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HC Coombs Policy Forum

Discussion paper

Grappling with Complex Policy Challenges: exploring the potential of visualization for analysis, advising and engagement

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Overview and introduction

In the 21st century there has been widespread recognition that complexity is an inherent challenge in public policy development. No matter the policy domain, there is greater appreciation of the manifold linkages of actors affecting problems and those affected by them, the lack of systematic knowledge and the importance of context, the time lags of causal variables not to mention lagged effects of interventions, and of the surprises and uncertainties associated with problems and policy interventions. Invoking terminology such as 'complexity' and 'wicked problems' are part of normal parlance in any speech or paper on policy development and design discussions. Capturing, acknowledging, and addressing this complexity is a signal challenge not only for governments but also those seeking to influence and advise political leaders.

One way to grapple with complexity is with visualization technologies, ranging from projecting findings from large data-sets, to finding creative ways to display information, to engaging staff and communities in recognizing complexity and identifying strategic directions. There has been increasing use and celebration of visualization and social media tools in the private sector, and considerable interest from inside public service institutions as well as political leaders about how to exploit their potential. The field of visualization is diverse, rapidly expanding, and moving forward with great enthusiasm. There is arguably a growing expectation that governments and public service institutions should be investing in visualization technologies for analyzing issues, advising ministers, and engaging citizens and stakeholders on complex issues. However, governments have appeared hesitant about moving forward, with take-up uneven across the waterfront of departments and agencies.

The purpose of this paper is to provide a framework for thinking about the potential (and limitations) for visualization technologies in assisting public servants in undertaking analysis, providing advice to elected leaders, and engaging citizens on policy matters. It will focus on the 'demand-side' for visualization technologies, since a related background paper (*Surveying the World of Visualization*) focuses in some detail on the 'supply-side', namely the various traditions in visualization (information, graphics, and facilitation). The goal of this paper is to stimulate and guide dialogue among practitioners and experts about their experience in government using visualization technologies, their sense of potential yields and risks, and how to build capacities in this area. The overarching goals are to provide a framework and facilitate developing a strategic approach towards investing and consuming visualization technologies, and to fill a gap not only in the public policy and management literature, but also in the literature on visualization technologies.

This paper has five parts. The first sections address two questions: Why visualization? And, what is visualization? The third section sets out a preliminary framework to locate and guide discussions, while the fourth considers how visualization might inform policy work. The paper concludes by identifying issues for consideration at the roundtables.

Why visualization? Complexity and policy development

There has been increasing interest in having public service institutions use visualization techniques to analyze and capture the complexity of many policy domains. This interest has arisen for disparate reasons: increased appreciation of the inherent complexity of many policy challenges; citizens and ministers becoming aware of alternative ways to convey and consume information; and experimentation and selective investments in visualization in different public organizations and program areas. We consider each of these developments in turn.

Public sector leaders are grappling with complexity

Many public sector leaders have long appreciated that the problems government seek to address are inherently complex and difficult to ameliorate. In recent years concepts from scholars such as 'wicked' problems (Rittel & Webber 1973) and complexity (Axelrod & Cohen 2000; Geyer & Rihani 2010) have become regular fare for practitioner communities. There is greater understanding of the properties of complex challenges, but for our purposes complexity can be seen as flowing from two fundamental sources:

> **Problems.** Governments oversee complex public organizations tackling difficult problems, often by means of multi-faceted interventions. Often the problems themselves are complex, difficult to comprehend, products of many factors, including the legacies of previous policy interventions, legal intricacies, and historical and cultural influences, and, often there is insufficient data and research on critical aspects. Moreover, different disciplinary, professional, and policy lenses illuminate very different and, sometimes, contradictory features.

> **Interventions.** Policy interventions – whether of deliberate design or a legacy of other initiatives – often span organizational boundaries across public service system, and often involve other governments and sectors, including non-profit, for-profit, and community organizations. Many of these interventions are tailored for the specific needs of citizens, sectors, and communities; the future of public sector governance will be one of recognizing and increasing diversity in the ways in which the full range of services are delivered.

Visualization techniques loom as potentially important sense-making, analytic and communications tools for capturing and addressing complexity. The promise is that, if properly chosen and calibrated, they can show the breadth and evolution of problems and interventions, permit more detailed explorations of facets and strands, as well as how these facets and strands link to the whole.

Citizens and ministers consume information in new ways

We know that individuals – young and old alike – are consuming and absorbing data and information in entirely different ways. Regardless of personal cognitive styles, they are increasingly familiar with hypermedia and digital technology, and more lateral in how they receive and take in information. Ministers, citizens, stakeholders and officials alike function in environments with information overload and time compression, and often paradoxically have too little and too much information for addressing specific issues.

At one level, these observations suggest that various audiences for policy analysis and deliberation will, more than ever, need to be stimulated by rich, high-impact renderings of accounts of how things work, the challenges that need to be overcome, and the diversity of actors and different situational contexts, often multi-level in nature. Such information has to be drawn from many sources, recognize complexity and multi-faceted nature of needs and challenges from a public governance perspective, but also lend itself to strategic and productive dialogue, no matter how contested with respect to values and beliefs. Finally, such visual information needs to be conveyed in a way that is easier to quickly absorb by users and possibly to be manipulated by them.

At another level, there also rising expectations about the ability of governments and public service institutions to use visualization. Not only do more people consume and produce information in this way, particularly the younger generations, political leaders understand this and know consulting firms and marketing agencies have considerable capabilities in these regards. One indicator of the credibility of public organizations in the eyes of citizens and elected leaders involves how well they present data and analysis about issues. If they are not making significant investments in this regard, public service institutions will have to play catch-up and become intelligent producers and consumers of such information.

Policy visualization: experimentation, selective investment or under-investment?

A premise of this discussion paper is that public service institutions have under-invested in visualization techniques for policy analysis, advising, and engagement. But there are likely many pockets of innovation and use visualization techniques in different parts of the Australian Public Service (APS). Important questions, then, are how widespread is the use of visualization techniques, and has this emerged as a result of strategic investments by departments and agencies or the professional training and curiosity of individual public servants? Much of the software for undertaking visualization is readily available on the web, and it seems that only basic programming and data manipulation skills is required to use them. Such early adopters could be found in any department and agency, but we should anticipate the likelihood of bottom-up experimentation and innovation would increase in more data-rich and science-or-engineering based program areas.

We would anticipate selective investments by departments and agencies where data-collection is critical to their missions (Wilson 1989). For example, that national security agencies use data-mining and visual analytics as tools, the Australian Bureau of Statistics collect and report on data trends to expert and non-expert audiences alike, science-based organizations (medical, health, biology, informatics, etc) have made investments to keep them on the leading edge of research and analysis, and the Department of Prime Minister and Cabinet's Strategy and Delivery Division has been encouraging departments and agencies to make more use of visualization as part of briefing material. For our purposes a strategic question is whether such investments have been sufficiently levered for other purposes, and whether similar investments in visualization techniques have been made in several domains without mutual learning, coordination, and sharing of resources.

Such experimentation with, take-up of, and insistence on visualization across the public sector should not be confused with a corporate strategic investment. Indeed, when compared to the huge outlays of governments for IT systems, communications, and public relations – in the hundreds of millions of dollars every year – the investments in modern modeling/visualization approaches for government policy-development and design challenges are undoubtedly relatively small.

This under-investment may be attributable to several reasons. First, in recent years governments and observers have focused on performance – achieving identified results by measurable outcomes and relevant outputs – shifting attention away from inputs and activities so crucial to producing the outputs that make desired outcomes possible, and reducing the need to convey internal and process complexity. Second, many governments may think they have made progress by making reports and web sites more attractive from a visual perspective, but the information actually remains linear and the enhancements are largely adornments, failing to provide more complex and efficient renderings of issues and work. Finally, Gov 2.0 advocates would likely also argue that government conventions and repertoires have not only limited the availability of data but also concomitant and concerted exploration of new ways analyze, depict and convey data, thus inhibiting new insight and perspectives on policy challenges.

The task ahead: assessing practice and potential of visualization for policy

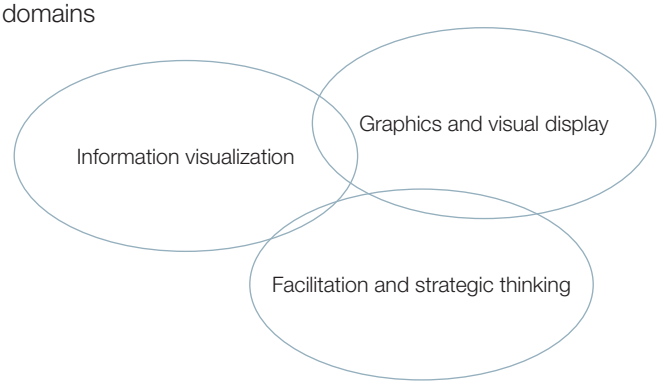
Even if governments seem to have under-invested in visualization techniques, this has not precluded bottom-up experimentation and selective investments across the public sector. There is clearly scope for sharing insight about the use of diverse visualization methods for different purposes, their benefits and limits, and how the investments of scarce public resources can be levered as much as possible. Moreover, finding better ways to convey information should have important yields for accountability, reporting on the progress of government, and engaging ministers, citizens, and other stakeholders in more productive dialogue on how to improve policy and service delivery regimes.

Before considering the state of visualization techniques in government, the extent to which they have added value, and the possibilities for more strategic investments, we should understand what visualization encompasses. We turn to this in the next section.

What is visualization?

Anyone invoking the term 'visualization' will soon learn it can refer to practitioners and scholars working in very different fields. Moreover, public servants can have distinctly different reactions to the potential of visualization to assist with policy analysis, advising and engagement depending on the visualization techniques they are familiar with. It is important, then, to delineate the different areas of practice and scholarship associated with visualization.

Figure 1 Three visualisation domains



This section provides a summary of the key findings from a detailed background paper entitled *Surveying the Worlds of Visualization* prepared for the HC Coombs Policy Forum. What follows identifies the three main domains of visualization practice – information visualization and data analytics, graphics and information displays, and visual facilitation for thinking and strategy – and concludes by identifying similarities across the domains.

Information visualization and data analytics

The field of 'information visualization' is relatively new and rapidly growing, driven by the latest developments in information and communications technologies, but tracing its origins to early mapping and graphing techniques (eg, Friendly 2008; Tufte 1990). It has developed at the intersection of the fields of computing, engineering, graph analysis, data management, cognitive psychology, software development, human-computer interface, etc Contributors come from a host of scientific, social science and humanities disciplines. The 'InfoVis' field has been institutionalizing with an expanding number of conferences, journals and university research centers, courses and programs.

InfoVis has been motivated by the need to visually represent increasingly large data-sets found in the sciences, as well as digital communications and records, to enhance how humans can analyze and learn from this information. Although the field is breathtaking in diversity, it is driven by the premise that access to different kinds of data, which – when found, accurately transformed, well represented, and properly matched with other streams of data – will help inform and improve awareness of issue, analysis, and decision-making. Visualization outputs, which can be stimulating and aesthetically pleasing, are still representations of data, which can be scientific measurements or other data (like information packets), abstract numbers buttressing variables (such as social or economic data), or images, text, and documents. Shneiderman (1996) identified seven kinds of data: one-dimensional (1D), two-dimensional (2D), three-dimensional (3D), temporal data, multi-dimensional data, tree data, and network data.

Bederson and Shneiderman (2003) identify several tasks that information visualization specialists typically undertake: overview, zoom, filter, details-on-demand, relate, history, and extract. Ward et al (2010) divide visualization techniques into six broad categories: spatial data, geospatial data, multivariate data, trees/graphs/networks, text, and documents. Chen (2006) identifies different forms of 'structural' representation: graphs, trees, and cones; proximity and connectivity techniques (such as semantic distance and word search, multi-dimensional scaling, and network analysis); clustering and classification (eg, dividing data into sub-sets and taxonomies, cluster-seeds); use of glyphs (eg, using symbols on charts to convey additional information); creating virtual structures (eg, WordNet, Wordle, etc); and creating networks (scale, small or large, topological, nodes, etc).

Chen (2006) observes that, while great strides had been made with many visualization techniques, most focused on ascertaining 'structure' from available data. He argued that the next round of research would focus on extracting and displaying the dynamic and evolutionary properties of data. A significant development has been the emergence of the field of visual and data analytics. Driven by the availability of increasingly large and multiple data-sets – but also the real-time needs of governments, corporations, and scientific disciplines – there has been great interest in 'data-mining' and the challenges of assembling, representing, linking, and analyzing diverse data in real-time contexts.

The frontiers of the field are manifold, ranging from continuing to find the best ways to represent data, understanding how individuals and group can better problem-solve with visually displays, how displays and systems (hardware, software and physical space) can be improved to assist in manipulating and interpreting data, and how techniques developed for one substantive field can be adapted for others. Finally, there have been calls for more education and training in information visualization for practitioners, particularly for novices and generalists (Chen 1995; Gramwell et al 2010).

Graphics and information displays

The field of information visualization overlaps with writing and practice on information and graphics design in two directions: (1) towards the broad field of graphics, which has long explored and celebrated innovative ways to convey information for scientific, professional and advertising; and (2) the increasing number of magazines (eg, *Wired, Scientific American*, *Popular Mechanics*, etc, to name only a few) and news organizations (eg, *Wall Street Journal*, *The New York Times*, the *Globe and Mail*, *ABC24*, etc) investing in visual renderings of issues and stories. Websites and books have been multiplying on this subject, as well as gurus like McCandless (2009) and (Baer 2008) who generate and/or convey the best and most intriguing of these efforts. However, the fields of graphics and information display should not be confused with information visualization described above: the latter is wholly data-driven, whereas in varying degrees the former places more of a premium on aesthetics, beauty and impact as points of departure.

This field is broad and diverse, ranging from the exploration of new programs and algorithms for producing visualizations, to showcasing the remarkable and beautiful examples of visualization, to exploring applications in an ever-increasing array of fields, to developing theoretical constructs, and to exploring the cognitive dimensions of processing and interpreting visualizations. Baer (2008) defines the field as “the translating [of] complex, unorganized, or unstructured data into valuable, meaningful information.” (p.12) Information-design practitioners can include graphic designers, information architects, interaction designers, user experience designers, usability and human-factors specialists, human-computer interaction specialists, and plain language experts (pp.14-15). Practitioners work with diverse media, ranging from printed matter (signs, guides, marketing, etc), to information graphics produced for magazines and newspapers, to interactive web sites and screen-based projects, to various types of animation and advertising. Baer (2008) and Steele and Iliinsky (2010) show this work includes: social and market network analysis; voting patterns in legislatures; aviation flight patterns and subway maps; text-related applications such as Wordle, searching New York Times data-bases, and monitoring the editing of entries in Wikipedia; and even autopsies! These applications could easily be multiplied to include advertising, designs, and renderings in almost any field, like engineering, natural sciences, etc.

Another focus concerns designing visual displays of information to engage audiences with presentations and animations (eg Atkins 2007; Heer & Robertson 2007), but Duarte’s Resonate (2010) takes this to new levels by using visuals to analye how speakers can create emotional and intellectual impact by tapping into good visuals, adroit timing and scripting of presentations, balancing oral and visual information flows, and linking data and presentations to good stories and overriding messages to broaden horizons, encourage commitment, and stimulate change. Such assessment and instruction is focused on persuasion. A related theme concerns the importance of storytelling in communicating the relevance of data to audiences. Segel and Heer’s (2010) research on how graphics are juxtaposed with newspaper articles leads one to consider the appropriate balance between narratives projected by the author versus the exploration of the reader. Fisher (2010) makes a distinction between using animation for the purposes of presentation versus exploration (and learning), reporting that users would take longer to explore and play with animations, and that, when responding to questions they were less accurate with animation as opposed to static diagrams.

A big question concerns the extent to which such visualizations, no matter how compelling and intriguing, are also relevant, useful and economical. Beauty is not inconsistent with utility, often arising from its correspondence and assistance to the tasks hand. Even when beauty predominates as a goal and effect of visualization, such ‘play’ can lead to greater interest in visualization, increased facility with associated technologies, and to discovering other more practical applications.

Visual facilitation for thinking and strategy

When the term ‘visualization’ is uttered, another equally engaged and enthusiastic set of practitioners might step forward: a growing community of visual and graphics artists who assist clients in grappling with complexity by means of sketching, often involving elaborate renderings of challenges and strategies. Their work proceeds under different labels – graphic recorders, graphic facilitators, and visual practitioners – but essentially they sketch in an engaging manner the evolution and key conclusions of meetings and conferences over a day and more, often in substantial and dynamic diagrams attempting to capture the movement, enthusiasm and vision of participants. It also includes a large circle of approaches for strategy development – systems thinking, simulation, scenarios, and performance thinking – which rely heavily on visual techniques. This stream most directly grapples with the challenges confronting policy-makers and advisors, even if it might involve information and perspectives supplied by other visualization streams.

The vector for the facilitation visualization community is the International Forum of Visual Practitioners (IVFP), founded in 1995 and anchored by its web site www.ifvp.org and an annual conference. Another vector for this community is the VizThink web site at www.vizthink.com, which ranges somewhat more broadly to include providing advice on compelling presentations with different visual technologies and monitoring different techniques for telling stories, but this difference may seem more apparent than real, since there seems to be considerable overlap in approach, gurus, and literature. The IFVP web site reveals many of the practitioners have similar styles, but some specialize as 'recorders', others also facilitate, and still others take on broader organizational development and stakeholder engagement. Nevertheless, there seems considerable convergence in approaches and techniques (Margulies & Valenza 2005; Hyerle 2009; Sibbet 2010; Blackwell et al 2008), including: Venn diagrams, concept mapping, bubble maps, mind maps, thinking maps, systems feedback loops, mind-scaping, thinking hats, visual journeys, assumption trees, icebergs, influence circles, etc Horn's classic *Visual Language: Global Communications for the 21st Century* (1998) used sketches to assist policy-makers and citizens to comprehend and think about how to address complex policy challenges and 'wicked problems' (Horn 2001).

Visualization practice and writing often taps into approaches that many observers associate with 'systems thinking' (but see Sibbet 2010), which seeks to bring more systematic analysis to organizations and sometimes communities to address complexity and wicked problems. We can also include, but are not limited to: simulations, scenario-building, and performance thinking. We consider each briefly in turn:

> **Systems thinking.** Practitioners here seek to work with decision-makers and stakeholders to better understand in the context of problems and interventions the issues, surrounding complexity, diverse interests and perspectives, the task and institutional factors at play, and, through dialogue, identify pragmatic ways for improving the situation. A key feature of systems thinking involves encouraging participants do commit perspectives, perceptions, and even emotions to paper in the form of diagrams, such as 'rich pictures' and other sketches, which can be shared and debated with others. (Checkland 1999; Checkland & Poulter 2010; Senge 1990; Chapman 2004; Chapman et al 2009)

> **Simulations.** These include models of how market, social, organizational, and natural systems are developed, with the ability of alter input and external variables as a way to understand the properties of complex systems.This allows users to consider the resulting trajectories of other variables over time and decision-making quandaries, constraints, and trade-offs. The altered intersections and trajectories of key variables are often conveyed visually (think of how economists display different 'runs' of a model) to engage analysts and audiences. Other examples of include airplane cockpit training devices, climate-change models, or multi-actor game simulations.

> **Scenario-building.** Practitioners work with participants to imagine diverse futures comprised of diverse variables defined by key contingencies,and to consider how these futures might be connected to the present. Scenarios are intended to develop 'shared mental maps', assist users to think broadly and creatively about future possibilities, and better appreciate dynamic, complex environments. The practice of scenario-building is typically very visual, even if the more elaborate exercises are informed by speakers and background documents: participants are typically encouraged to share ideas on walls and whiteboards, to explore the interconnections among variables, to develop coherent narratives and images of future states (eg, Rosell et al 1995; Ringland 1998).

> **Performance thinking.** Most public executives are familiar with developing 'logic models' that link the inputs and activities associated with programs to outputs and desired outcomes as a basis for developing performance measurement and management systems (McDavid & Hawthorn 2006). Although the final diagrams are linear, delineating logic models is a highly visual and iterative process: often balancing the needs of parsimony and detail to develop a 'model' representing a more complex reality, usually leaving out details ons the state of organizational capabilities and culture, political dynamics and commitment, resource allocation, client perspectives, and environmental change.

Practitioners in these traditions would not consider themselves 'visualists', but, each approach in varying degree, relies on facilitation of group processes to encourage sense-making and strategic dialogue about complex challenges, and uses visualization to capture complexity at different stages and levels of analysis.

Of the three visualization streams, the 'strategic' visualization practitioners are perhaps the closest to addressing the specific challenges of decision-makers: they seek to assist clients in capturing the nature of problems and developing strategies for addressing them, as opposed to simply supplying them with data or perspectives driven by data, and strive to assist them in discovering what they know and don't know. Conversely, they do not rely on computer-mediated visualizations (simple or complex) of findings from data-sets (larger or small), instead relying on hand-sketched renderings to move conversations along. However, strategic visualization practitioners and their clients can be informed by data and rendering from the other visualization practitioners.

Conclusion: lessons, challenges and opportunities for visualization

There is no shortage of visualization techniques! The three domains of visualization reviewed above vary considerably with respect to their focus, the problems addressed, the visual techniques applied, the intended audiences, and the kind of data driving the visualization. However, there are no hard and fast boundaries, and there are overlaps. Those working in each domain note Tufte's work and earlier efforts at mapping and drawing; see visualization as a potentially superior way to render information for illumination and decision-making; and try to balance and improve the aesthetic and practical qualities of visualizations, albeit in different ways.

The three visualization domains do not really embrace the others, except some overlap between information visualizations and graphics and display, and recent research by information visualization scholars that evaluates the efficacy of different strategic visualization techniques. There is no overarching theory of visualization. However, there are several broad messages that arise from all three areas of practice and scholarship:

> **Holism and focus.** A key reason for adopting visualization techniques is to see the 'whole' in order analyze the parts. This requires the ability to zoom in and out, to rotate, and to use images to see connections and serve as point of departure for further exploration and re-integration.

> **Representations involve trade-offs.** Represent complexity and the 'whole' – whether it involves data, images, networks, voices or conclusions – often requires simplifications of complexity, distillations of information, and not showing underlying detail that might be critical for interpretations and strategies.

> **Visualizations may (or may not) promote exploration.** Visual images and imaging may arise out of iterative and often group processes, and despite the potential for illumination, it is an open question as to whether the ultimate audience can manipulate the variables underpinning the visualizations.

> **Dynamic visualization rocks.** Static data and representations are important, but displaying trends and evolving relationships is highly desirable as a basis for better understanding phenomena and arriving at strategic interventions.

> **More data streams and perspectives are better.** It is superior to have multiple lines of data, diverse perspectives on their semantics, and/or the wherewithal to appraise the final results from different vantage points. However, this also depends on the nature of task (eg, analysis, security, strategizing).

> **Users lag and react differently to visualizations.** Evidence suggests that humans may not benefit from more sophisticated visualizations due to cognitive limitations, preferences, or lack of prior knowledge of interfaces or substance.

> **Story-telling enhances visualizations.** Even the best visualizations are enhanced by story-telling in order to draw out interesting facts and interesting issues. The audiences need context, narrative, and often a guide to parse information.

> **Designers and users should interact.** The best and most relevant visualizations emerge from dialogue and interaction between the designers and the users, with the former needing a nuanced appreciation of users' needs.

> **Innovation, re-discovery and re-packaging.** Visualization techniques developed for one purpose can be applied to other challenges. Conversely, similar packages get branded with different names. This creates confusion and augers for cross-fertilization and cross-cutting reviews of techniques and applications.

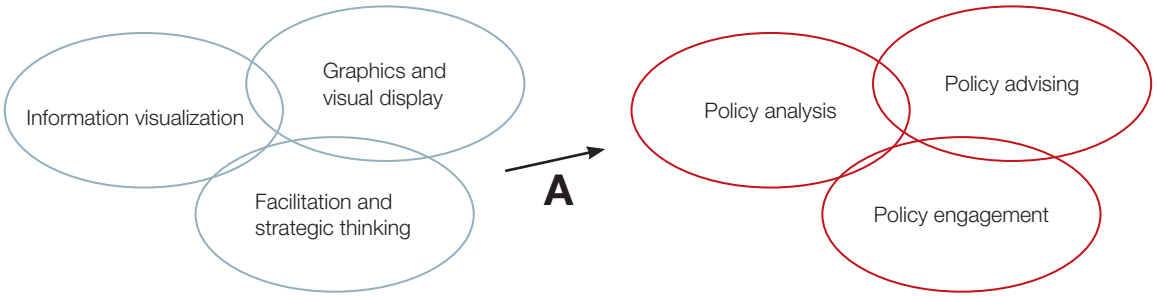
> **Education/training increasingly essential.** Even in the information visualization field, where researchers have pushed the boundaries of technology and imaging, there is agreement that a broader circle of users – primary and secondary – should become literate in visualization techniques.

Arguably, there is a shared 'rational' disposition animating all forms of visualization: that better and more data, better representation of that data, and improved processes will improve information-sharing and decision-making. However, with the exception of the field of visual analytics for security and intelligence, there has been little exploration of how visualization techniques add value in different policy contexts (analysis, advising, and engagement). Conversely, despite an interest in narratives and story-telling, the public policy and management literature has shown little, if any, interest in visualization.

Visualization and policy development: a preliminary framework

The HC Coombs Policy Forum project on *Grappling with Complex Policy Challenges* will seek to explore the experience with and potential of visualization technologies for different aspects of policy development. It is always useful to have a framework to guide wide-ranging discussions. Figure 2 indicates that the project seeks not only to understand different domains of visualization (information visualizations, graphics and information display, and facilitation and strategic thinking) and specific techniques, but, more importantly, to consider how visualization can add value in distinct areas of policy work: analysis, advising, and engagement.

Figure 2 Visualisation and public sector development



The roundtable dialogues organised by the project seek to encourage discussion about the take-up and practice of visualization for policy work by Australian Government departments and agencies, and this suggests that participants will want to explore not only how these practices and capabilities came to be but also how they can be better organized going forward. We should anticipate that different organizations and programs will take up visualization and tap into different techniques. Figure 3 suggests that the extent of take-up will be a function not only of the critical tasks, mission and culture of departments and agencies, but also of staff recruitment patterns and the networks they engage. An open question is whether the adoption of visualization techniques derives from strategic direction in a top-down way or the bottom-up curiosity, talent and discretion of staff.

Figure 3 (on the following page) also shows that, while the roundtables will seek to better understand the take-up and experience to date with using visualization for policy work in departments and agencies, another goal is to ascertain how to improve capability, utilization and strategic investments across the public sector, where capacities are distributed and focused on very different challenges.

The rest of the framework seeks to put all of this in further context, and to encourage participants to think about the ultimate goals of incorporating and perhaps improving visualization for policy work. Figure 4 identifies several of the relevant trends that have been driving interest in visualization, but also emphasized that all of the forms of visualization nevertheless must compete with well-known streams of policy inquiry (data, research, analysis, and reporting from the great variety of government and non-governmental institutions shared in published formats and at events) but also with the never-ending streams of media reporting and political intelligence, including contending beliefs, values, and narratives.

Figure 3 Visualisation in distributed public sector system

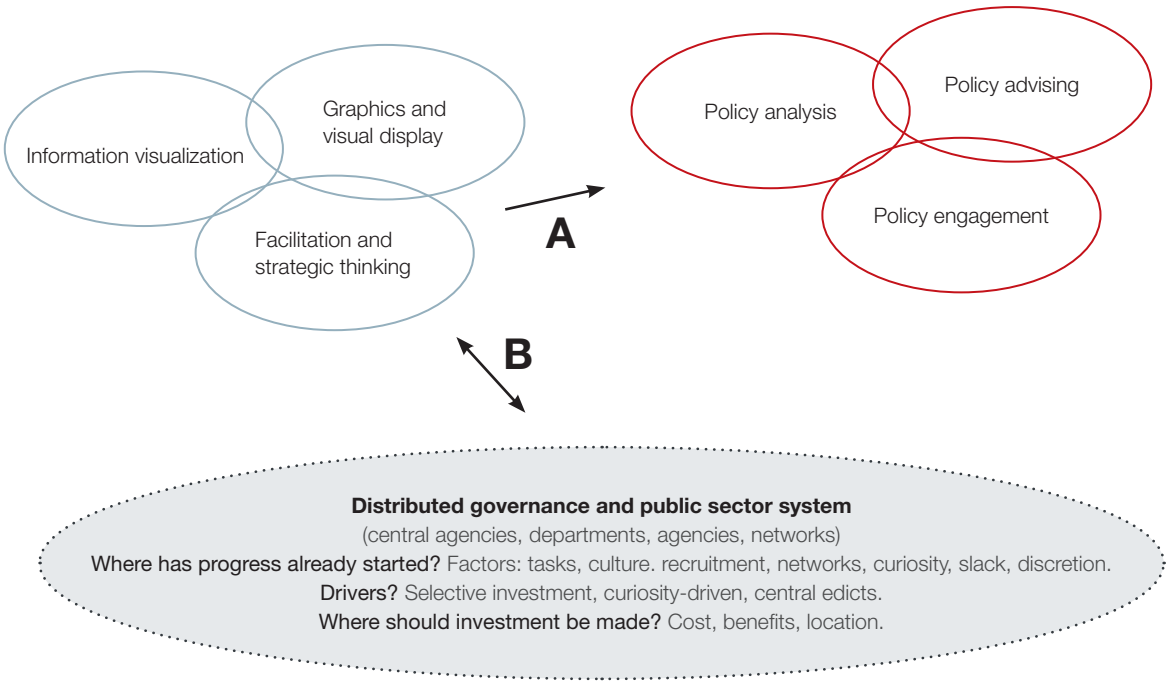


Figure 4 (on the following page) also suggests the ultimate test is how well ultimate users – decision-makers, citizens, and stakeholders – are served by new ways to present information. Such assessments will be difficult because many factors are at play, including (1) the cognitive style of leaders, (2) the preferences and expectations of citizens and stakeholders, (3) the time available for absorbing and probing information, (4) the availability and quality of other streams of information, and (5) whether the visualizations project policy narratives or seek to provide others to explore issues and construct or project their own narratives. Visualizations will variously compete with and complement other streams of information, differentially meshing with the cognitive styles and dispositions of users inside and outside government, and possibly making more effective use of available cognitive and deliberative bandwidth for decision-making and engagement.

These considerations imply criteria for evaluating how visualization might add value:

> broadening horizons and strengthening understanding of context

> greater appreciation of complexity of problems and pertinent delivery systems

> more productive use of scarce time

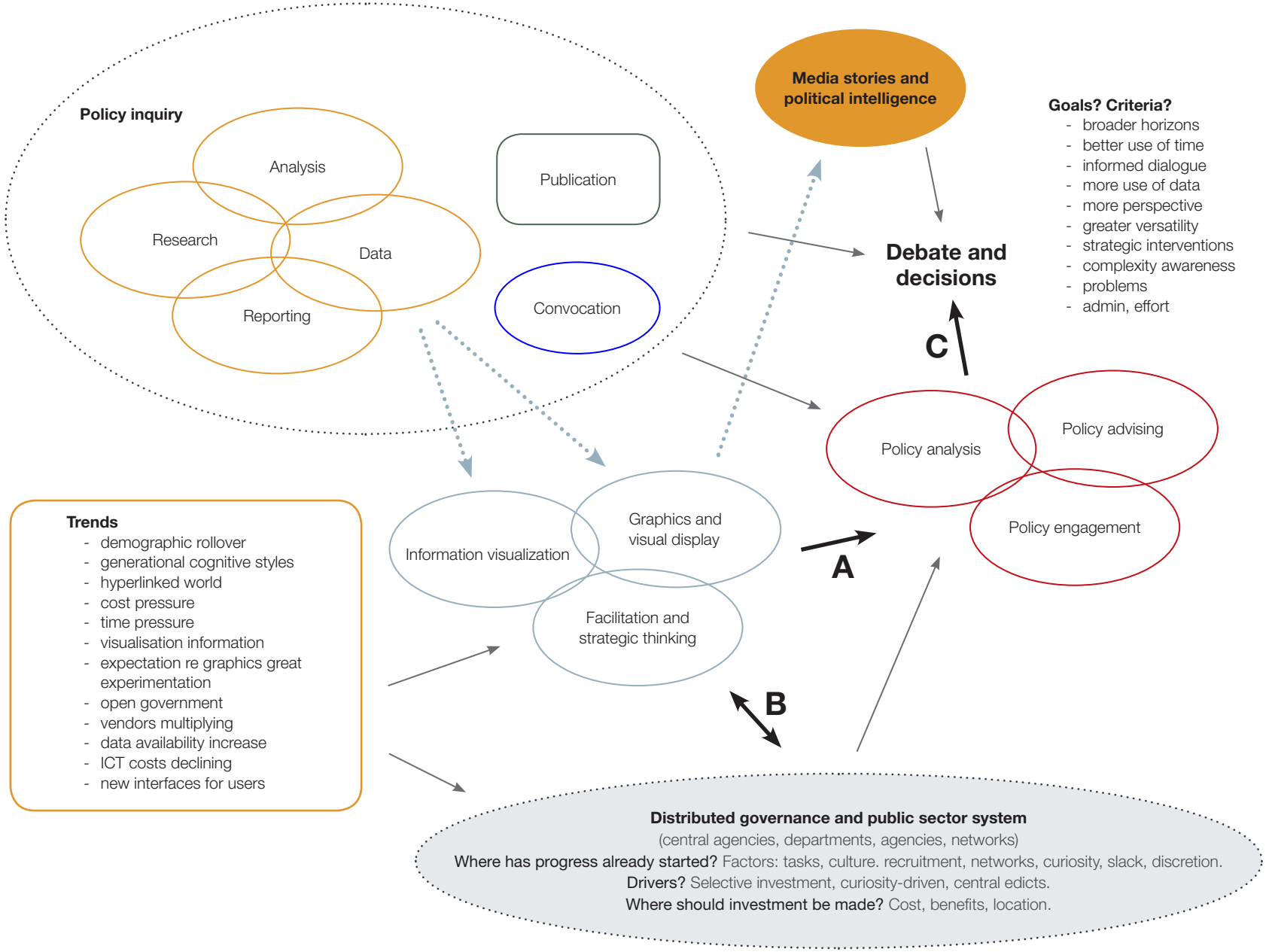
> more use of data; greater versatility in advising

> more informed dialogue

> an enhanced strategic perspective.

Visualization should not be understood as substitute for policy analysis, advising and engagement, but rather, how it supplements policy work in challenging environments.

Figure 4 Visualisation and public sector governance



How might visualization inform policy work? Questions to consider

The proposed framework outlined in the previous section has established that policy work proceeds in environments with a surfeit of information, competing values and beliefs, government systems with many departments and agencies contributing advice or delivering services, and diverse expertise rooted in disciplinary and professional networks extending outside public service institutions. The purpose of the HC Coombs Policy Forum roundtables is to explore how visualization techniques have been used by staff in departments and agencies for policy work. Visualization is diverse and intriguing, so we need finer-grained appreciation of they have been applied and whether they improve understanding and decision-making in time-compressed, fluid policy contexts. What follows identifies three distinct but overlapping areas of policy work – undertaking analysis, advising ministers, and engaging citizens and stakeholders – and, informed by the background information of different domains of visualization, suggests several questions to guide dialogue among practitioners about their application in policy work.

Policy analysis: how do visualization techniques mesh with diverse expertise?

Reflecting the complexity of most challenges, governments receive policy-relevant information from a great variety of sources – from departments and agencies, as well as from outside, from citizens, other levels of government, associations and other interest groups, think tanks, and universities. A great deal has been written on policy analysis (eg, Althaus et al 2007; Bardach 2005), so here we consider how visualization might contribute to analysis inside government. Here our focus should be less about how visualization can assist with conveying the conclusions of analysis to political leaders, and more about how it might assist with analysis per se.

Every department and agency has considerable subject-matter expertise pertaining to the challenges they address, and, in varying ways and degrees they may either tap into or have developed specific visualization techniques. The extent to which there is take-up in visualization will depend heavily on internal factors, such as the tasks and structure of programs (do they depend on real-time data? does complex information need to be assimilated and shared?), the array of experts undertaking analysis providing analysis (disciplinary and professional backgrounds, each which may or not have visualization traditions), and the culture of departments and agencies (conservative or innovative?). (Wilson 1989) External factors include recruitment systems and networks which may, by design or inadvertently, bring in new expertise and skills (Selznick 1957).

With these considerations in mind, there are several questions to explore concerning the practice and potential for visualization techniques to inform policy analysis:

- To what extent are visualization techniques utilized? Which ones? Where do they add value, and at what stage of the analytic process?
- Are visualization techniques used for sifting streams of data and literature (information visualization and data analytics), considering possibilities and scenarios (simulations and scenarios), making sense of and defining the character of complex problems (systems thinking, soft systems modeling, network analysis, GIS, etc) and testing different interventions (simulations)?
- Are visualization techniques used in combination with other information and streams of analysis? Is it policy analysts and/or program staff developing the visualizations, or specialists from graphics, computing, and statistics divisions?
- Is there competition across different disciplinary and professional experts with respect to using visualization? When dealing with different kinds of expertise, is visualization used more for analysis or synthesis?
- Does visualization inform upstream data and policy analysis, or does it follow, focusing on projecting background and options conclusions already arrived at?
- If visualization techniques are in use, did they emerge from strategic investments by departments and agencies or from bottom-up learning and curiosity, perhaps influenced from outside-in recruitment and knowledge-sharing with networks?
- How do officials involved with visualizations keep abreast of new approaches and smart practice? Do they belong to a de facto community-of-practice in the agency or externally, roam the web, or attend visualization conferences?

It should be anticipated that departments and agencies will have diverse experiences with utilizing visualization techniques, and other issues and dimensions may emerge from the roundtable deliberations.

Policy advising: do visualization techniques improve the briefing of ministers?

Policy advising is an iterative, time-compressed activity which involves public sector executives, among others, providing background and options to elected leaders for understanding and addressing complex challenges. It involves building and sustaining relationships among politicians and public servants, often under considerable stress. Ultimately, the goals are to foster productive communications, strategic dialogue, and informed decision-making. Visualization could supplement policy advising because it holds promise of more efficiently, holistically, and accessibly conveying to political leaders a range of background information and strategic possibilities.

It has long been understood that the preferences and schedules of political leaders shape and constrain how advice is provided by public servants. Even before the arrival of modern visualization techniques, ministers and their staff have demanded information in forms tailored to the specific cognitive styles of ministers. The question here is whether visualization techniques can accelerate the provision of information and advice, as well as deepen its quality under time constraints. It is important to understand that ministers and staff build up familiarity and mental maps of issues and background over time, and usually develop trust in the information provided by their officials. Enduring challenges have included providing sufficient detail and perspective to ministers and their staff so that they can appreciate complexity, trade-offs, and risks so they can make informed political and policy judgments.

With these preliminary considerations in mind, here some questions that could be explored concerning how visualization techniques inform policy advising:

- Have ministers and staff been demanding more briefings using visualization techniques? Why? If so what kind? What has the experience been to date?
- Have central agencies or other agencies been insisting on the use of visualization techniques with briefings to ministers? Are standard formats required? Do they improve how the department/agency provides advice to their own minister? Do different departments and agencies have different ideas about visualization?
- Conversely, has it been policy staff who have sought to use more visualization techniques in their briefings to ministers? What kind? What was the reaction of ministers and staff? Where have visualizations proven most useful?
- What lead-times are required for developing truly useful visualizations as part of briefing and advising packages? Do the visualizations for ministers emerge from policy analysis work, or is this seen as a distinct domain?
- Do visualizations add value by simultaneously showing complexity, the essence of issues, the implications of different options, sensitivity to uncertainties and key variables, and assessments of political and other risks? As a result, do ministers ask better questions?
- Can the phase of sense-making, knowledge-building, and horizon-broadening be distinguished from judgment and decision-making phases? And, do visualization techniques get used differently during these phases?
- To what extent do trade-offs in visualization occur and get appreciated? Does providing a sense of the whole come at the expense of seeing and delving into the parts? What is the impact of different underlying theories of how and why things work (or don't work)?

Roundtable participants should anticipate that observations based on these questions will be diverse, not only because of the distinct mandate, tasks, cultures, and expertise of their departments and agencies, but also because of the particular preferences of ministers and governments.

Policy engagement: can visualization techniques improve the quality of dialogue?

Engaging citizens and stakeholders to test and inform policy deliberations and design is a huge field of practitioner and academic interest. There are many different ways and gradations of engagement, ranging from government simply informing citizens and stakeholders about policy decisions and strategies taken, to engaging them on problem definition and potential policy mixes but retaining authority to make final decisions, to sharing decision-making responsibility (Arnstein 1969; Bishop & Davis 2002; Smith 2005; OECD 2009). Our purpose is not review the considerable literature on consultation and engagement, but rather, to probe whether and how departments and agencies have used visualization to assist with engaging citizens and stakeholders.

Regardless of where governments are in the continuum of engagement possibilities, one of the biggest challenges for governments is to provide sufficient information to citizens and other stakeholder on the history, issues, technical background, contending interests and considerations, etc, to ensure that consultation and deliberation is as productive as possible (we leave aside the possibility that consultations are undertaken only for symbolic reasons). There are some parallels to advising ministers: the amount of time for engaging citizens and stakeholders is always limited, so careful thought must be given to how to provide appropriate background to ensure that feedback and advice is well-informed, and to ensure that dialogue is as productive as possible. Conversely, there is no equivalent to the cognitive style of ministers; here we might think instead about whether visualizations are congruent with the needs and expectations of those engaging with government, and whether they provide a sufficient semantic platform for productive exchange of information. Visualization techniques hold promise in several regards: (1) displaying the dimensions, history, and complexities of policy challenges through visual displays; (2) capturing the insights and dynamics of deliberations for participants with different viewpoints; and (3) monitoring and displaying the themes from dialogues and submissions of citizens and stakeholders so they can be reviewed by political leaders, public sector executives, and others.

How visualization might enhance engagement by governments is a broad topic, so here are questions to focus reflections on experience to date as well as future possibilities:

- Have visualization techniques been used to provide background and focus to consultations and deliberations? Who produced the visualizations? Were different formats used for different groups? Were these considered to be successful? Sufficient?
- Were these visualizations designed to convey and possibly test government perceptions and narratives about policy challenges? Or, could audiences play with and inform visualizations? Could they create their own narratives and stories? Was data sufficiently available so that outsiders could develop their own visualizations, perhaps doing better than the public service itself?
- Were the visualizations static or dynamic? If the latter, did they have with the versatility to zoom in and out from the whole depending on the directions and issues arising in the dialogue? Could they be used to show different scenarios or sensitivity to certain variables?
- Did the visualizations attempt to depict the complexity of the policy challenge? Was the intention to wrestle with the complexity or use it as a platform to discuss more specific issues? Were participants appreciated, put off, or overwhelmed by the complexity?
- Even if visualizations were not used extensively, did citizens and stakeholders demand information and evince expectations that could have been supplied with visualization techniques?
- Were visualization techniques used to facilitate and track the twists and turns of discussions? Were central to the process, the primary way to record insights or an adornment? Were other sorts of records of insights kept of the dialogue?
- Were visualization techniques used to convey the key themes and insights from engagement to political leaders and executives? What forms did this take?

How and whether governments engage citizens and stakeholders with visualization may vary considerably not only because of the policy issues under consideration, but also the consultative traditions of associated departments and agencies administering them. This will be further complicated by how governments choose to engage during certain stages of policy development in light of political sensitivities.

Conclusion: reflecting on visualization across different domains of policy work

It is worth noting that delineating among the three areas of policy work – analysis, advising, and engagement – is an artificial construct. Policy development is generally an iterative and often messy process, working in fits and starts: analysis can inform ministerial advice and lay the groundwork for engagement, but consultations can inform analysis by policy staff as well as the advice given to ministers, and direction from a minister often shapes the scope for policy analysis and engagement with citizens and stakeholders.[1]

1 One reviewer of this paper wondered about the use of remote devices in government departments to vote for various options and share the results on graphs on screens. While beyond the scope of this paper, such polling does use dashboards to report results and instantly conveys the views of the "whole" to the larger group. Such technology, of course, can also be used for external engagement.

Stepping back and looking across the domains of policy work, there are several broad questions that could be broached about the penetration and potential of visualization practice. These include the following:

> Are there equivalent amounts of experimentation and take-up of visualization techniques across the domains of policy work?

> Is there reliance on different visualization techniques in policy analysis, advising and engagement?

> Has visualization has been experimented with more fully in certain policy domains than others, which may reflect the disposition of certain ministers and/or their departments and agencies?

Preliminary answers to these questions will be important for considering whether and how strategic investments should be made across the Australian Government.

Visualization in policy work: from perspective to strategic investments

The HC Coombs Policy Forum roundtables should produce considerable insight about the state of practice, the diversity of techniques and applications, and the potential for visualization in addressing complex policy challenges. However, when interpreting these observations it will help to be aware of the limitations of visualization and to have realistic expectations about this latest stream of expertise and knowledge flowing into policy-making processes. In this concluding section, we will first consider several high-level perspectives on how visualization might fit into policy-making broadly understood, and then identify some elements that could comprise a strategic approach for improving visualization capabilities across the APS.

Taking a further step back: perspectives on visualization and policy-making

This paper (and the background paper) have identified many types of visualization techniques. In reflecting on experiences with visualization in diverse policy sectors, there will be a wide range of views and commentary on the applications, worth, and how to proceed with further investments in visualization by government. In stepping back, it will be important to think broadly about how visualization intersects with policy work and governance more generally. Here are some broad perspectives to consider that might help to locate and leaven those assessments:

> **Visualization for what?** During the roundtable discussions there are bound to be very different reactions to the practice and promise of visualization. These will be informed by casual knowledge of certain specific types of visualization, used for certain purposes, and by the experience of organizations that participants are familiar with. **Visualization techniques and practice are incredibly diverse, so not only we need to think about why others produce and invest in visualization, but also what our own motivations are for learning more about it.** This should allow participants to appraise the possibilities not only for their immediate context but also for needs across the system. Is visualization useful for problem definition, horizon-building, illumination, sense-making, or analysis of complex problems and underlying relationships? Or is it more for synthesis, presenting the results of analysis and deliberation, integration, and options development? Or does the interest in visualization more for developing vision and strategic direction for an organization, policy sector, or community? Or is the interest to succinctly convey complexity, to show government works delivers and collaborates, the diversity of needs and points of delivery, and what resources and capabilities can reasonably be mobilized to address challenges. Or is the interest in visualization motivated by informing real-time decision-making, as is the case in transportation, security, and emergency services? All of these purposes for visualization are legitimate, but they each tap into different techniques, and condition how we think about the benefits and effectiveness of investments.

> **Cognitive styles, bandwith and channels.** The impact of visualizations will depend not only on their design, but also on context and the preferences of users – different visualizations will be appropriate for different facets and stages of policy deliberation and development. **It is important to develop a good sense of how visualization intersects with, supplements or competes with the many other streams of information, including data and analysis, along with beliefs and values, making their way towards decision-makers.** In this connection we should be sensitive to not only the cognitive style but also the bandwith and the shifting and contested playing fields of specific decision-makers and public organizations. This also implies that those producing and incorporating visualizations require versatility and deep knowledge of underlying data in order to seek alternative ways to

present findings and perspectives. Some ministers and outsiders may be reasonably sophisticated consumers of visualization and other communications tools, mavens for judging the capabilities of public servants; others may not like visual displays and indeed could be overwhelmed or threatened. This raises the interesting possibility that, like service delivery, visualization is simply as another 'channe' for providing information and service, and suggests that public sector organizations need to be more versatile in conveying information.

- **Visualization as play.** Visualization can be very aligned with policy-making needs or could flow from 'visualists' accessing data streams or zeroing in on factoids which intrigue them – these latter efforts could be undertaken for fun or serious purposes and, regardless, lead to interesting visualizations that capture attention and stimulate people.[2] Some of the latter might range from the seemingly frivolous and indulgent to the genuinely thought-provoking on important issues. **Such play, whether serious or fun, can been seen as experimentation, developing a broader taste on the demand-side visualization techniques as well as a broader community of individuals who could apply such techniques to other problems.** Here March's (1989) notion of the importance of 'gossip' is useful, which he defines broadly as non-decision-specific information production and sharing in organizations. Feldman and March (1981) also noted that information is typically over-produced and under-utilized in organizations, and serves many symbolic and organizational functions, including readiness for future and preparedness for unimagined decisions (Lindquist 2009). Visualization, like a lot of research, may appear to be 'hit and miss', and often irrelevant, but this is consistent with the fate and probability of impact of data, research, and analysis produced more generally by government, think tanks, universities, and other sources.
- **Perspective: Relative costs, benefits, impact.** There is a great number and variety of visualization techniques. Some effort should be made to get a sense of the costs as well as the benefits of producing credible and high quality visualizations. Costs might include the outlays for software, training, staff, contracting, etc There is some literature on the effectiveness of certain kinds of visualization, and this is a growing area of interest. **Regardless of the ability of the cognitive take-up of different kinds of visualizations, the benefits for 'policy work' might be more diffuse and difficult to gauge, given the more allusive ways in which information feeds into and influences decision-making.** More generally, it would be useful to get a sense of the relative costs and benefits of different types of visualization. We should always keep in mind the relative impact of other information streams and technical expertise, and keep an open mind to other time-honored and new ways to convey information, particularly on complex challenges, to decision-makers and other audiences, such as maps, stories, personal stories, field visits, etc It may also be interesting to consider how visualization related to the broad evidence-based decision-making movement.
- **Visualization and 'open government'.** Information visualization, particularly the area of data analytics, and graphics and information display, rely heavily on the availability of reliable streams of data, an ability to categorize and manipulate the data, and often to different streams in order to inform conclusions. As more data sets are made available by government and other organizations, there is greater opportunity for analysts inside and outside government to work with, analyze and present renderings of the data. **Whether such visualization adds value from a strategic policy viewpoint is an entirely different question because that depends on insight and finding gold in the dross.** When considering the relevance of this possibility inherent in open government, we can think of two possibilities: (1) outsiders given access to data in order to come up with any sort of analysis they can produce, which may or may not be relevant; or (2) outsiders might be encouraged – may be through prizes – to develop visualizations for certain streams of data for certain audiences, thereby focusing less on different data and relationships, and more on quality of visualization.
- **Is visualization so different?** The visualization movement presents many exciting possibilities for how governments can approach policy work. But all may not be new: worth considering is how visualization might be similar to other inputs into policy work. For example, the challenge of tapping into visualization experts is not a new one: it is easy to think of how policy units have absorbed a succession of different analytic, research and presentational techniques over the decades (economists, statisticians, demographers, etc). Often much was promised by specific techniques, but with testing and adaptation, they were factored into the larger craft and repertoires of policy work, and the resulting mixes varies across policy domains. **The real challenge is to increase awareness of the possibilities and conversant about the techniques, eventually becoming intelligent and smart consumers of visualization.** Indeed, a key challenge here promises to be how to develop

2 See McCandless (2009), a book full of such renderings, but scour the web too!

capabilities across the public sector system to handling multiple types of visualizations for multiple challenges and users. Visualization may broaden the policy tool-kit – as noted above, we can also see visualization as another family of 'channels' for reaching ministers, stakeholders and citizens.

These broad perspectives should reduce the impulse to see 'visualization' as a magic bullet for policy work, and inform strategic discussion about how to develop capabilities.

Investing in visualization: some strategic possibilities to consider

Visualization has been seeping into public service institutions from outside as well as from individuals and units tapping into or developing capabilities. Such capabilities are often purpose-oriented to address proximate, specific challenges. Moreover, many visualization capabilities may have long existed in various parts of the Australian Government, including GIS, modeling, simulation skills, etc, associated with different disciplinary and professional expertise. There is the strong possibility that many individuals and units may be working on different problems with similar visualization techniques. Missing is a APS-wide perspective on these capabilities, how they might inform policy work, and how to make smart investments. Developing a more strategic approach might include some of the following elements:

> **Galvanize visualization expertise.** Pockets of visualization expertise are already dispersed around the APS, and there is evidence of curiosity, if not demand, from elected leaders, some executives, and citizens about its use. This suggests that simply galvanizing this expertise into a network would be one element of a low-cost strategy with potential to lever experience and foster learning, and to identify and share the costs of purchasing proprietary software and associated training.

> **Develop a system of distributed capabilities.** Given the diversity in visualization techniques and different policy needs and uses, the Australian Government should consider investing in a central-of-excellence and clearing house capability in a central agency (perhaps jointly held between PM&C and the APSC), but allow for the deepening of capabilities to occur in departments and agencies which have already specialized in certain areas (Geoscience Australia, ABS, etc). This would be buttressed by a central web site. The model to follow here would be the approach of many jurisdictions in developing 'foresight' capabilities.

> **Linking visualization and policy expertise.** This discussion paper suggests that, while some policy units in larger organizations may have sufficient resources to hire and retain visualization expertise, the range of demands for different kinds of visualization and the degree of technical expertise required may rapidly exceed those capabilities. This suggests it may be more productive to keep the two networks of expertise distinct and intermittently link them.

> **Invest in visualization literacy and training.** Simply linking policy analysis and visualization expertise will prove insufficient: there should be central investment in encouraging policy experts to increase visual literacy through training and professional development courses, and, in parallel, a set of training courses for those analysts who seek to develop real skill in this area. Such courses could be developed in concert with in-house capabilities or universities.

> **Keep eye on the quality of data.** It is easy to focus on the beauty and quality of visualization, and such aesthetics are critical when engaging ministers, citizens and stakeholders. However, equally important is gaining access to useful data, ensuring proper analysis and transformation of that data, and developing good response repertoires to policy-driven demands.

> **Front-end investment; longer-term pay-offs.** While the costs of investing in visualization capabilities in the short-term may seem significant, and the direct benefits of improving decision-making difficult to demonstrate, they will be small compared to other IT-related outlays and the increased familiarity and facility with visualization for specific purposes will rapidly improve. Indeed, in certain areas there will emerge a more defined sense and range of visualization needs, which can be factored into analytic and briefing routines.

These are preliminary suggestions, and not meant to pre-empt better insights and ideas based on the empirical and strategic discussions that will emerge from the HC Coombs Policy Forum roundtable dialogues. However, given the vast array of visualization techniques, it seems to appropriate to set out such strategic possibilities so as to ensure that the discussions move into this territory.

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