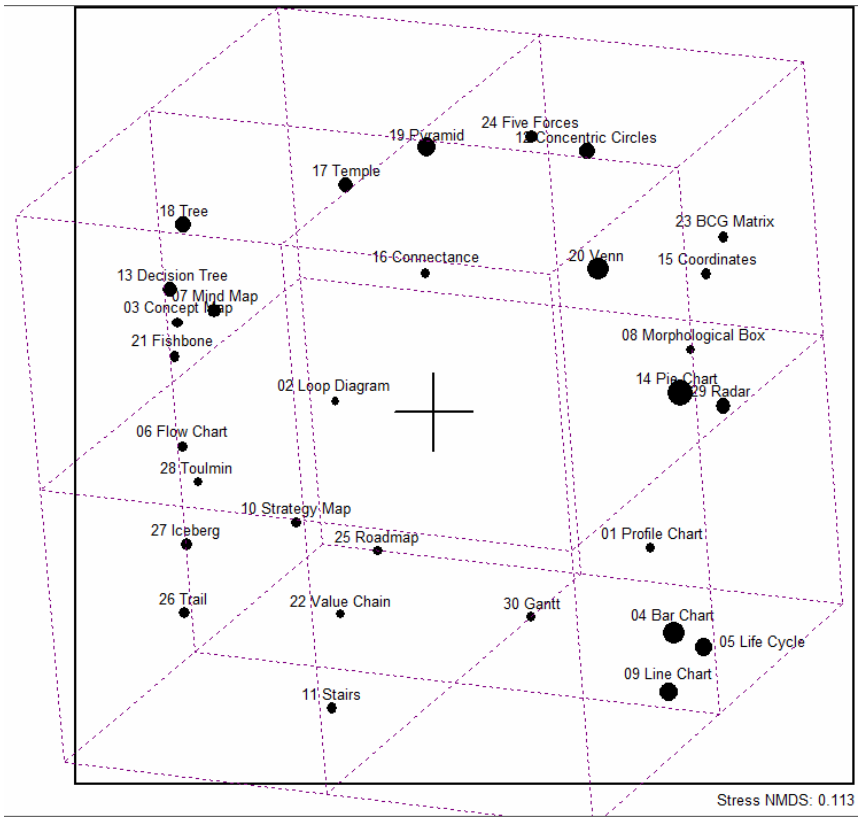

Figure 4: NMDS Rendering of the collective similarity judgements of all 102 students

3.4 Differences among the Chinese and British Groups

Having described the emerging overall grouping patterns, we now focus on the differences among the two student groups. This can provide indications about intercultural or educational differences, specifically regarding differences in European and Asian perceptions of business diagrams.

The following two classification diagrams show the resulting grouping of the Beijing and the Cambridge classes.

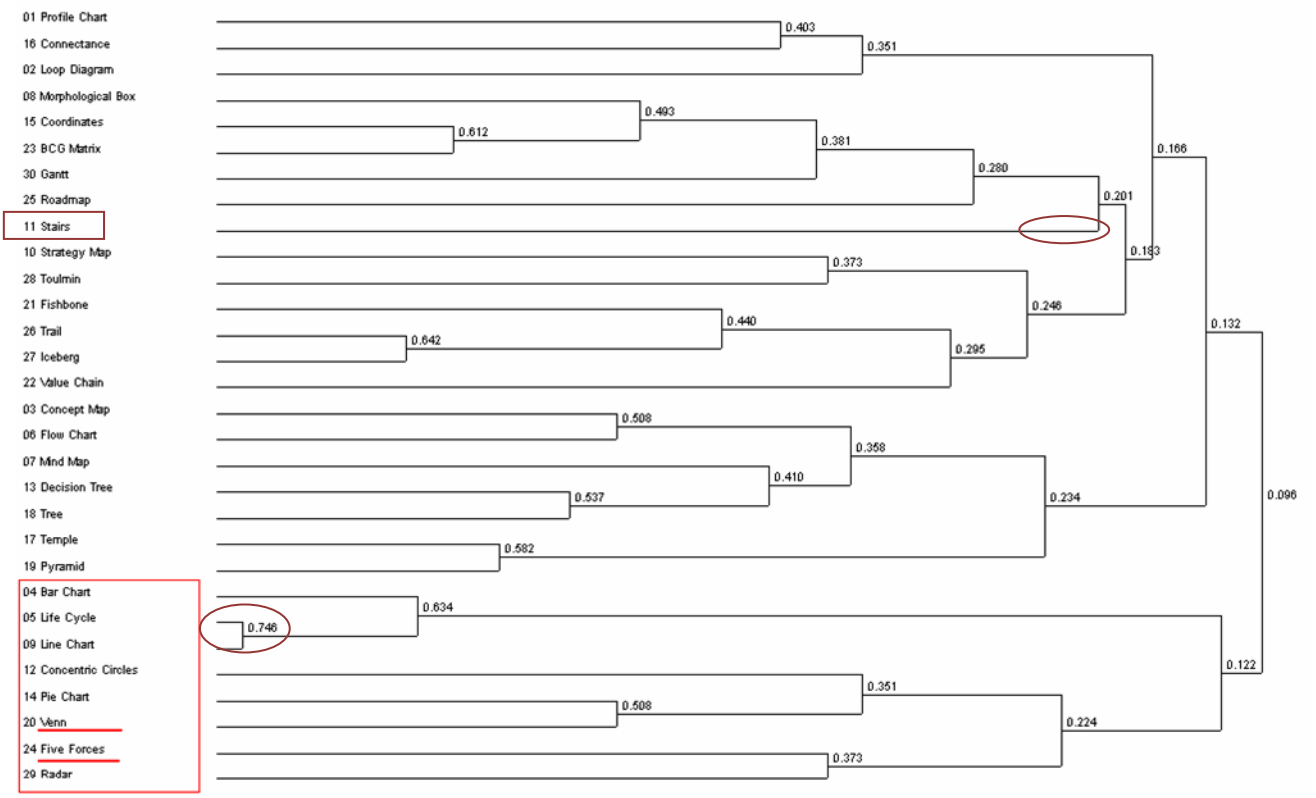

Figure 5: Dendrogram of the aggregated classification of 67 Students from the CUFE Business School (China)

The dendrogram of the Beijing students shows that they group line and bar charts closely, but do not associate them with pie charts or radar charts that also represent quantitative information. They also do not group all of the process charts together as the British students do. The Beijing class seems to have grouped the cards relying on prima facie appearance rather than function or domain.

Figure 6: Dendrogram of the aggregated classification of the 37 students of Cambridge University (UK)

Whereas British students clearly differentiate between quantitative and qualitative methods, Chinese students do not make this clear distinction. The Chinese students grouped the quantitative method of pie charts together with concentric circles or Venn diagrams, which obviously only share their circle-based shape. To test for the impact of gender on the grouping, we have generated an aggregated grouping of the 30 men present in the Beijing group. But this group did not yield a consistent quantitative grouping either. Another odd member of this more quantitative group, that the Chinese students already knew, is the Five Forces diagram. These differences are highlighted in the two figures above.

The greatest similarities among the Cambridge and Beijing Students regard the grouping of the life cycle and line charts, the decision tree and tree, the BCG and coordinates, and the temple and pyramid. These are quantitative and qualitative, abstract and metaphoric diagrams that seem to be perceived as similar regardless of differences in cultural or education.

Further interesting differences and commonalities among the two classes in Asia and Europe relate to the agreement or disagreement regarding the grouping of particular graphic formats: Whereas the Beijing students had the *least* agreement regarding the group member-

ship of the "stairs" visualization (i.e., the forking for that picture is farthest to the right), the "connectance" chart was the graphic format that the Cambridge students *least* agreed on regarding its co-membership with other formats. In terms of the elements that were *most* often grouped together, they were the life cycle and line charts in the Beijing class (which were also often put into the same group by the Cambridge students) and the flow chart and Toulmin chart in the Cambridge group. Although the flow chart and Toulmin diagram may look similar, they serve vastly different purposes. The Toulmin chart (an argument visualization technique) was the least known method in both student classes (they were never correctly labelled by the students). In this sense, the Cambridge students' groupings shows that the Toulmin map and flow chart are 'false friends', i.e., they may seem similar but serve very different purposes.

4. DISCUSSION

The results presented in the previous sections show that students in our sample cannot reliably distinguish among key visual formats and frequently group them according to *misleading detail aspects* (such as the simple presence of arrows or circles). They also create groupings of '*false friends*', i.e., diagrams that look similar, but serve vastly different purposes, such as Toulmin charts and flow charts in the case of the English students, or Venn and pie charts in the case of the Chinese students.

The most frequently used grouping criterion was *shape* or orientation (such as circle, node-link, left-to-right, and bottom-up) which does not provide any guidance in choosing a visualization format. A few individuals, however, have organized the set of 30 methods by purpose, indicating a higher level of expertise or awareness. But none of the participants, as mentioned in section 3.2, has distinguished methods with fixed categories, such as Five Forces, Life Cycle, or BCG Matrix, from generic formats such as tree diagrams, bar charts, or mind maps. Unlike the British students, the Chinese students have not created clear groups of quantitative versus qualitative diagrams. Neither group of students has differentiated the provided visual metaphors (temple, mountain trail, iceberg, stairs) from the abstract conceptual diagrams (such as matrices, circles or tables).

In terms of *practical implications*, this paper has made it clear that one should provide classifications that educate students and managers about the *differing functions* of visual formats and inform them about frequent misunderstanding and ambiguities inherent in certain

visualization formats (such as the misinterpretation of the meaning of unlabelled arrows that can designate functional relations or sequences). The inconsistent groupings also reveal that diagram understanding is neither intuitive nor cross-cultural. Communication managers who wish to profit from the findings reported in this paper are well advised to carefully plan the use of graphic communication formats and to steer clear of lesser known formats such as Toulmin charts or Connectance diagrams. They should make sure, for example, to label arrows, as they are a frequent source of misinterpretation. Providing *interpretative assistance* to business diagrams hence seems a necessity in internal communication, especially when communicating across cultures. One should not take the knowledge about these formats and their conventions for granted.

Our inquiry has not been without *limitations*. Methodologically, the restrictions on the allocated time for the card sorting (35 minutes), the missing prior knowledge about some of the visualization formats on behalf of the participants, and the generic picture thumbnails (i.e., the lack of illustrative content in the diagrams) and their schematic style (and thus perhaps drawing particular attention to the arrangement of the elements) may have negatively affected the reliability of our findings. In addition, the selection of 30 methods can be criticized as arbitrary, as it is not based on absolute measures, but rather on individual ratings of importance and representation. Finally, the study is limited with regard to the choice of participants. While students are a good proxy for future or inexperienced managers, they cannot be seen as representative of the current generation of managers. Future studies should thus apply the card sort experimental method to a management population, and this ideally not just within the scope of a two country comparison, but with multiple countries in Asia and Europe (and feasibly with managers of different experience levels). Ideally such a study would make use of real-life, authentic business diagram examples instead of generic templates as in this study.

5. CONCLUSION

In this paper we have reported on the experience of conducting two card sorting experiments with strategy students in Beijing and Cambridge. The cluster analysis of the aggregated cards sorts resulted in an empirical classification of business graphics according to two overall groups: graphics emphasizing *relations* and graphics emphasizing *sets*. The first group consists of linking diagrams, flow diagrams, and hierarchic diagrams. The second group consists of quantitative charts, simple shapes with embedded information, and grids. Although

these groups can be seen as reasonable collections, they do not seem, from a researcher's point of view, highly consistent (as they mix different classification principles). As a major finding we have thus seen that the students in our sample – regardless of their home country – were not able to generate a highly consistent ad-hoc grouping of the 30 visual business formats. This is partly due to the fact that they did not know all of the business visualization formats or their conventions and that no application context was provided. This makes the education regarding such formats all the more necessary, including key differences, similarities, and application parameters. Based on these results, manager should be careful in using business graphics without providing elaborate explanations as to their interpretation. Our comparative results among the British and the Chinese students further suggest (tentatively) that European managers should be especially careful when using visual means of communication in China, as Chinese employees may not be highly familiar with these formats or interpret them differently (i.e., as with regard to quantitative vs. qualitative charts). Future studies should show whether these generalizations based on our limited student sample are indeed justified. Nevertheless, these results already show that communicating with diagrams in management can be problematic, and that it cannot simply rely on intuition and must consider intercultural differences.

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