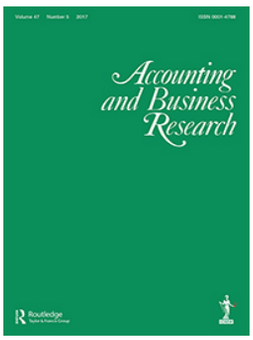

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Embracing ambiguity in management controls and decision-making processes: On how to design data visualisations to prompt wise judgement

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Making decisions when managing organisations always involves the constant management of ambiguity and a great deal of complexity due to uncertainties and the intrinsic political nature of every decision-making processes. This paper argues that in order for management accounting to deal effectively with this ambiguity and uncertainty, both must be embraced, not suppressed, by the design of data visualisations produced by management controls as aids to the decision-making processes. Drawing on studies in rhetoric, alongside others on the rhetorical and communicative power of images and visualisations, this paper identifies a series of principles that can contribute to the development of a visual rhetorical framework to inform the design of data visualisation (e.g. dashboards, business reports). The need to conceive of data visualisations beyond their representational function, and the principles that are identified, are then illustrated through the visual rhetorical analysis of a complex dashboard utilised in the programme management of the construction of a large airport terminal. The paper ends with an outline of a research agenda for the future design of data visualisation in accounting, and beyond.

Keywords: business knowledge; data visualisations; rhetoric; risk; ambiguity; uncertainty; unknown unknowns; wisdom; major programme management

Writers and men of the cloth are the same in that way.
They can't afford to solve the mystery, because the next day they'd become irrelevant.
(Jude Law in *The Young Pope*, by Paolo Sorrentino, 2016)

Introduction

In a world characterised by an increasing degree of uncertainty and ambiguity, the words used by James G. March to describe decision-making processes are as relevant now as ever before:

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> Many things happening at once. Technologies are poorly understood; alliances, preferences, and perceptions are changing; problems, solutions, opportunities, ideas, people, and outcomes are mixed together in ways that make their interpretation uncertain and their connections unclear […]; solutions seem to have only modest connection to problems; policies are not implemented; decision makers seem to wander in and out of decision arenas. (March 2008, p. 36)

What James G. March described in this statement is the norm, not the exception, when observing how decisions are made in daily organisational lives.

Accounting and controls have often been seen as a response to this ambiguity. The supposedly accurate information that accounting provides is crucial in Chandler's history of the emergence of modern corporations (Chandler 1977, Chandler and Daems 1979), where accounting calculations play a key, albeit technical and seemingly neutral, role in orienting managers' 'visible hands' by providing them with information to make decisions on the efficient allocation of economic resources and effective coordination of organisational units. Some of the more sociologically inclined research on accounting and controls (see Chapman et al. 2009 for a review) has placed similar importance on the relationship between accounting knowledge and decision-making. However, for this research stream, in communicating reality, accounting constructs reality (Hines 1988). With their rhetorical power of persuasion, accounting and controls bring an aura of rationality to decisions (Carruthers and Espeland 1991), especially when the relationship between knowledge and action is uncertain and ambiguous (Quattrone and Hopper 2001). They are therefore more likely to appear as key organisational features when organisational actors face situations of uncertainty and opacity, thus becoming a cognitive tool to 'count, not the visible, but the invisible' (Meyer 1986, p. 351). Viewed as such, when both the objectives of the decision and its consequences are uncertain and ambiguous, accounting is a 'rationalization machine' (Burchell et al. 1980) that operates to legitimise decisions or rationalise them 'ex post'. This is the realm of 'unknown-unknowns', to which March's opening quote of this paper alludes.

As Carruthers (1995) noted, expert accountants are aware of accounting's ambiguity as much as accounting scholars are aware that accounting representations are written (or virtual) inscriptions (Preston et al. 1992, Robson 1992, Chua 1995, Dambrin and Robson 2011, Qu and Cooper 2011) that can only partially represent organisational worlds. Such representations are therefore inherently incomplete knowledge systems (Quattrone and Hopper 2005, Wouters and Wilderom 2008, Jørgensen and Messner 2010, Dambrin and Robson 2011) that cannot fully inform rational decision-making, while being fundamental to prompting a desire for such a rational approach to knowledge and beliefs (Knorr Cetina 2001). This attention to accounting and controls 'signs' and the effects that they generate on organisational action and decisions (Lipe and Salterio 2000, Wouters and Wilderom 2008, Qu and Cooper 2011, Busco and Quattrone 2015) has generated a growing attention to the materiality of these signs. In this sense, a number of studies have investigated signs as material platforms (be these screens or pieces of paper) through which, and in which, accounting and control data are visualised. From the layout of old accounting (text-)books and how they engage accounting users (Quattrone 2009), to the role that figures, colours and other visuals play when communicating financial reports (Davison 2015), via the effects that the presentation of accounting information has on decision-making (Cardinaels 2008, Cardinaels and Van Veen-Dirks 2010), we have witnessed a visual turn in accounting, control and organisational studies (Jack et al. 2013).

This paper is inserted into this stream of works. By drawing on historical studies in rhetoric (Bolzoni 1995, Carruthers 1998, 2013, 2015) and combining them with studies on images and visualisations (Kress and van Leeuwen 1996/2006, Stafford 2007) and their rhetorical power (Kostelnick and Hassett 2003, Kostelnick 2004), this paper aims to construct a framework to inform the design of management control visualisations (e.g. dashboards, business reports) in a

way that makes them suitable to deal with uncertainty and ambiguity in decision-making processes. The paper argues that as much as 'words have a history' (Long 2001), visual images and forms have a history too (e.g. Kostelnick and Hassett 2003, p. 50ff), although this tends to be forgotten and visual images acquire new functions under new conventions. Learning from such a history, and understanding the rationales and rhetorical principles which underpinned these images' design, can help to shed new light on the contemporary use and utility of management control visualisations.

The paper also aims to make clear that management control visualisations have further, and possibly more important, roles than the representation of organisational processes and performances. If it is true, even in the more professionally oriented literature, that every 'chart is a manipulation' (Berinato 2016, p. 151), it is even truer that, when one deals with 'unknown unknowns' (which are, by definition, unrepresentable), management control visualisations cannot be seen and used as if they are truthful representational devices. If there is one thing that the accounting community of scholars and practitioners has learnt in recent years (at least from Hines 1988), it is that such images cannot convey 'truths', although it is equally true that such a truth cannot be stretched too far. Management control visualisations are therefore viewed in this paper and, I suggest, must be utilised in practice, as tools to question and envision what such representations cannot represent (Busco and Quattrone in press).

Beyond a modern dream for accurate representations of objective data, and without the presumption of proposing a framework which will works in any given situation, this paper is therefore a step towards the construction of a 'language of images' (Mitchell 1980) in management control and in business more generally.

In order to illustrate this point and to give empirical content to the data visual design framework proposed, I will apply some of these principles to the analysis of a dashboard utilised in managing the construction of the satellite B of Terminal 2 at London Heathrow airport. The paper will conclude with an outline of a research agenda on the language of business visualisations, in order to better understand how to study and design them in a fashion that escapes positivism, while still playing a positive role in managing organisations of all kinds.

The visual turn in accounting studies: from a rhetoric of persuasion to a rhetoric of invention

It is not the aim of this section to provide a full literature review of the works on visualisation in accounting and in organisational studies (for this purpose, see, for instance, Meyer et al. 2013, Davison 2015). The aim is, instead, to show a shift in the way the literature is conceiving of the role of images and visualisation in accounting and beyond.

The publications of works on the role of visualisations in business has recently mushroomed, with special issues of accounting journals (e.g. Hopwood 1996, Davison and Warren 2009), edited collections (e.g. Puyou et al. 2012, Jack et al. 2013, Davison 2015) and comprehensive literature reviews (Beattie and Jones 1992) devoted to the role that accounting visualisations play in business communication. The literature has shown how this role is particularly important when the contours of the business message are not well defined and ambiguous, as is the case, for instance, in intellectual capital (Mouritsen 2003, Davison 2014) and in corporate and social responsibility reports (Déjean et al. 2004).

In accounting, the study of the rhetorical power of double entry as a persuasive tool to engage various audiences has been explored by investigating both the images and the visualisations that populate accounting texts and manuals (e.g. Aho 1985, 2005, Thompson 1991), and those that surround accounting reports (e.g. Davison 2008). The study of the 'visual forms related to accounting' (Davison 2015, p. 123, Table 1) ranges from photographs to cartoons, and in business

communication more generally, it has also begun to involve videos, websites and social networks (Barros 2014). These studies span history too, with some works looking at the evolution of accounting as a rhetorical practice (see the seminal pieces of Aho 1985, 2005, Carruthers and Espeland 1991, Thompson 1991) and others concentrating on more contemporary settings concerning various forms of reporting (see, for instance, Davison's various works, including, 2008, 2014).

In general, as noted by Justesen and Mouritsen, a common theme 'running through most discussions on the visual in annual reports is the attempt by the firm to convince an audience about the firm's capabilities and futures' (2009, p. 973) via strategies of impression management (e.g. Neu et al. 1998) to ensure congruence and consonance with external expectations.

I have noted elsewhere (Quattrone 2009, 2015a) that the link between rhetoric and accounting is not casual, and that the fact that the etymology of the word 'inventory' directs us to *inventio* (the first canon of rhetoric, Rossi 2000) is to be intended as much more than a simple coincidence. Beyond the important persuasive role of accounting (Aho 1985, Carruthers and Espeland 1991, Thompson 1991), there is a more profound and historical link between the revival of rhetorical studies in the late Middle Ages and Early Modern times, and the concurrent development of double-entry bookkeeping and the related formalisation of the accounting craft in a growing number of accounting manuals.

Investigating these links and etymologies through a lexical strategy which links the text to its context ('context' indeed comes from Latin *com*, *cum*, 'with' 'together' and *textere*, Hoad 1996) has helped us to appreciate the nature of both rhetoric and accounting as practices of knowledge invention and composition, rather than simply of persuasion. This has proved useful in understanding the contemporary power of accounting numbers to engage users (Quattrone 2009) and help them to develop unfolding notions of rationalities (Quattrone 2015a). It has also shed light on how certain management control figures operate today (see Busco and Quattrone 2015, on the Balance Scorecard as a rhetorical wheel). This is why, in some of my works, my interest has shifted from the visualisations that appear in manuals and reports, to seeing accounting numbers as figures themselves (e.g. Quattrone 2009, Puyou and Quattrone 2014). This shift has allowed me to conceive of accounting practices as forms of spatial thinking, problem-solving and decision-making, in line with some developments that view business practices as boundary (Star and Griesemer 1989) and epistemic objects (Knorr Cetina 1997) that facilitate both collaboration across different communities of practices, and change management (e.g. engineering drawings, Bechky 2003; business models, Doganova and Eyquem-Renault 2009; power point, Kaplan 2011; and indeed, accounting, Briers and Chua 2001).

A similar strategy of analysis can therefore be utilised here to sketch a framework that could lead to the construction of a grammar of images (Kress and van Leeuwen 1996/2006) in the context of management control visualisations in order for their design to be made consonant with the need to make decisions in ambiguous and uncertain situations.

What follows combines insights from the history of rhetoric (Barthes 1970, Carruthers 2013, 2015) with works on visual design (Kress and van Leeuwen 1996/2006, Stafford 2007) and visual rhetoric (Kostelnick and Hassett 2003) in order to distil a series of design principles that can shape the form of management control visualisations.

Building a framework for data visualisation design in management controls and decision-making processes: a visual understanding of rhetoric

> Rhetoric, Aristotle tells us, has to do with 'things about which we deliberate but for which we have no systematic rules'. [In a nutshell], rhetoric concerns uncertainty. (Miller 1990, p. 162)

In her comparison between different approaches to decision-making, Miller (1990) notes how the problem of uncertainty has often been dealt with as a problem of 'discrepancy between the information available and information needed', in other words, uncertainty has often been treated as 'a problem of knowledge' (Miller 1990, p. 175). This tendency is currently augmented by the availability of large data sets and digital technologies that make us live in a 'screen society' (Knorr Cetina 2003) that continuously instils in organisational actors a desire for more knowledge and perfect information, despite the evident impossibility of epistemic objects to deliver their promises. Given the intrinsic and unavoidable incompleteness of the inscriptions that they produce (Latour 1991, Quattrone and Hopper 2005, Jordan and Messner 2012), visualisations have to be understood as more (and/or less!) than representations.

A rhetorical understanding of uncertainty (i.e. one that is based on pragmatic practices to orient action), rather than an epistemological one (i.e. based on the assumption that uncertainty is solved with more knowledge), would generate this possibility as it would lead us to different sources, ideas and practices of decision-making. As Miller notes (1990, p. 175ff), at least since Aristotle, uncertainty has concerned human actions and not just human knowledge. While a focus on knowledge would ideally end with a binary choice between 'right', on the one hand, and 'wrong', on the other, a focus on action instead implies taking account of ambiguities and potential conflicts amongst organisational actors (March 2008). The need for deliberations, be these management decisions or political choices, emerges because problems have multiple, and often conflicting, solutions. The distinction between epistemic and rhetorical understanding of decision-making processes is thus an important one to make and draw upon, in order to rethink the role management data visualisations play in decision-making processes.

In a language familiar to accounting literature, when one faces non-programmable decisions (Simons 1990), accounting cannot work as an 'answer machine', where more accurate quantitative methods and numerical calculations provide objective data to take better (and possibly best) decisions (Burchell et al. 1980). As it happens, people simply have 'different beliefs about the uncertain future' (Miller 1990, p. 177). This is why accounting has historically (with differences in temporal eras and geographical and cultural spaces), often been viewed as a means of scrutiny, as a platform to mediate different interests and as a source of procedural rationalities, which 'force' self- and collective reflection (Quattrone 2015a) and 'guarantee criticism' (Miller 1990).

In other words, human actions always entail unavoidable conflicts, ambiguities and tensions originating in different attitudes, objectives and beliefs. We therefore need a framework that embraces these conflicts, ambiguities and tensions rather than trying to align them while, in fact, marginalising organisational actors and making them ready to react and disrupt organising processes at the first available opportunity. Ambiguity and uncertainty have to be embraced (Novotny 2016, p. 144ff) rather than expunged. A visual understanding of rhetoric helps to do just that.

A visual understanding of rhetoric

Nowadays, rhetoric is mainly associated with persuasion and, most of the time, in a pejorative sense. However this has not always been, and does not have to be, the case. In the Middle Ages and Early Modern period, for instance, rhetoric was a method to explore ideas at a time when logic and rhetoric were much closer than they are now (Carruthers 2015). Today, rhetoric is still seen as an instrument of inquiry in academic disputes, and of deliberation in public and economic affairs (McCloskey 1985, Nelson et al. 1987, Simons 1990).

In order for rhetoric to pursue this exploration and inquiry, it makes use of various types of mental and material images (Bolzoni 1995). These images range from wheels (as those currently used in figuring out and pursuing strategies through Balanced Scorecards, Busco and Quattrone

2015), to grids and matrixes (like contemporary excel sheets and budgets, Busco and Quattrone in press), and hierarchies and trees (like those normally associated with modern bureaucracies, Chandler 1977). What follows explores the principle that rhetoric is an art of imagery composition devised to prompt a reflection on the unknown, be this related to the mystery of God (as, for instance, in spiritual exercises), or when managing complex situations, such as missions to unexplored territories (Quattrone 2015a).

In search of wisdom: sacred oppositions, the value of variety, and the need for aesthetical harmony

A key image utilised in rhetoric to classify and invent knowledge is the tree (see Bolzoni 1995), which is used in managerial hierarchies thanks to the translation of the *Parisienne* pedagogy in the administration of the US railways through the West Point connections (Hoskin and Macve 1988). The association between hierarchies and bureaucracies is thus somewhat misleading, as the origin of this specific imagery is to be found in a different space and time that does not coincide with the 'managerial'. Hierarchies are, indeed, often seen as instruments of subordination (Levine 2015) and lines of command, control and coordination (from Frederick Taylor onwards), which make orders flow from top to bottom. This managerial understanding of hierarchies is not surprising as all kinds of images, charts and graphs are highly conventional, with their design 'socialized by discourse communities that construct, adapt, and refine conventional practices and that enculturate users into those practices' (Kostelnick 2004, p. 225). We are so used to seeing these images, that we 'are unlikely to regard them *as conventions*' (Kostelnick and Hassett 2003, p. 15). Our understanding of the graphical design of hierarchies is not an exception to these conventions. Debunking them requires some work.

This is why, in this and other works, I have often gone back to the history of accounting terms and visualisations. The search for etymologies of accounting terms and the construction of carefully crafted analogies between current data visualisation designs and their precursors belongs to lexical strategies of inquiry (Carruthers 1990, 1998, 2013), which seeks to explore how certain everyday practices have the form they do today: understanding the forgotten use of these contemporary visualisations and why they were designed can potentially reveal what affordances they have as forms that organise our thinking and acting (Pollock and D'Adderio 2012, Levine 2015). Understanding the power of images, their functioning, their grammar and even their syntax (that is, how they are linked together; think, for example, of the links between balance scorecards and strategy maps) requires this kind of analogical and etymological work.

Hierarchies (and rhetorical trees; Ong 1961, 1982, Bolzoni 1995), those to which management scholars are so familiar, are central figures for understanding how rhetoric works both as an instrument of knowledge classification and of knowledge invention, composition and inquiry (Carruthers 1998). They historically mediated vertically between celestial and terrestrial matters (hence the sacred nature of hierarchy, from *hieros*, sacred and *arche*, rule). Horizontally, they established a creative tension between two equidistant opposites, in a 'sacred geometry' (Lowlor 1982) that inspired a sense of proportion, a *ratio*, which would have then generated a kind of '*ratio*-nality' (Quattrone 2015a). Occupying and seeking a middle ground and a middle measure was a synonym of wisdom (Weyl 1952) and the idea of a balance between two opposing poles was meant to be key to the exercise of good judgement (Kaye 2014). The graphical design of hierarchies, in recursive analytical divisions (see Figure 1, for a representation of the Jesuit Order which could potentially allow the recombination of various organisational units and the continuous ordering of the Society), created a series of spaces 'in between', which generated a locus of interrogation (a negative space, Agamben 1998) and allowed a third party to mediate between opposites, guaranteeing the productive role of the tension

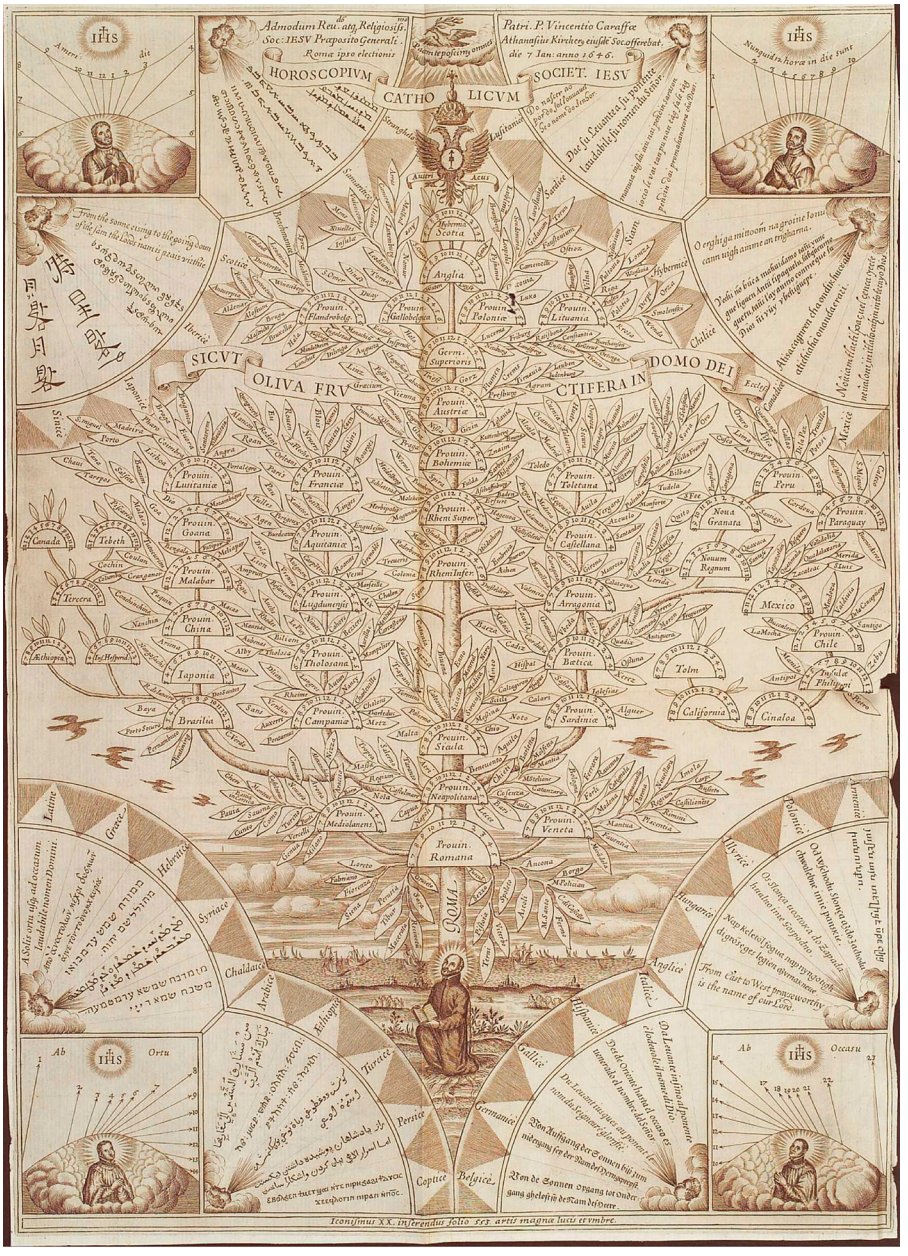

Figure 1. The universal chronoscope of the Society of Jesus (Kircker 1646).

generated by the opposition. For accountants, where balance and graphical symmetry have characterised the whole history of the craft (Thompson 1991, Puyou and Quattrone 2014), these are quite relevant notions, especially given that *ratio* in Latin, also means 'account' (Goody 1996).

Rhetoric has, therefore, a 'taste for tensions' (Carruthers 2013, p. 22). This technique of purposefully seeking dissonance (Stark 2009) was otherwise known as *controversia*, that is, a practice of constructing 'pairs of terms compared and contrasted, brought into neighbourly

conjunction' in order to foster speculation and the exercise of judgement (Carruthers 2015, p. 13). In the late Middle Ages and Early Modern period these rhetorical techniques were used in religious practices to foster the exercise of judgement via meditation and reflection, for example, when monastic practices utilised tensions and *controversiae* to make sure that friars used the known almost as an excuse for speculating about what they could not know (i.e. the mystery of God, Ward 2015).

This taste for oppositions is the first of a series of principles that rhetoric has devised to understand how to design visualisations that are aesthetically harmonious, and may eventually prove helpful when making decisions in ambiguous situations (see Figure 2(a)).

This tension was also crucial to make sure that one could use the known to interrogate, and eventually comprehend, the unknown. As Mary Carruthers eloquently stated in reconstructing the craft of medieval thought:

> If I am asked to think about something that does not actually exist [e.g. a possible future and uncertain event], I can readily do so. No one has ever really seen a black swan (*cignus niger*). But one can picture the bird because one knows what a swan is and what black is, and so the thought-image is readily made. (Carruthers 2013, p. 50)

What we see here is a skilful *inventory*, that is, a catalogue of notions classified in abstract categories or physical spaces, for example, *cignus*, *niger*, which generates an *invention*, that is, new knowledge, by the means of recombination (the second canon of rhetoric, *ordinatio* and *dispositio*).[1] The larger and more diverse the inventory, the greater the possibility of recombining the elements of this inventory to generate new knowledge. In this way, black swans (Taleb 2007) have always been in our imagination and memory so that, when we eventually find one on our trip to the Antipodes, we are ready to understand and embrace it: embracing unknown unknowns requires a huge variety in the blocks that constitute our knowledge in order to foster our ability to imagine what we do not know.

This emphasis on symmetrical oppositions is thus augmented by the notion of *varietas*, that is, variety, another feature that good rhetorical images should have (see Figure 2(b)). *Varietas* in Latin 'resists single definition. [It is] a word covering many degrees of experience along a continuum between opposites […]. The very imprecision of the measure is essential to its nature, for variety can never be one thing' (Carruthers 2013, p. 136). Here we are back to the epistemic vs rhetorical understanding of uncertainty and ambiguity, where the natural tensions that characterise political and organisational lives are reproduced in the system that aims to make sense of them.

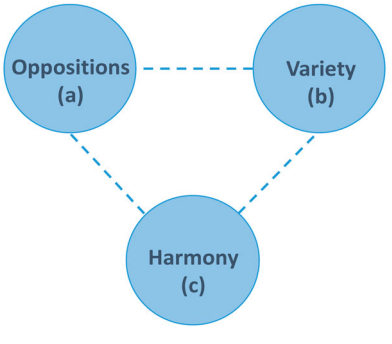

Figure 2. A triadic understanding of a rhetorical composition of imageries.

Varietas lays the ground for the exploration of different *ducti*, that is, patterns and paths (Carruthers 2010), and thus requires the exercise of judgement when choosing the way to follow. It requires *arbtrium*, which will eventually lead to harmony. Variety is an essential feature of every rhetorical composition, from music (as in polyphony, where 'the harmony is produced [by] a combination of disparate voices sounding together', Carruthers 2013, p. 141) to visual representations which become 'polyfocal' (Carruthers 2013, pp. 151ff), that is, they require the eye to continuously move across them, thanks to a high degree of difference in the technical composition of the image (e.g. different colour, sizes, etc.). Figure 3, for instance, works in a polyfocal way: given the different sizes of the painted characters and the background colour of the fresco, the eye moves from one point to another making counting the devils represented in the picture difficult, as the convention of the folkloristic tradition wants (Pitrè 1871–1913/1981).

Like Byzantine icons (Pentcheva 2010, p. 2), which are performative not because they force the user to see the icon in a unique way, and thus convene a given message, but because they transform the spectator into a participant to the visual and sensual experience generated by the aesthetic of the icon, visualisations designed in a polyfocal manner call for the viewer to choose where to look first (Carruthers 2013, p. 161): 'Rather than transparence, here the sought-out aesthetic is that of layered opacity, of solid yet coruscating covers' (Pentcheva 2010, p. 148). The polyfocality of the *varietas* generates and draws upon ambiguity, which then becomes a key element to prompt judgement and wisdom: *varietas* becomes the space 'in between' aesthetic and ethics, making them meet.

And yet, this epiphany of variety and difference does not have to be pushed beyond a certain limit. One would otherwise run into the unintended consequences of making the viewer/participant confused. As argued by Pollock and Williams (2017, p. 250), in relation to the famous Gartner's Magic Quadrant, this 2 × 2 matrix does not have to be representative of all firms operating in an industry in order to construct a market for their solutions: too many dots in the matrix would leave the viewer confused, offering her too many cues to follow. Similarly, in medieval rhetoric, for *varietas* to be generative and effective, *curiositas* was not to be fostered to the limit of becoming superfluous or confusing (Carruthers 2013, p. 150). Understanding where to stand in the

Figure 3. *I diavoli della Zisa*, Palermo, Castello alla Zisa.
Source: www.wikipedia.it, accessed on 06/01/2017.

opposition between *varietas* and *curiositas* required skilful training and an acute sense of aesthetics: it required aesthetical harmony (Figure 2(c)).

Operationalising wisdom: in-tensions, di-visions, in-difference

I have noted elsewhere how the composition of rhetorical images requires the visual to be conceived as a performable space (Busco and Quattrone 2015) in which the participant is called on to perform an activity. Here I add that this action also implies the making of a choice, in terms of what path to follow, with the eyes moving along and across the visualisation itself. Given the moral and pragmatic nature of rhetorical compositions, utilised in fields as disparate as meditation and accounting, their purpose was to foster action and choice. In other words, the rhetorical composition of the figure that the visualisation affords always implies the choice of a path, a *ductus*. This choice requires an *intentio*, that is, an intention, a purpose (from Latin, *intendere*, 'to turn one's attention', literally 'to stretch out'). But this intention does not have to be understood as a fixed purpose, an immanent teleological and functional objective, as most functionalist management practices do. It needs to be interpreted instead as a 'movement' around the various paths that the visualisation offers. In that sense, an *intentio* is always '*in*-tension' (the first design principle, as in Figure 4(a)). As much as the modern accountant has to move across the different spaces represented by the accounts in a chart of accounts, the medieval viewer finds herself navigating the visualisation as if she was entering a maze, which offers, through the convolutions of its various paths, an opportunity of choice, and therefore an opportunity for reflection and the exercise of judgement.

This choice requires, though, a calculable ability that goes beyond numbers and extends to 'manipulating letters, bits of text, and common places' and, not lastly, colours (Carruthers 1998, p. 19). A calculative skill which is both highly spatial and highly visual, as the etymology of the word 'division' suggests (from Latin, *de-*, 'to be about' and *dis*, 'two' + *videor*, i.e. to see but also to imagine), the tension between two opposites (a spatial separation) allows seeing and imagining things better (the second design principle as in Figure 4(b)).

But what makes these judgements and calculative abilities wise? The key is in the attitude towards these different choices, towards this epiphany of difference. In order to navigate this difference and embrace the ambiguity generated by the multiple paths and courses of action, one has to inhabit the middle ground of the *diversitas*, that is, one has to be '*in*-different' to different choices (the third design principle as in Figure 4(c); see Quattrone 2015a, in relation to rational vs reasonable choices). It is this indifference that makes rhetorical and logical oppositions productive, as it is standing in the middle of them, in an equidistant (*ratio*-nal) position between

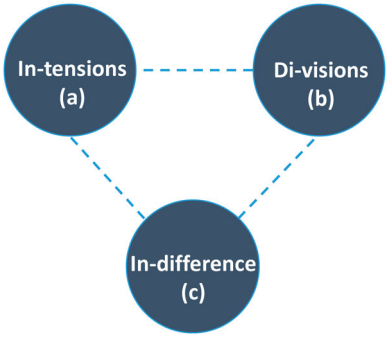

Figure 4. A triadic set of design principles for a rhetorical composition of imageries.

the two, that makes the viewer see but also generate unity out of difference, by keeping the opposites together (see Quattrone and Hopper 2006 on IT systems as 'heteromogeneous objects').

It is this complex balance between opposites, between *varietas* and *curiositas,* between the different views, conflicts and beliefs, that make calculations possible even when they concern what cannot actually be positively represented, and therefore needs to be imagined. It is the combination (and recombination) of 'di-visions', 'in-tensions' and 'in-difference', supported by a proportioned variety, opposition and harmony, that in rhetoric informs a wise and aesthetically balanced composition of images and, for the aim of this paper, visualisations.

In summation, to see the unseeable, be this the black swan of modern theories of complexity or its analogous ancestor (the *cignus niger*), one requires 'imagin-ation', that is, the action of composing images of the unknown (either in the mind or on a piece of paper or a screen), not representations of it: *Videor* is 'the verb of imagination and envisioning', not of mimesis (Carruthers 2013, p. 40).

This shift, from a representation of 'passive' objects to a productive imagination operated by rhetoric, is made possible by what I call a visual rhetorical apparatus for Data Visual Design (see Figure 5), which I will utilise in the remainder of this paper to inform a visual analysis of the design of one of the dashboards used in the management of the construction programme of Terminal 2a at London Heathrow airport.

It is this apparatus that lays the foundations for a visual based 'rhetoric of inquiry' (Simons 1990) that can then be utilised to design what Churchman defined as 'inquiring systems' (1971). These systems, in the context of accounting, do not seek to provide users with answers but seek to elicit questions, scrutiny, judgements and wise choices. Visualisations are therefore epistemic objects of experimental inquiry (Stafford 2007, p. 6), which build upon their incompleteness and ambiguity. What I am proposing here, and have begun to outline elsewhere (Quattrone 2015a, b, c, Busco and Quattrone in press), is a Socratic approach to the design of accounting visualisations, where answer machines (Burchell et al. 1980) have to be supplanted by maieutic ones, where the term 'maieutic' refers to the Socratic method of generating knowledge by asking questions (from the old Greek, *maieuticos*, 'midwifery').

Exemplifying data visualisation design: insights from the analysis of a dashboard

This section does not presume to offer an empirical proof of the principles and practices that I have described in the previous section. Rather, it provides, as would be the case with the rhetorical

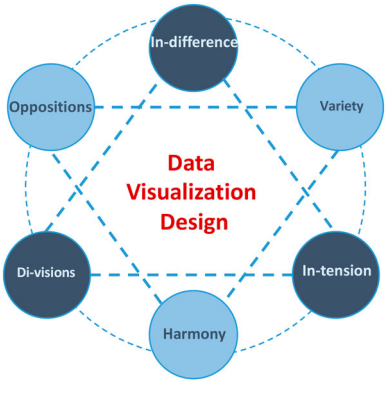

Figure 5. A visual rhetorical apparatus for Data Visual Design.

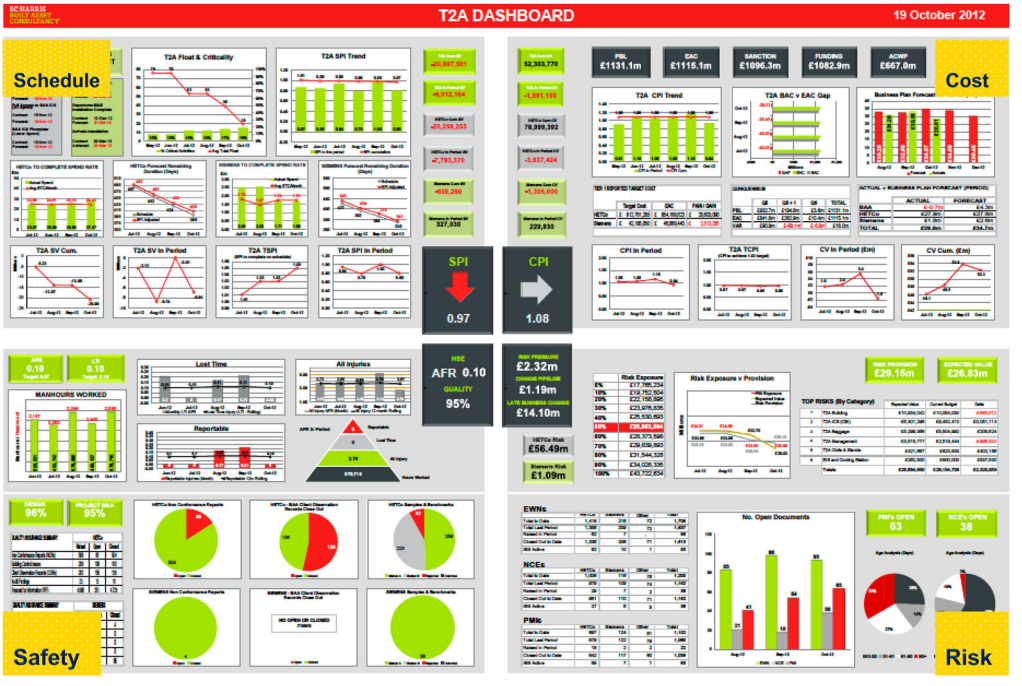

Figure 6. Visualising ‘Di-visions’, ‘In-tensions’ and ‘In-difference’.
Source: EC Harris/Arcadis company material, with adaptations.

structure of early modern ‘how to do’ books (Oldrini 1997), an example of such principles and practices in order for the reader to appropriate them as they find suitable.

The dashboard reproduced in Figure 6 is from a much broader project on reporting and governance practices in major programme management. It refers to one of the various project controls used to keep track of the construction of London Heathrow Terminal 2a.

As is often the case with images (Kress and van Leeuwen 1996/2006, p. 79), one of the first things this visualisation does is to produce relations, in this case among four distinct but related aspects of every individual programme or project: Schedule, Cost, Safety and Risk. Everyone familiar with major programmes knows the adage ‘Safety first!’, which was particularly relevant for this major programme given the excellent safety record that it enjoyed. Forms indeed prioritise and subordinate (Levine 2015), and often produce a ‘covert taxonomy’ (Kress and van Leeuwen 1996/2006, p. 78), where certain features of the story are subordinate to others, although this subordination is not explicit. This visualisation is instead built on a series of dichotomic oppositions (see Figure 2(a)) which are conceived as logically opposed and geometrically proportioned: it embeds oppositions that lead to a division of space based on logical tensions (see Figure 4(a,b)). This not only relates to the graphical design of the four areas and the space that they occupy on the dashboard; it also relates to the implied logical relations amongst these four aspects of the programme: one cannot increase the speed of delivery without incurring greater costs, nor can one reduce costs without risk of ruining the excellent safety record. In other words, this data visualisation is a ‘topology’, where space and logic are intertwined, in this case in a ‘compositional symmetry’ (Kress and van Leeuwen 1996/2006, p. 89; Weyl 1952, p. 1952) in order for them to generate effects on the viewer (Kress and van Leeuwen 1996/2006, p. 99) through processes of non-verbal thinking (Ferguson 1992).

This visualisation then constitutes the space for this conflict to not only take place (Miller 1990) but also to be purposefully orchestrated and mediated, in order to make these tensions potentially productive and creative (Lowy and Hood 2004, pp. 10–11). It reproduces but also generates a series of tensions that work not only horizontally and vertically but also, as in polyfocal images, diagonally (Carruthers 2013, p. 13).

This polyfocality is also expressed in other aspects of the visual design of this dashboard. Firstly, through the *varietas* of its composition (See Figure 2(b)), the viewer is presented with a plethora of now-familiar shapes and forms (pie and bar charts, histograms, arrows) and colours (white, green, black, red), which can be operationalised thanks to those visual conventions that characterise Western (and increasingly global) contemporary management practices, as well as those specific to this organisation and programme. Secondly, through the dynamism and movement that it generates, the eye is 'forced' to move up *and* down, back *and* forward, left *and* right as in a maze, in a searching process where programme managers do not exactly know what they are looking for until they have found it (Stark 2009, p. 1).

These supposedly scientific and objective representations are much closer to a work of art than we can possibly imagine. Kress and van Leeuwen (1996/2006, pp. 85ff) elegantly teach us that images have 'carriers' which denote the whole (the LHR T2a programme in our case), and 'attributes' which define the whole in terms of certain features and not others (e.g. schedule, cost, safety and risk) and, in our case, according to certain canons (e.g. quantitative vs qualitative information). In relation to Figure 7, for instance, they note how van Doesburgh's *Pure painting* is not too dissimilar from a map, as it tries to tell something about a reality, but does so partially and in very abstract terms, with 'rectangles of different size and colour' which do not define the carrier or the attributes of the whole: The painting thus 'leaves the viewer to do so' and 'is open to many readings' (Kress and van Leeuwen 1996/2006, p. 90) which are not imposed by a representational

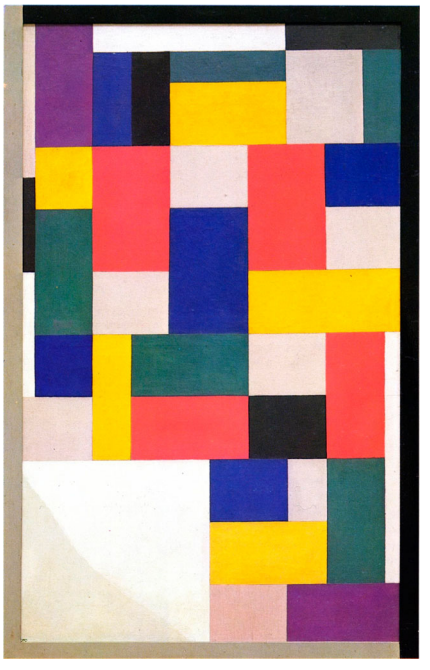

Figure 7. *Pure painting* (Theo van Doesburg, 1920) (quoted in Kress and van Leeuwen 1996/2006, p. 91). Source: commons.wikimedia.com, accessed on 06/01/2017.

or perspectival gaze, but actively chosen by the viewer who operates within the frame that the painting offers.

As Pentcheva notes in relation to Bizantine icons (2010), here as much as in the dashboard the viewer is not a spectator but a participant, an organisational actor who wanders around the visual space. These images are *imagines agentes*, that is, acting images (Carruthers 1998), because they 'demand' (Kress and van Leeuwen 1996/2006, drawing on Panovsky 1953) the viewer to do something. This is the case, for example, for 'Uncle Sam' when he states 'I want you' and calls for youths to go to war (Mitchell 2005, see Figure 8).

These visualisations and pictures also reveal a certain lack of complete information, in the case of LHR-T2b; of priorities, as is the case in *Pure painting*; and of ability to go to war, as in 'Uncle Sam', who therefore has to rely on 'you' to fight the war (Mitchell 2005). They are not (and in most cases cannot) be exhaustive (i.e. they do not intentionally include all of the features of the carrier, Kress and van Leeuwen 1996/2006, p. 96).

This lack of 'exhaustivity', in the case of major programmes and more generally, becomes an ontological as well as epistemological issue. It concerns the very nature of the programme (which

Figure 8. Uncle Sam (J. M. Flagg, 1917) (quoted in Mitchell 2005).
Source: www.wikipedia.com, accessed on 06/01/2017.

is difficult to define for all kinds of reasons ranging from the technical to the political), and not just the impossibility of representing it (on the ontological vs. epistemological approaches to complexity and knowledge, see Law and Singleton 2005).

The case of the HMS Queen Elizabeth aircraft carrier programme is a case in point. If we think of this artefact as a warship, we would considerably limit our ability to manage the programme, because it is so much more than that: it is a hotel, a nuclear power station, a small community of thousands of workers, a research and development department, a defence weapon and a political deterrent, for instance. Yet, this multiple ontology is also emergent and in a state of flux as this warship has the potential to become even more than this list implies. It has the tendency to become 'other than itself' (Ricoeur 1990, Latour 1993), when, for instance, large programmes such as this are mobilised for purposes that were not imagined or defined at the inception of their long life. In order to manage them, it is necessary and useful to define and think of them in negative terms: 'This is not a warship!' is a much more useful statement to describe the artefact and manage its construction and delivery than its positive counterpart (see Figure 9).

This is why financial reports about major programmes often include, and are closed with, an 'allowance' rather than a 'result': the allowance is a 'matter of concern' which fosters political and technical debates (concerning the size of the allowance), creativity and invention (to address the concern effectively). A measured performance, instead, tends to be interpreted as a 'matter of fact' and is more backward than forward looking (Latour 2005, Revellino and Mouritsen 2015).

Our dashboard also expresses a 'lack' in the sense of a central space of undecidability (see the central grey area of Figure 10), a space 'in between' the four tensions that cannot be aligned and that therefore forces a debate amongst the four managers accountable for schedule, cost, safety and risk, making them embracing the unavoidable ambiguity and uncertainties that characterise large projects. A debate should be orchestrated by the programme director, who ideally occupies this central space in a way that is theoretically 'indifferent', that is, that cannot give institutional preference to any of the four aspects while making daily decisions on which of these aspects are to

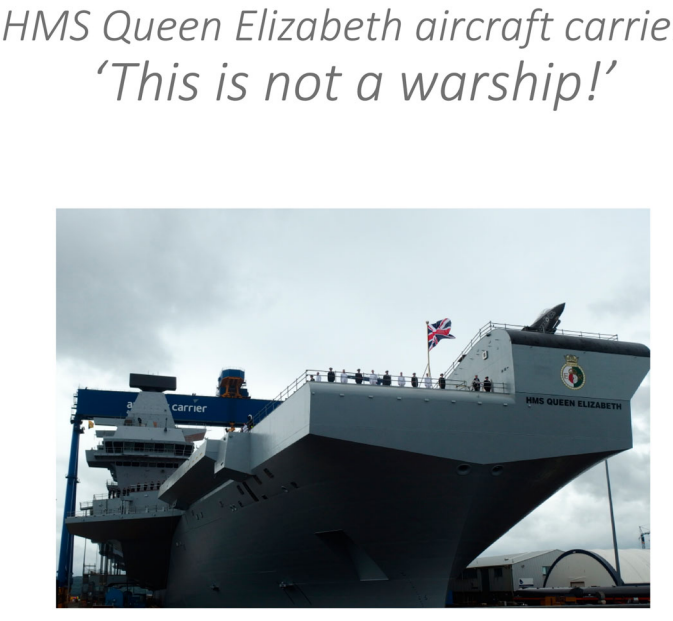

Figure 9. *This is not a warship!* (photo by Tony Graham, with permission from the author, and adaptations).

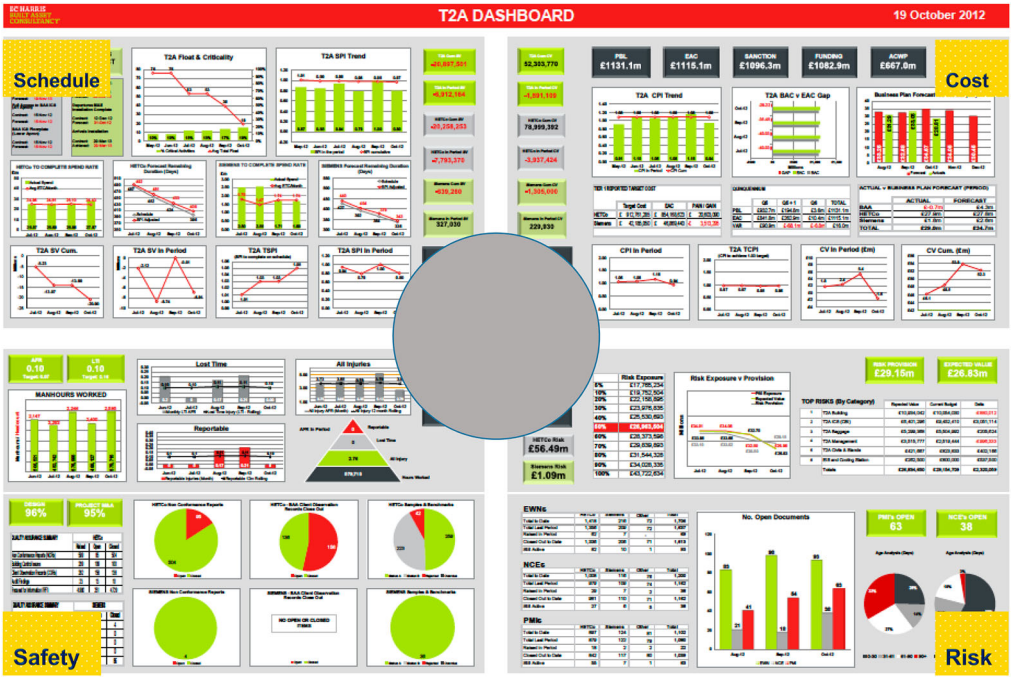

Figure 10. In-different and un-decidable spaces.
(Source: EC Harris/Arcadis, with adaptations).

be pragmatically prioritised (see Figure 4(c)). Only this indifference can lead to harmony in the programme. As Mary Carruthers reminds us, a rhetorical space is always 'social and political, requiring not just actual knowledge but wise judgements. [Rhetorically] derived truths are "opinions" (*doxa*, *opiniones*) [which] are contingent upon circumstances and particular occasions' (Carruthers 2013, p. 42). These judgements 'need to be confidently made, so belief is not entirely a matter of logical demonstration […] but also requires "feeling confident" in one's particular decision' (Carruthers 2013, p. 42). A confidence (*cum fides*) is always a matter of belief and credos, and is formed thanks to practical experience and careful theoretical training. It is this experience and training that allows programme managers to deal with the contingent situations that abound in major programmes, and keep them awake at night and alert during the day.

We are back to that imaginative, rather than mimetic, nature that a rhetorically informed understanding of visual design reveals. Figure 10 shows how the dashboard cannot fully represent the programme (as the whole in the middle of Escher's *Print Gallery,* to which I refer in Quattrone 2000), but constitutes and offers us (or the programme manager) the 'scaffolding that support[s] our thinking' (Stafford 2007, p. 22). The structure of the dashboard does not speak so much about the inner structure of the programme, which is selectively described in terms of 'safety', 'cost', 'schedule' and 'risk', given the practical impossibility of giving a full account of the programme on an A4 page. Rather, it tells a lot about the inner mental structure of the 'habit of the minds' (Kostelnick and Hassett 2003, p. 23) of the programme managers who have designed it, and recursively use it. Such a habit is made of spatial thinking and visual conventions that constitute a 'rich arsenal of analytical means' (Lefèvre et al. 2003, p. 84), and is a powerful tool of reflection and imagination, not just representation.

The dashboard is therefore in between the performative power of images (which try to constrain viewers) and the performance that allowed (which liberates and empowers them). It provides a narrative to the project, but also narratively constructs the identity of the managers involved in its design and use, in a triadic relationship between the dashboard (i.e. the aesthetic work), the programme manager (not only the designer of the dashboard but also the users who, thanks to their wandering around the complexity of the dashboard, make it work differently every time they use it), and the various and emerging stakeholders (be they firms in the supply chain, local authorities, team members or political stakeholders) intertwined with the programme and who have to be enticed and managed as well as 'fought' when truth is stretched too far, or organisational politics become unmanageable. Such triadic relations (see Figure 11) co-define the contingent function of the dashboard itself, making the symbols it portrays (e.g. charts and arrows) work as 'generative symbols' (Stafford 2007, p. 16). The dashboard is not a simple representation, but an 'echo object' (Stafford 2007) that requires a community for it to work.

This is also a dashboard where the relationship between the centre and the margin is constantly in a state of flux, as what is marginal one day can become central the next. As in Medieval manuscripts, on which the modern gaze had not yet acted as a subordination mechanism, rendering some aspect of an image more prominent and therefore more important than others, the page constituted an engagement space where margins (the decorations on the board of the page) and the centre (the body of the text) are in a constant state of relationship and flux (Camille 1992).

The centre of the dashboard, though, is the space that a skilful programme director must inhabit in order to find harmony in the programme (see Figure 2(c)). Like in polyphony's *discordia concors*, numerical and proportional relationships 'unlike sounds concord with each other', generating 'the eternal harmony of life and of the conflicting elements of the whole world [which] is united as one with material things' (Carruthers 2013, p. 160): a unity made of difference rather than homogeneity, a unity that embraces rather than suppresses: a form of communication becomes therefore a form of governance (Quattrone 2015a, c).

What we see in this data visualisation is a dual and synchronic process of compression, where the ambiguities and uncertainties of complex programmes are reduced to numbers and graphical signs, and of augmentation, where what is known, for example, a measure, is used to interrogate what cannot be known (see Stafford 2007, Carruthers 2015). It is the same rhetorical process that allowed the geometrical construction of gothic cathedrals, where 'complex sets of anticipated spaces, events, and circumstances […] were compared and assessed' in order to then be '*expanded* in the laying out of the edifice' (Murray 2014, p. 200). This process resembles Latour's *circulating reference* (1991, p. 72) where every inscription reduces the complexity of

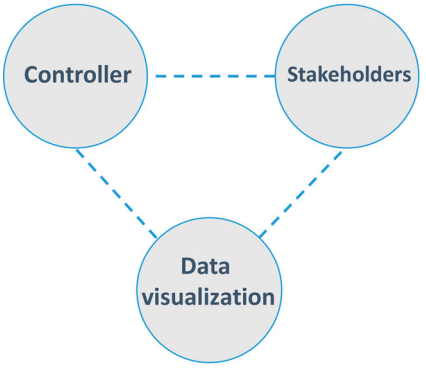

Figure 11. The triadic relation of data visualisations designs.

the represented phenomenon to numbers, but also amplifies the possibility of our understanding by producing standardised, uniformed and comparable figures. In our dashboard this happens too, but the augmentation does not end with standards that close the range of possibility but with images that open, and augment, our ability to deal with the unknown, thus making us not only want and desire for more of these representations (Knorr Cetina 1997), but also hope and believe that these figures will eventually help us to deliver the programme. The dashboard of Figure 10 embeds all of these data visualisation design principles in a way that makes it of a rare aesthetical beauty and effectiveness.

Towards an understanding of the language of business knowledge: a research agenda for data visualisation design

> We still do not know exactly what pictures are, what their relation to language is, how they operate on observers and on the world, how their history is to be understood, and what is to be done with or about them. (Mitchell 1994, p. 13).

Mitchell's statement above is still very true today, in all of its facets. We are just at the beginning of a process of understanding how images (see Davison 2014), business charts (e.g. Pollock and Williams 2017) and accounting formats and graphs (e.g. Thompson 1991) affect the way in which we conceive of organisations, markets, societies and relationships between various organisational actors and external stakeholders (Bell et al. 2013).

The statement is also true in relation to our lack of understanding of the genealogy of business visualisations. Drawing the contours of a research agenda for better understanding data visualisation design cannot thus ignore the development of a historical analysis that draws together the various uses, translations and cultural influences through which these visualisations have historically developed. As beautifully shown by Paul Crosthwaite, Peter Knight and Nicky Marsh in their exhibition *Show me the money* (Crosthwaite et al. 2014), understanding the culture that surrounds and is constituted by visual and material artefacts requires attention to be paid to broader echo systems of cultural, business and economic knowledge and practices. In Mitchell's words, picture theories require 'a critique of visual culture that is alert to the power of images for good and evil and that is capable of discriminating the variety and historical specificity of their users' (Mitchell 1994, p. 3). The same applies to the study of data visualisation design.

In an era fully dominated by images (increasingly produced, diffused and translated by new forms of digital communication), it is not paradoxical to call for a historical, and therefore intrinsically cross-disciplinary, understanding of those visualisations whose function and role we now take for granted. This is the case, for instance, with organisational charts and their hierarchical layout. Is there any scope for the design of images that either debunk this taken-for-granted and implicit subordination (Levine 2015) or utilise more 'democratic' representations where proportionate tensions and relationships are fairly pictured, and therefore potentially generate different kinds of social interaction? In this paper and others (e.g. Busco and Quattrone 2015), I have tried to show that this is possible. In trying to achieve this aim, the combination of history and cross-disciplinary work repays the enormous effort required (or at least it repaid my *curiositas*!).

Mitchell also noted that:

> Images are certainly not powerless, but they may be a lot weaker than we think. […] That is why I shift the question from what pictures *do* to what pictures *want*, from power to desire. (Mitchell 2005, p. 33; emphasis in original)

The analysis of the dashboard that I have performed in this paper to exemplify some principles and practices of data visualisation design also shows how pictures are less (but also more!) powerful than we normally think. This is why I have refrained from venturing into the analysis of works that treat the visualisation of data as a simple problem of communicating 'data' to a recipient audience, as for these works the meaning of 'data' is given and not also 'attributed', as an etymological analysis of the term would powerfully reveal (from Latin *datum*, that is, with the meaning 'given', but also given by the observer who generates such *datum*). When studying the power and weaknesses of data visualisations, the questions we should therefore ask ourselves are: 'what does this picture lack; what does it leave out? What is the area of erasure? Its blind spot?' (Mitchell 2005, p. 49).

A second item on a research agenda for understanding data visualisation design therefore has to start from this 'lack' that every representation entails, and not from its supposedly mimetic power that is its ability (or even a Popperian aspiration) to represent. Works on epistemic cultures (Knorr Cetina 1999) have begun to explore how 'lack' generates greater desire for epistemic objects such as scientific representations. As with mirrors that prompt a desire for perfection, despite the fact that one never likes the reflected image, accounting reports have the same power. It is a rhetorical and reflexive power, as I have signalled with reference to the metaphor of the mirror to describe the accounts in Early Modern accounting treatises (Quattrone 2009). However, why we keep looking at ourselves in such a mirror despite the failure to reach perfection (or even improve) is still not understood. In this sense, accounting practices are closer to religion than to economics, as they instil hope in the user, the hope of finding a solution to a wicked problem, of making the 'right' decision, of making more money (see Quattrone 2015a). Much more work is required to understand the composition of accounting numbers in reports as figures, that is as combination of numbers, texts and graphical layout. Kress and van Leeuwen (1996/2006), for instance, illustrate how the analytical composition of images contributes to the generation of such hope and stratification of desire. In advertising, they argue, important and evocative dreams are shown on the upper part of the image (think of a car travelling on an imaginative traffic less route on a beautiful landscape), while the technical specification and the closer-to-reality features are subordinated in the lower part of the advertisement. Data visualisation designs are not dissimilar, although they may show reversed orders, especially in accounting where a plethora of divisions segment the space of the report (e.g. expenses vs. revenues, assets vs. liabilities). In value added statements, for example, one may witness this inversion where the production of value (with its technical aspects of manufacturing, costs of goods, production factors) dominates the upper part above the line of 'Value Added', while the part below is all about dreaming for a better future, with a hopefully equal distribution of value amongst different kinds of stakeholders (see Quattrone et al. 2014). The dynamic between these divisions and the kinds of interactions, social contracts and promises they generate is something to which accounting scholars and practitioners have paid extraordinarily low attention. The study of what is otherwise known as the 'semiotic of passions' (Greimas and Fountanille 1993) seems therefore to me another interesting area worth developing (see for instance, Boedker and Chua 2013).

This emphasis on passions, wants and desires, hope and beliefs, immediately prompts the need for a much broader understanding of the aesthetical experience that visualisations prompt. While we are now bound to the 'tyranny of transparency' (with the 'eye' seen as the most powerful instrument of knowledge), we forget that knowledge and its aesthetical dimension (and therefore decision-making processes), are 'bound to human sensation and that human knowledge is sense derived, the agents of which are all corporal' Carruthers 2013, p. 8). Not by chance, more fully bodily experiences can lead to different strategies to cope with uncertainty in trading due to new form of socio-material arrangements (Beunza and Stark 2003).

The emphasis on the lack of representation power also calls for a new vocabulary that goes beyond representation, in both qualitative and quantitative approaches (cf. Tufte 2007). As Barbara Stafford noted in relation to terms such as 'representation' and 'meaning', 'what exactly do these terms mean? When refracted through the glass of neurosciences, humanists are troublingly reminded of how equivocal these concepts have become' (2007, p. 140), especially because of the emergence of new technologies that show the intrinsic nature of mental processes and how these shape viewing, thinking and feeling. However, this problem also affects the neurosciences themselves, for

> when the same concepts are viewed from the perspective of the history of images, it is striking how the neurosciences are struggling to find 'neutral' that is, unproblematic, replacements for the venerable and nuanced humanistic vocabulary of 'representation', 'symbol', 'resemblance'. (Stafford 2007, p. 140)

This is also true when trying to develop a new language and grammar of visual design, and is especially true when explaining visual interactions and procedures, rather than just forms and meanings. The polyfocal images (see Figures 4 and 5) in this paper illustrate the need for a study of the procedural logic of visual interaction, not only among the various elements that they offer and the respective actors that are accountable for them, but also with broader audiences (see Figure 9). The four areas of the dashboard, for example, generate a continuous movement across it, and a series of shifting meanings that are generated by the social interaction between the four related programme managers, who also must interact with their team and manage a large and changing number of stakeholders. We are used to assessing the quality of a data visualisation design on whether it 'represents' performance well, but we are quite distant from judging its quality in terms of how it makes people interact.

A last, but by no means least, important point for this research agenda concerns visual conventions (Kostelnick and Hassett 2003), which naturally lead to training practices and content and the ability to critically interpret data visualisations and their wise design. In reflecting on how I have 'composed' this paper, I have adopted a highly interdisciplinary approach, but also faced quite substantial difficulties as I am not trained in visual methodologies, although I am a trained accountant. The question here is for accounting scholars who have to invest in regaining an understanding of 'numbers' as 'figures' (Pietra 1586) – that is, as pictures – which accountants mobilise in spatial forms of thinking (as, for instance, is the case when organising charts of accounts and carefully allocating accounts to physical and virtual economic spaces, such as cost and income centres). There is a need for accounting scholars and practitioners to become 'visually fluent' (Kostelnick and Hassett 2003, p. 24) when we speak and practise the graphical language of accounting. The issue also concerns accounting bodies and the content of their curricula. Particularly, when the accounting profession is called on to rethink the way it addresses issues of inequality and its response to the challenge of machine learning and block chain, what room does the accounting curriculum have for training new accountants as skilful data visual designers? In what ways can we teach a new generation of accountants not to exclusively prioritise shareholders' value (currently in the format of a conventional P&L, all geared towards profit to be distributed to shareholders), and to devise more sustainable forms of reporting and to contribute via new forms of calculations to new forms of societies?

Perhaps another journey into the past could provide insight into how to move forward. Not many know that in the early days of the British accounting profession, preliminary entrance exams to later qualify as a chartered accountant included subjects such as French, German, Greek and Latin (Puyou and Quattrone 2014). This very likely related to selection concerns and the need to legitimise new professional bodies with the admission of a selected elite. It also related, though, to the attention paid to assessing logical abilities and to selecting candidates

with a broad and fully rounded education. This was a way to ensure that new accountants avoided being fooled by a disproportionate 'trust in numbers' (Porter 1996). I am not calling here for the reintroduction of Latin in the curriculum (I like etymologies disproportionally as you will have noted, but not to that point). But in order for a new accounting Renaissance to happen, a new form of humanist approach to judgement has to inform the way in which we all (accounting scholars and professionals) think about the nuts and bolts of our craft, that is, how to design data visualisations in 'aesthetically' effective reports. The choice is between a belief in facts and 'matters of fact' or the exercise of judgements and the interrogation and scrutiny of 'matters of concern' (Latour 2005). Pursuing the former will lay the basis for a logical argument in favour of having algorithms replace double entry, coding experts replace accountants, and data scientists replace accounting professors. Pushing, and even lobbying, for the latter will instead make accounting practice, its profession, and academic counterpart, flourish for the years to come. Or at least so I hope and believe.

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Disclosure statement

No potential conflict of interest was reported by the author.

Note

1. I have explored elsewhere, drawing on Carruthers (2015), how accounts (Quattrone 2015a), excel sheets and matrixes (Busco and Quattrone in press) operate a mechanism of compression (i.e. reducing complex phenomena to calculable signs) and augmentation (i.e. interrogating what cannot be represented in the sign and therefore in the calculable space). In analysing the dashboard of London Heathrow T2b, I will return to this mechanism to explore how it rhetorically works in visual terms.

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