ResViz: Politics and Design Issues in Visualizing Academic Metrics

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ABSTRACT

The use of data and metrics on a professional and personal level has led to considerable discourse around the performative power and politics of 'big data' and data visualization, with academia being no exception. We have developed a university system, ResViz, which publicly visualizes the externally funded research projects of academics, and their internal collaborations. We present an interview study that engages 20 key stakeholders, academics and administrators who are part of the pilot release for the first version of this system. In doing so, we describe and problematize our design space, considering the implications of making metrics visible and their social use within a large organization. Our findings cut across the way people communicate, review and manage performance with metrics. We raise seven design issues in this space – practical considerations that expose the tensions in making metrics available for public contestation.

Author Keywords

Metrics; Visualization; Critical Data Studies;

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous;

INTRODUCTION

There is an increased public and academic presence and utilization of datasets, ostensibly promoted to improve performance across a wide variety of personal and professional activities. Discourse around the use of these datasets often refers to 'big data' on a large scale [5,23,29,36] and 'quantified self' at the individual level [32,42,44]. At both ends of this scale, the availability of, and the opportunities offered by, such datasets are arguably tied to; increased personal, interpersonal, and contextual awareness; more effective decision-making; and systematic goal achievement [31]. Simultaneously, transparency and

the availability of 'open data' are increasingly common public policy goals (e.g., opendatainstitute.org). Academic research is no exception, and the metrification of higher education and research has been firmly established in the UK through national level evaluation of research output. Globally, there has been a proliferation of individual academic metrics with sites such as Google Scholar [scholar.google.co.uk]. Such trends have received widespread criticism [11,25,27,49] and there is a growing body of academic research examining the implications of metrification for academic performance and welfare [7,22].

We contribute to these debates through the design and pilot deployment of ResViz, a visualization tool developed with university management and academics. ResViz visualizes internal data of academic collaboration on externally funded research projects. The visualization creates an overview of the research funding achieved by individuals, schools, and across faculties, while also demonstrating the extent of the collaboration supporting that funding success. We have conducted a pilot deployment of the system and report interviews with 20 university staff (at one university), spanning senior management; research support; heads-of-school; and research-active academics.

We expand on growing concerns in HCI research with regard to the politics of design and of digital systems [15]. We focus on the politics of making data and metrics available, rather than solely questioning their creation and existence. Specifically, we question the implications of making organization and professional data transparent to several levels of management and individuals. Ultimately, this leads us to question the role that information designers can, and should, play in attempts to democratize data. This novel empirical study contributes to the HCI community through the careful elucidation of *seven design issues* that chart this challenging and emerging design space. These problematize the trends towards metrification and open data as they relate to critical work in InfoViz and data studies.

RELATED WORK

This research broadly intersects two areas of related work. First, research on metrics and 'data' at work and in everyday life, focusing on the growing role of metrics in our particular context: the UK Higher Education system. Secondly, recent work that demands a critical approach to an understanding of data – especially which considers data visualization a critical, political, and constructive practice.

Metrics, transparency and performance management

There is a growing literature about the increase in metrics and measurement in everyday life. Much of this work has focused on 'personal informatics' the 'Quantified Self' movement, and rise of 'self-tracking cultures' [32]. Although often concerned with behavior change, health monitoring, or goal achievement, a critical turn is developing within this field, to consider the personal and lived experience of a data-driven life [20,28,44]. Performance management and metrics are now common in many workplaces (e.g. call centers [43] and logistics services [8]). These often involve new means of detecting and measuring work and can be interpreted as new forms of surveillance [33], of both the workplace [35] and the workers. Within HCI, research has begun to consider how employees interact with these metrics, as they become more visible. Pritchard et al.'s study [41] of the quantitative performance management of bus drivers showed how bus drivers both accommodated and resisted metrics in their work. Concurrently, there is a contemporary value in 'open data' and transparency [26]. The need for public accountability frequently offers a strong justification for measurement and surveillance. However, recent research also describes many myths and impediments surrounding 'open data' initiatives [26,50].

Within academia, Burrows [7] highlights six prevalent metrics: citations; workload models; transparent costing data; research assessment; teaching quality assessments and university league tables. ResViz represents a seventh metric – grant income – and uses this as a means to represent funded collaboration with other academics. Academic metrics have been of much interest in HCI. Most commonly, creating visualizations to understand a research landscape through citation patterns [19,26,39], or tools, which seek to stimulate academic collaboration [37,39]. Sociologists Burrows [7,27] and Craig et al. [11] provide a strong critique and overview of 'audit culture' and 'metric assemblages' arising in academic work. Their anxieties fundamentally concern the impact that '*the commodifying logic and priorities of capitalism*' [49] have on academic practice. Boden et al. [3] question what this means for academic freedom, while Craig et al. [8] suggest that performance management in universities should be recalibrated to make academia more accountable to core communities and core academic purposes, rather than markets and convenience. Burrows [7] and Gill [22] go even further and state concern for academics' very welfare.

Much of this opposition derives from an ideological, theoretical, or personally reflective standpoint. Both Craig et al. [8] and Burrows [6] explicitly call for empirical work to better understand the complex implications of metrics on academic practice. As such, we are less concerned here with the problematic construction of these metrics – though this is clearly at play – and rather *the implications of their wider visibility and social use* within an organization.

Critical studies of 'data' and InfoViz

'Big Data', and the practice of 'data science' has become a mainstream concern, with scholars unpacking their oft-troubling power, production, processes and potential [5,23,29,36] in a range of contexts and fields. However, the concern for digital or data-driven governance of organizational life has long roots in the work of Bowker and Star [4] and Agre [2]. This body of work firmly elucidates that data is not, and cannot be, 'raw' but is instead actively constructed (and constructing) of reality. It is not, therefore, a mere reflection of reality or of any 'facts' about the world. This applies not only to modern 'big data' processes, but is evident in the history of measurement [40]. This literature appeals to the need to understand the ethics and politics of data – so often positioned as a neutral and objective view of the world. Van Dijck develops this as a concern for an "*ideology of dataism… a widespread belief in objective quantification and potential tracking of all kinds of human behaviour*" [13]. Rettberg [42] likewise remarks how data can appear "*beyond argument*" by presenting an authoritative representation of the world.

The most recent research in HCI and CSCW has taken these issues further to consider the meaning and work of, and around, data and metrics, once they are "*data-in-place*" [46]. There has been especially rich work about data in communities (e.g. [30,46]), but also with regard to the experience of personal data (e.g. activity tracking [44]) and data as a material [38]. Such work calls attention to the role of design in how 'data' is constructed, situated and its inevitable social role [10]. What is achieved through this rethinking of data [46] is a demonstration of the complex and nuanced ways in which data becomes entangled in our social worlds, beyond notions of insights and achieving goals. These works recall and draw attention to the spaces created by digital technologies, through which individuals and groups can and do raise matters of concern [12,14,15]. Visualizing data creates opportunities for individuals to read and recite that data in ways that can converge and conflict, either directly within the visualization [48] or around it (e.g. [14]) Visualization therefore possesses a 'power' to tell a particular story of a particular world.

Here we recognize the multiple perspectives that exist around datasets and visualizations; the many ways that people can read and interpret data; and the possibilities for these readings to come together. Echoing the call for a move towards creating more exploratory forms of data visualization, which support people in finding their own meaning from data [16,18,47], we ask in what ways data can be used to critically explore shared worlds.

Emerging literature in Critical InfoVis [9,18] is explicit in recognizing the political ends and implications of data visualization. One proposed response is to encourage a '*questioning lens*' [18] and exploration of the data. ResViz extends these interests in the politics of data to the practices

and places of work. Simultaneously, the design and pilot deployment of ResViz responds to calls for empirical study of the manifestation of metrics in the modern university [7,11]. We first reflect carefully on the context and design of ResViz, before developing the findings of our interview study. Together, we use these to surface the significant design issues in this space, and extend the reflective and critical work about data and visualization in HCI.

RESEARCH SETTING

Context of ResViz Development

ResViz concerns a particular source of academic funding – *competitive research grants*. Although also significant, ResViz *does not* concern block funding allocated via the periodic UK-wide assessment exercise called the 'Research Excellence Framework' (REF). In the UK, research grants for specific projects and initiatives are awarded mostly through competition and peer review, by 'Research Councils', charities, the EU and industrial partners. Academics are increasingly evaluated on successfully bidding for these grants.

ResViz is the first version of a university-supported visualization of an internal university dataset, as part of a larger ongoing project. It is a new system and it overlaps – though does not replace – other current spreadsheet based reporting systems. It was developed with members of university management, who funded the project, had frequent meetings with us, and led on what data could be included – while we led the visual and interaction design. There is a complex set of players and motivations that have led to the design and configuration of the system as it is now, and there are mixed aims and purposes for ResViz from the University. For one part, it is a means of performance management within a culture of raising and measuring performance throughout the university. ResViz also reflects a push for 'open data' and transparency about the metrics and expectations the university has. Finally, it seeks to foster inter-disciplinary collaboration in strategic areas of excellence and large consortium funding bids.

Our Stance

As researchers, we do not naïvely see these aims and the proposed uses of ResViz as unproblematic. As such, it is worth briefly setting out our own stance, which informed the design and subsequent research. First, whatever the merits and flaws of the metrics that ResViz visualizes, we are forced to acknowledge that they already exist and are in use, in various guises, by the university. However, currently those metrics, and their politics and roles, are largely obscured in spreadsheets, restricted access IT systems, and the workings of committees. Therefore, while adopting a largely critical stance to management by metrics (as evident in reviewing related work), we propose a public confrontation with these metrics as a potential mode of productive response. This is the primary work ResViz achieves – to make existing metrics visible to a wider public. Conveniently, this ambition is consistent with the

management rhetoric on 'transparency' and open data. As such, we have a point from which we can investigate how metrics and their politics can be (sensitively) made visible.

Critically, we do not present ResViz itself as a final or unproblematic solution. While informed by perspectives in Critical InfoViz, we also recognize how these can become compromised in real-world settings. Hence, we aim to be continually reflective about the tool, and the process and politics of its development with university management. Development of a future version of ResViz is ongoing. This paper deals with our initial ventures into this significant and challenging design space.

RESVIZ: SYSTEM AND DESIGN RATIONALE

ResViz was developed on top of a university data set including all externally funded, active grants within the university. This dataset is derived from the system through which academics manually create and submit funding applications for projects. As provided, this data could include details such as: the funder; project title; start and end dates; total value; the names of individual academics and their role (Principal Investigator/Co-Investigator) and split value (the amount from a total grant apportioned to a specific entity, e.g. academic/department). During design, university management had concerns about the sensitivity of revealing funding from particular organizations or on sensitive topics. For this reason, they requested the removal of project titles and the replacement of funders with generic terms (e.g. UK Research Council). Consequently, ResViz operates on a dataset of current grant awards, academics, and, crucially, split values. This dataset therefore offers a means to discover and present collaborative relationships through these active grants.

Notably, smaller internally funded projects are not represented and neither are collaborations with other universities. These limitations highlight how necessarily partial any visualisation is. Academic labor – in this case generating external funding – is much too complex and nuanced to be adequately and coherently represented in its entirety by a single dataset and visualization. Throughout the design process, there are points where we might have sought to add more data, or 'context' and achieve this fuller picture. However, we saw this as another layer of interpretation, which risked inflating the way ResViz would be read. Therefore, we were conscious to be specific in the design, 'accurate' about the data we had, and frank about its 'incompleteness', and the need for a further, and human contextualization of that data.

Our design began with sympathy for a monadic approach [17] and the value in seeing all elements of the data in one place. This gives a sense of the whole university, and how this 'whole' is constituted by individual elements. This frames the outward-looking and exploratory perspective ResViz aims to achieve. A spherical approach was also an attempt to realize an equal starting point – the initial view is of the whole, rather than of any individual. This sphere still

affords an immediacy of comparison, but also allows for a representation of the funding as it relates to the organizational structure of the university as a whole.

As such, the central visualization *(Figure 1)* is based on a basic chord diagram with the addition of hierarchical segments on the outer ring, representing a faculty, department, or individual. Chords are a common form of visualization (see http://circos.ca and Stefaner [45]) but are well suited. Each solid chord represents a distinct entity – a funded, collaborative project. This seeks to further foreground collaboration ahead of comparison. Critically, the user can click on different segments, or search to filter and compose an alternative visualization. Each view within the visualization has a unique address, which can be bookmarked or shared with others. However, there is no means to download and manipulate the data into a spreadsheet – this is to encourage the interactive use and interrogation of the arcs and chords as they are. This range of possible views aims to offer 'contingency' [17] and multiple means of sense-making.

Figure 2 shows an overview of the chord diagram for a simulated dataset. In this view, visible projects have been filtered (using controls labeled (**a**) or interacting with the initial graph) to include only those projects with the academic *Dr John Smith*, the *Faculty of XYZ*, or the *School of ABC* as described by (**b**). Collaborations are represented with grey chords in the centre of the rings, with the direct collaborations from each of the explicitly selected filters
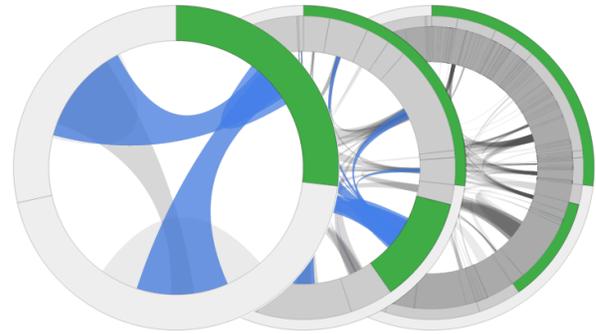

Figure 1: Three Rings of Faculty, School and Academics

drawn with a dark green arc and a chord in dark blue as indicated by (**b**), and (**e**). Hovering over each segment (**f**) will temporarily highlight other arcs and chords, as well as displaying further details, including the project values (**d**). The specific projects selected are listed below the graph (**g**) with further details including the funder, project values, and internal reference number.

METHOD

Participants

We conducted a stratified interview study with 20 university staff. Participants (13M/7F) were derived primarily from those who had access to ResViz as part of the limited release pilot. We systematically approached participants from different faculties and schools in the engineering and arts faculties requesting their personal participation. We interviewed three senior managers (3M);
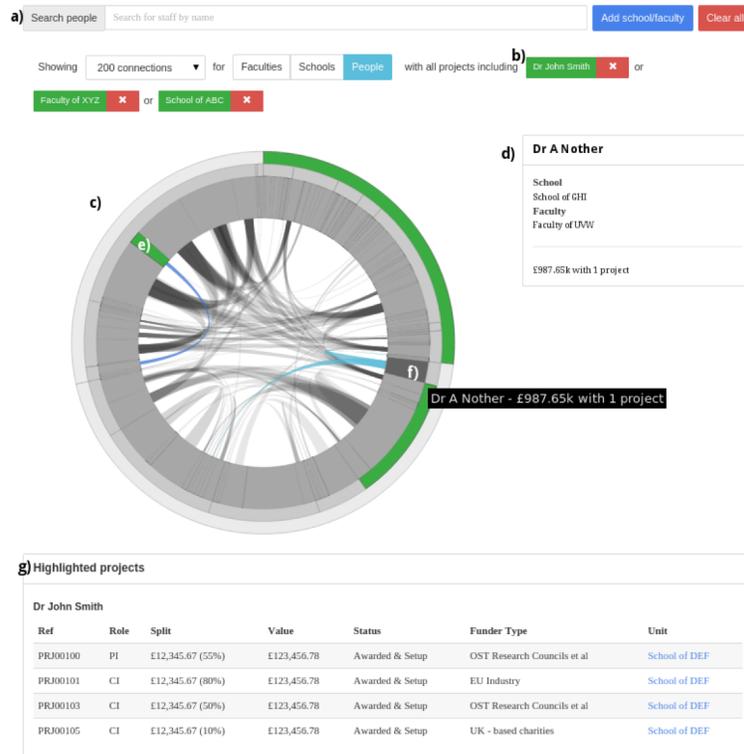

Figure 2: Screenshot of ResViz interface: a) Search bar b) Selected filters (person, school, or faculty) c) ResViz visualization d) Detail of highlighted element e) Selected segment for one collaborative academic f) Hover over g) List of selected projects

six research support staff (1M, 5F); nine senior academics (8M, 1F); and two early-career researchers (1M, 1F) without prior access to the pilot. There were more men than women interviewed due to the gender balance among the senior academics who had access to the pilot

The availability and expectations of research funding varied greatly among participants and their many disciplines. They also varied in their seniority – some had many funded projects, some currently had none. This sample does not seek to be explicitly representative, but rather heterogeneous, displaying a wide range of positions and viewpoints in the university. Given the high-profile nature of some of our participants, they have been strongly anonymized throughout, and are discussed only according to their general role and position. Senior managers and research support worked at a faculty wide level. Academics worked primarily at a school level. They include 'Heads of School', and 'Directors of Research' who are responsible for research within a school. Participants also varied in their familiarity with ResViz. Most had seen a demonstration by senior management and had been encouraged to have a 'play around', but few had yet used it concertedly for a specific purpose. Those who had no experience or recollection of ResViz were given a brief description and demonstration before the interview, and were able to ask further questions about its functionality throughout.

Methodology
Interviews took place over the course of two months, with most participants having access to ResViz for between two to 10 weeks prior to interview. Interviews were semi-structured and lasted 30 minutes to an hour. ResViz was employed critically, and was present throughout the interviews, acting as a material representation and focus for the broader interview topics. Hence, the interview was not intended to be, nor was it presented as, an evaluation of the system. Rather, it was a conversation about the roles of funding, metrics and open data in participants' work. Turning to ResViz during the interview provided a crucible for them to discuss, make suggestions, react against and speculate on these topics with ease. Their lack of long-term experience with the system actually supported this – rather than only criticizing or evaluating the existing system, they were more open to reflection on what such a system could do; who it was for; and why and how it might better fit their work. Interviews were tailored to each participant's role and responsibilities. They focused on: interpretations of ResViz's aims and purpose; the potential uses of ResViz, specifically for supporting collaboration and developing research funding; criticisms of, or concerns about, the visualization and the data; and the implications of the visibility of this data; as well as the general use and future of data and metrics more generally.

Data Analysis
Interviews were conducted by the first author and transcribed in full. Open coding was undertaken on all the transcripts, and a subset of transcripts was analyzed collaboratively with remaining authors to produce a thematic analysis [6]. In our analysis, we seek to go beyond reporting the many specific uses and criticisms of ResViz – a particular system. We identify how people interact and positioned themselves in relation to ResViz, and interpret this within broader discussions about the implications of publicly visualizing organizational data.

FINDINGS
We present three key themes, incorporating an analysis of how people in varied roles would seek to communicate, find opportunities, review and manage with ResViz.

Communicating: funding landscapes and narratives

Funding landscapes and opportunities
At first glance, ResViz can offer a 'broad-brush' overview of the university or of a particular department. Participants envisaged this as a useful means to introduce and orient others to the funding landscape – particularly early-career academics, new arrivals, or external partners.

"...with our half a dozen most-recently appointed members of staff, [...] "Right, we're going to talk about research funding. Let's just see how it works. Who gets it? What proportion of it is within the School? What proportion is between schools?" (Will, Head of School)

ResViz thus serves as a mechanism to 'step through' the research landscape within the university. It could be used live, collaboratively, as a means to discuss and consider different funding avenues or potential collaborators, or even mentors. These discussions of the funding landscape frequently pertained to identifying opportunities and *"specific synergies"*. Senior management hoped ResViz would foster an aspirational, questioning and occasionally competitive '*view of what's possible' (Jeremy, Senior Manager)* regarding both funding and collaboration. ResViz distinctly presents an inclusive, aggregate view of the data in a single visualization. This rapidly represents the status quo of research funding in the University. In doing so, along with its central chords *(Figure 1f)*, ResViz invites the viewer to look outward to other departments and individuals, to consider comparisons and possible relations to one's own position. Making all schools and individuals commensurate and comparable by using external research funding as a shared metric – despite its inequalities – supported this common perspective.

This inclusive higher-level view, showing each element in relation to the whole, suited senior management and research support staff in identifying and supporting 'broad areas of expertise' in the university. These could potentially be supported or enhanced through networking events, or channeled towards '*large consortium bids' (Melissa, Research Support)* or faculty-wide initiatives around a topic (e.g. ageing). Research managers also considered how they could *"patch people up a bit" (Jenny, Research Support),* where underperforming departments or individuals could be

supported through links with a successful school. In this way, ResViz could raise awareness or be a first port of call, with some suggesting it was more likely to provide prompts for further investigation rather than detailed answers. Yet, in highlighting opportunities, ResViz also communicated a notion of 'success' – or *"research stars"* – very clearly.

"So you realize these people are quite influential. So for me, actually it was even just understanding the sort of influential people within the university in terms of research that we can get to." (Kevin, Professor)

ResViz therefore arguably reifies and empowers existing successes, while marginalizing those without any current active funding, who are literally invisible on ResViz. The flattened perspective supported different overviews, but risks overlooking a smaller, innovative collaboration between departments or a rising early-career researcher. Though ResViz presents 'accurate' data on the current state of the world in terms of funding, it is detached from the historied and projected world and narratives of academics.

Communicating narratives

Notably, people often anticipated communicating narratives using ResViz statically, in a pre-prepared manner through a screengrab. Presenting ResViz in this way allowed people to largely control and contextualise the data revealed. Such use would be more 'strategic' and rehearsed. Participants proposed seeking data and visualization to communicate particular narratives to peers or management,

"If you wanted to convince people at faculty or university level, this is a school with sort of real interdisciplinary collaboration or potential; that would be quite a useful thing to do too."(Tim, Director of Research)

Although ostensibly designed for internal use, other participants were most invested in using the data to highlight successes and research capability when communicating with external partners or research and public communities:

"I think to be able to use this to communicate in a selective way, externally or internally, would be very useful, but I worry about how having open access to it, you're seeing a very limited dimension of a person's professional role and how that could be interpreted or misinterpreted." (Lisa, Head of School)

Whoever was being appraised of local funding arrangements, ResViz could thus be employed in two quite distinctive ways. First, in an unstructured, interactive and exploratory way – stepping through the funding landscape to stimulate dialogue, discussion and opportunity. Secondly, in a structured, static and rehearsed way, in a bid to 'objectively' evidence subjective claims and narratives. Via such objective claims, managers of schools and faculties hoped to perform certain narratives and identities, and to achieve certain aims. Nevertheless, we found numerous curious examples of 'double-speak' from

participants on how they interacted with data. Especially in relation to H-indexes and citation data, participants described its irrelevance or inadequacy in relation to their discipline, before describing its role in procedures such as promotions. Few people took ownership of metrics, which were frequently cast as an external obligation.

"I mean, they [H-indexes] do have a function. They are part of people's lives, but only when that is forced on us externally."(Richard, Director of Research)

This resonates with a survey in Nature about metrics, describing similar 'mixed messages' [1] and a 'play or be played' mentality [7]. Frequently, data is inconveniently situated or contrary to particular narratives. However, metrics were not rejected or resisted outright. Rather, alternative measures or context were frequently proposed or asserted in their place. This may be a REF result, or an appeal to something missing. A historical or future perspective, lacking in ResViz, was frequently employed to paint a positive picture. '*We've just had two big grants'* or discussing projects and grants that are *'in the pipeline'*. ResViz in its present focus,, obscures such details, but in so doing provides ambiguity, which can become a viable means to resist and articulate an alternative narrative.

Reviewing and contesting performance with ResViz

An immediate envisaged use of ResViz was in reviewing performance, or at least how performance might become portrayed – from individual, school, and faculty perspectives. Many participants described initial curiosity, searching first for themselves, their department and then colleagues. Rather than an everyday tool, many participants imagined turning to ResViz at particular times of planning, such as an annual review. The value in ResViz appeared to be to quickly provide an overview, or an alternative perspective, to show '*where we are'.* Importantly, rather than providing definitive answers, ResViz could be a starting point for review: to start a conversation; understand what data was available and could be done with it; or identify areas that required more investigation.

"The thing the visualization might be helpful with is throwing up things they haven't thought to ask, because they will say, "Oh, what's that? [...] When you put graphs into documents, people aren't usually reading the exact figure off. They're telling a story. (Will, Head of School)

Fundamentally, to review data like this means to ask oneself or others: 'what story is this telling me?'; 'how do they relate to existing narratives?'; and 'what do these new stories mean for how I present myself or will be perceived?' To be clear, these questions are deeply contextualized and subjective. However, a concern voiced in both our study and wider discourse on metrification is the materialization and reification of 'performance'. Though ResViz visualizes a common metric – funded research projects – many felt that comparing funding across fields (e.g. arts funding with

medical funding) was problematic. They "*live in different worlds*" – a case of comparing "*apples and oranges*".

"What that does is simply lumping everything together [...] You simply do not have the appropriate comparative." (James, Senior Manager)

As such, participants frequently contested a lack of further context – either in defense of their own record, or in search of understanding others. A lack of history; subject keywords; project titles; research outputs; specific funder details; teaching income; REF results; historical funding; upcoming grants*;* and research impact, were all considered as important context. Though numerous viewpoints could be filtered and reconfigured in ResViz, the lack of further context fuelled concerns about misrepresentation and misunderstanding.

Furthermore, ResViz assumes a '*uniform funding landscape' (Gail, Research Support)* when in fact a 'large' funded project in different subjects can range from £100,000 to multi-million pound ventures. On this basis, there was disagreement about whether research funding could be a common and meaningful metric – especially in contrast to the REF results, a periodic national assessment of research 'quality'. Others sought the incorporation of funding history, allowing one to chart an individual or school's progress – comparing a school to its historical self. It was commonly retorted that '*everyone knows'* that different fields have different funding opportunities – that the data would be *read* differently from the data *as is*. However, there were some concerns about how a naïve viewer could arrive at quite false or damaging conclusions.

Well, the sensitivities relate to the data on funding becoming available in a fairly uncontrolled way to a very wide constituency. (James, Senior Manager)

A counter-argument to the lack of context was expressed by research support staff at faculty level:

"I think if we try and be too prescriptive, then people will just say: "Well, it's not accurate [...] I think our role is to provide the data that we can and then it's up to the people that want data to interpret it. (Amy, Research Support)

This view was expressed elsewhere. Richard, for example worked in a school with many fewer funded projects than others, but unlike some of his colleagues, he seemed to be comfortable with the limitations of ResViz – and was confident that other measures, such as a strong REF result, would counterbalance the simple image ResViz offered.

"I mean, it is what it is and so long as the data is accurate, that's absolutely fine." (Richard, Director of Research)

Implementing ResViz makes plain that the entire context can never be achieved. Data visualization is, by necessity, reductive – and always privileges particular perspectives. One response is the suggestion that only those sufficiently familiar with the context should see the data, as only they are able to fairly interpret and make sense of it.

"Now, obviously, I have great trust [on a University board] that they understand all of those differences and the nuances, but I know that not all of my colleagues do. That would be my primary worry." (Anthony, Head of School)

Both of these positions – contextualizing data through presentation, and restricting access to those who understand the context, position senior academics in schools as gatekeepers of the data – to present it in the right context and to the right people at the right time. Many participants discussed how ResViz might be used and appropriated.

"I think some colleagues may well see it possibly in a threatening light, but it depends on how it's used." (Jason, Head of School)

Participants seemed to have clear ideas about the 'right' and 'wrong' uses of ResViz. Primarily, that this could be used too strictly to manage performance, rather than to develop, as a stick rather than a carrot. To determine answers, rather than raise interesting questions.

Managing transparency: self, school, and faculty
ResViz embodies and materializes two key principles of senior management: transparency and 'raising the bar' for research. There was a range of often-political responses, about who should manage, from where, and on what terms.

Encouraging self-management
Putting this data in the hands of all staff was proposed to encourage self-management – academics at all stages of tenure should use ResViz to compare themselves to others, aspire to improve themselves and their school, and seek new opportunities for collaboration and funding.

"I basically would encourage every colleague to use it and I mean, just some really astonishing things you discover." (Jeremy, Senior Manager)

It was frequently repeated that academics have a contractual responsibility to pursue grant income. ResViz reinforced this responsibility, and promotes funding income as a transparent performance metric.

"If you're an academic in this institution, and if you're in a teaching and research contract, you do have an obligation to apply for external research funding." (Melissa, Research Support)

There were mixed views about whether ResViz represented 'sensitive' or personal data. It was widely acknowledged that few academics would know in detail how much research funding colleagues were bringing in. Yet, the fact that much of the data was technically in the public domain was widely acknowledged. Nevertheless, ResViz does immediately reveal and create new information by describing the 'split' of a funded project and giving and immediate, comparable total.

Pressuring school management
ResViz could be most disruptive at a school level. While many were skeptical that colleagues would use the tool, some felt it might help them communicate down messages from faculty, or create both competition and complacency. Others felt more threatened by ResViz, usually on behalf of their staff. ResViz could be misinterpreted out of context and 'expose' people unnecessarily.

"We're very actively managing the research careers within our school, and there's a resistance to the much more micro-management kind of culture that's emerging with 'Raising the Bar'." (Lisa, Head of School)

There was a strong sense from some schools that they knew best how to motivate and develop any underperforming staff – both in terms of being aware of the particular context of the individual (e.g. high teaching workload, writing a book) ensuring the data is used *developmentally*, and collaboratively, rather than as a means of *managing* people. As such, they were somewhat opposed to ResViz where it undermined how they achieved this – or assumed that few of their staff would be interested with it.

"That's my job to look at that, and it's only my job to disseminate any of that when it is becoming a problem for either a bunch of staff or individual staff." (Anthony, Head of School)

However, senior managers argued that an important role of ResViz was exactly to remove school management as gatekeepers of this information. Transparency reduces the information asymmetry between academics and their schools with ResViz being a *"much more democratic and modern"* means to undermining hierarchies within schools.

"...essentially the Research Directors and Heads of School can tell them what they want. And it's often not fact based. [They] play their own games and with this it sort of makes it more difficult to play" (Jeremy, Senior Manager)

"Okay, let it be a management tool… but also could it not be a way of, just turn it on its head and be disrupting that and actually democratizing a bit more? [...] and it has maybe a few things in it that allows people who don't just typically get the money, to use it." (Ali, Early-Career)

Others appreciated transparency, expressing a lack of trust and shared understanding about what data the university actually has and uses. One academic described '*one-off*' figures and diagrams put before him by senior management:

"You end up chasing them upstream to work out exactly where the data has come from and quite what that means and having to defend your school against an accusation of performance." (Tim, Director of Research)

Tim above envisioned with ResViz a hope for a '*standard reporting system*' that could help him understand where different data comes from, and form a common reference point and basis for discussion.

"I believe the tool itself and the things coming out of it will be something people will discuss. [...] You need something that is more of a common ground." (Kevin, Professor)

Ambient faculty management
At faculty level, ResViz is positioned as a democratic tool to support people in taking responsibility for their own research and funding. In this way, ResViz quite explicitly materializes two key management principles about creating greater transparency about funding across the university, promoting competition and comparison to raise aspirations and 'raise the bar'. ResViz, in the words of one senior manager, *"flows from those principles"* (*Jeremy*). Given this, it is all the more remarkable that ResViz was perceived rather neutrally – as a passive technology – with concerns projected onto possible ill-informed interventions by management or others rather than the technology itself. However, the university fosters this neutrality, by presenting quite an open, hands-off and non-prescriptive approach to how ResViz is used. This aims to create a more ambient style of management, which seeks to avoid the appearance of a heavy touch, or micro-management.

"So that, without any sort of heavy-handed intervention of the head of school, [ResViz] also should create healthy competition." (Jeremy, Senior Manager)

"It's a visualization tool. It's not a 'Tell me what I need to do' tool." (Amy, Research Support)

Some senior academics would seek to ambiently manage as well - encouraging their staff to look for themselves in ResViz, supplementing particular messages, and developing a degree of performance expectation or even to '*name and shame' (Scott)* underperforming staff. Besides passively managing performance, in making data normally obscured, public and scrutable, ResViz may shift the responsibility to maintain accurate data to the academics who create it.

"I think some research centres are better than others at getting things on [university systems]. We've been doing a bit of a historical wash-up recently, that not all the data that should be there is there." (Lisa, Head of School)

Such work again highlights how transparency, almost as surveillance, pressures schools in particular, and academics, to engage with particular elevated data and metrics.

DISCUSSION AND DESIGN ISSUES
Beyond questioning and critiquing the construction of metrics, our study seeks to consider the significant role that design plays in the mediation of metrics – especially as they extend beyond the boardroom to a wider public. First, in what data is made available, and secondly, the means of presenting that data interactively. ResViz is not uncontroversial or without concern. It bumps up against a number of ongoing organizational politics. In this discussion, we wish to productively draw attention to a set of contrasts and challenges that our findings indicate exist in this design space and reflect on where the design of

ResViz sits in relation to these. Our intention is that in such a way, we provide a further practical lens through which data-driven systems might be designed, understood and evaluated. We discuss these design issues as they relate first to the visualization; secondly the situated interpretation and context of ResViz; and finally, management by metrics.

Interaction and visual design issues

1) Unstructured vs. Structured interaction
Our findings regularly suggested two possible styles of interaction and management with ResViz. The first style is more inductive, and closer to Dörk's characterization of the 'Information Flaneur' [16]. ResViz was seen as a possible primer for discussion – participants proposed playing around with it in a more ***unstructured*** way to see what might be gleaned, browsing and exploring the data. Metrics are seen as suggestive and indicative, a means to raise questions or flag issues. A particular detail, comparison or connection can highlight, or be symbolic of, a wider point of interest, which can then be pursued to contextualise and make sense of this data. A second style, more deductive and management oriented, perceives metrics as there to be interrogated for answers; to confirm theories or feelings on an issue. Participants proposed using ResViz as a reference point, or to present data in a rehearsed and selective way to make an argument visually and objectively. Such reference and search is a more ***structured*** interaction. They help to determine answers to questions, and evidence claims one might make. These different styles also depended greatly on the participant's attitude towards metrics, data and management. Nevertheless, we should be sensitive to the way different design decisions encourage one or the other.

2) Visualizing vs. Reporting
These distinct styles are particularly evident in the way ResViz was perceived, both as a ***visualization tool*** – to explore and better understand the world – and a ***reporting tool***; to categorically report and evidence the world. On one hand, ResViz supports the novel interaction and exploration of a large dataset. On the other, the data it makes available can be used as a form of report, in place of spreadsheets. The monadic approach aimed to foster exploration; by showing the individual in the whole; representing diverse connections; and affording the configuration of many different views of the university. Furthermore, ResViz was designed for live interaction; there was no option to download the data as a standalone report. But this inclusive view invited comparisons, which were like *'apples and oranges'* for some participants, who worried how easily aggregated data could be misread in reporting performance.

3) Multiplicity vs. 'Standard reference point'
This relates to a second issue – the trade-off between ***multiplicity,*** and ResViz as a ***'standard reference point'***. Aspirations for ResViz as a 'one-stop shop' suggest that a common point of discussion could make it easier to locate, account for and interpret where different data or figures come from. Yet this was tempered with a fear that such a

system becomes a 'go-to', and single source of data without question or counterpoint. Other approaches to designing democratic systems point to the importance of such *multiplicity* – avoiding the determinacy of one technology. The variable views and filters in ResViz are an attempt to provide this, but we ought to consider how ResViz could sit alongside and reach out to similar university systems.

As a 'one-stop-shop', ResViz could be well suited as a starting point, which then points to other resources as confirmation and counterpoint. In this light, ResViz could optimistically be considered a more informal, perhaps unstructured, reporting tool – more lightweight than the 'data dumps' drawn from the same data-base into spreadsheets to create tables and lists as part of policy making. Given the current opacity of some of these processes, ResViz could be conceived of as a window onto that reporting, and the data behind it – to raise awareness and understanding about what data there is and how it could be used, in a range of processes.

Situated design Issues
The political and personal nature of our interviews made evident the socio-technical nature of ResViz. We found that most participants were often much more concerned with how ResViz would be used and appropriated by different actors, rather than only finding fault with the visualization or data itself. We think this highlights how the successful design and introduction of metrics relates to the existing organizational culture. Specifically – who is in a position to interpret and contextualise the data, and on what terms?

4) Open metrics vs. Private expertise
In this respect, there is a clear tension in the way that ***open metrics*** challenge ***private expertise.*** Espeland and Stevens [21] suggest metrics promote '*depersonalized forms of knowing*' rather than '*private and particularistic forms of knowing*'. For some participants, ResViz undermined their expertise and sensitive management based on particular, contextual understanding. However, it is precisely for their seemingly objective distance that metrics are valued. A move to make data clear, public and engaging inevitably demands that much detail and context is stripped out. The acute political question for design is: how do metrics come to be contextualized and by whom?

5) Context-through-data vs. Context-in-person
Put another way, should ***contextualization*** occur ***through data*** or ***in person***? Participants frequently appealed for more context and thus data that could be added to ResViz – e.g. project titles, partners and funding histories. However, besides the potential practical, legal and aesthetic limitations, this approach rests on an assumption that 'if only there was enough data, a full enough picture could be presented and avert misrepresentation'. However, as Dörk et al. caution: *"There is no 'one' visualization that captures all aspects of a particular phenomenon from all possible perspectives…"* This pro-data attitude resembles van

Dijck's [13] fears of 'dataism' and positions ResViz as a source of clear answers, rather than interesting questions.

If ResViz were to be made more abstract with numbers removed, arguably it might stimulate a more exploratory and speculative interaction. Absent data would be sought from those with a closer, though private and subjective understanding of the situation. It would also be more challenging to report or manage down through such a system. Yet it was frequently very details such as funding history or the funding body that participants sought to navigate and orient to the data. It is a fine balance to afford such detail, and create a system for varying roles, where both data and human share equal voice.

Management Design Issues

6) Agency vs Responsibility
The live interactivity of ResViz was, in part, intended to give people **agency** in the construction and discussion of metrics. Pritchard et al. have previously emphasized the importance of agency in the human relationship with metrics [41]. However, this is accompanied by greater **responsibility** for those metrics – not only to ensure that data is correct and up to date, but also to be able to understand, and articulate oneself in terms of those metrics.

The design of systems like ResViz challenges the existing use of metrics by making them clearer and available to a wider constituency – for their own use and appropriation. Hence, ResViz creates some agency for academics to play rather than to be played. However, in doing so – through the appeal to the objectivity of metrics – a potential consequence is, in fact, to make those metrics even more pervasive. We have been wary and reflective about how the design of ResViz challenges or progresses the metrics agenda. ResViz does adopt a more relational than numerical stance. Numbers were not paramount, or marked on the visualization itself. ResViz is designed to engage interaction where frequent manipulation and filtering allows multiple points of comparisons and contingencies [18] in which overall income is less evident.

7) Appropriating Metrics vs Prescribing Metrics
ResViz was intended to challenge existing hierarchies, but simultaneously there were fears that the tool might be **appropriated** in the 'wrong' way – to judge peers, especially ahead of contentious decisions such as internal promotions. However, the principle of transparency was to leave it to individuals and schools to make of ResViz what they will, without too heavily **prescribing** or micro-managing its use. Nonetheless, some schools still saw the very presence of ResViz as embodying top-down micromanagement – they recognized a political agenda embedded within this transparency. It is therefore unclear how much direction the university should give regarding ResViz, beyond merely demonstrating its functionality and encouraging its use. Disclaimers to prevent a rush to judgment could be perceived as paternalistic, and limit the positive and creative ways people might seek to use it. This is also resonant of a previous design issues. Should ResViz have specific, standard, structured, intended uses in reporting, or be an unstructured, and open platform to visualize, explore and familiarize the data in multiple ways?

CONCLUSIONS
In this paper, we have taken a critical and productive stance in engaging with academic metrics, through the design, deployment and reflection on ResViz – a public and interactive visualisation of a university dataset. It is not yet clear how ResViz will become embedded in a work practice over longer periods of time or the potential culture and norms that will evolve. However, the concerns raised allow us to articulate the politicized landscape such systems occupy, and which careful design must negotiate. There is a fine balance, driven by conflicting desires amongst users for metrics *to give insight* and answers, and yet not to be taken *as given*. In our case, we believe the findings lend support for a 'questioning lens' [18] on the data. This, like other critiques [5,27], recognizes the difficulty for any metric or data visualization to offer a neutral or objective perspective on the world – and the inevitable contestation of their meaning and relevance.

Our findings suggest that the value and meaning of data is developed and contested through its *human appropriation and application*, rather than being asserted through a technological materialization. In other words, the situational politics of the visualization – who sees it, on what terms and with what intentions – becomes *as* important as the visual and interactive design. We suggest there is unlikely an ideal visualization which alone adequately deals with the issues that metrics-based management present.

Simply 'more data' is often not possible, and problematic if the system tends towards determinism. Furthermore, though the principles of 'transparency' and 'open data' have much worth, they are politically motivated and constructively designed. This all leads to challenges for design in engaging positively with the metrics agenda, while providing means for academics to contest it. Underlined is the need to understand how data, metrics and visualizations become 'enmeshed in everyday life' [44]. We do not think there are simple answers to the design issues we highlight. Indeed, we present them as tensions, and dimensions along which different data-driven systems can be situated and find their own place. Nor does ResViz pose as a comprehensive solution. Rather, it is one vehicle by which we can chart the challenging terrain, as data and metrics become pervasive in everyday life and work.

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