From Massive Mainframes to Massive Data, Databanks to #OpenData, ‘As We May Think’ to Thinking Machines: Computer-Supported Policy Analysis and the Future of Practice

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A single NASA desktop calculator in 1969
had vastly more computing power than the Colossus at Bletchley Park.
Your smartphone has more computing power
than all of NASA had when Armstrong leapt.

British cryptographers broke the German Lorenz code
and helped win the war.
NASA launched rocketships and put a man on the moon.
We launch angry birds into pigs
and knock over buildings.

LOL

(a semi-original poem based on a tweet of unknown authorship)

Introduction

This paper surveys the application of computer technology in support of the policy analysis function in western governments over the post-World War II period, and points to possible future implications for practicing policy analysts arising from continuing technological developments and as the consequence of three emerging phenomena: the massive data era, the open data movement and anticipated advances in artificial intelligence.

Enthusiasm for, and skepticism about, the ability of advances in information and communications technologies (ICTs) to improve the policy analysis and decision making processes has ebbed and flowed over this period. From the infiltration of post-war machine-computer advances into automating the business of government (Gammon, 1954) and hope for the improvement of the human condition (Bush, 1945), through a golden age of computer-supported policy analysis (Bossel, 1977) and the bold Chilean Project Cybersyn (Beer, 1974), to the present vision of Gov2.0 as a “governance platform” (O’Reilly, 2010), this history has been propelled by both advances in technology and the force of visionary personalities.

Today, the emergence of a second generation Internet (Web2.0), coupled with ubiquitous cloud computing, advances in semantic data mining capacity and smart data linkages (Web3.0),
powerful mobile devices, massive data availability and the continuing promise of artificial intelligence all portend a resurgence in computer-supported policy analysis. Yet this technologically-fuelled vision stands in contrast to the ambiguity of quantitative policy analysis in the post-positivist age (Fischer, 2003; Stone, 1997; Mouffe, 2000; Nilsson et al., 2008), and the challenge that the rise of open book governance (Dunleavy and Margetts, 2010) and instinct politics (Susskind, 2004) pose for inside-of-government, evidence-based policy analysis. Where fundamental questions about the value and role of policy analysis in the context of political decision-making continue to raise basic questions such as “what is policy analysis for?” (Shulock, 1999), advances in computer-supported policy analysis raise hopes for a policy analysis renaissance yet also pose existential questions about the future of the profession.

This paper does not propose nor pretend to resolve these dilemmas. However, we can anticipate that continuing advances in computer technology, and the revolution in Internet-based civic interaction embodied in Web2.0, will have implications for the future of policy analysis practice. If we accept as given these premises, the point of this paper is to argue for an open-eyed anticipation of this unknowable and uncertain future, and for policy studies academics to begin to think strategically about how current and future policy analysts can prepare.

Following a brief discussion of the concept of computer-support policy analysis as a distinct sub-field within a much broader e-gov literature, an attempt is made to sketch the history of computer-supported policy analysis over the post-World War II period along five avenues: the introduction of mainframe computers to support large scale arithmetic manipulation; the proliferation of modeling, scenario and algorithm efforts deployed in an effort to manage complexity; the brief, though intense, dalliance with decision support tools and management information systems; the rapid spread of desktop computer technology throughout governments, resulting in the ubiquitous presence of computers in the work of policy analysts; and the emergence of networked technology as a central feature of today’s policy work.

**Locating Computer-Supported Policy Analysis within E-Gov**

Computer-supported policy analysis, the focus of this paper, is a component of “e-gov” (itself a convenient amalgam of the often undistinguished fields of e-government and e-governance). If e-gov is roughly defined as the application of ICTs to the business of government and processes of public governance, an unwieldy literature soon emerges under this heading. This section (building upon Dobell and Longo, 2011) seeks to make sense of this e-gov space in order to define and locate the field of computer-supported policy analysis.

Taking a narrow slice of the broad e-gov field, this paper will focus principally on the impact of the computational aspects of ICTs on “inside government” processes of policy analysis and
decision making, with particular emphasis on the analysis of public problems by civil servants and the use of information technology by decision makers.

To be clear, the focus is not particularly on the computer-mediated communication of policy analysts with other actors (whether manifest as knowledge management systems that facilitate internal-to-government collaboration processes, or communication technologies that support stakeholder consultation and civic engagement), nor on the communicative capacity of ICTs in support of deliberation and decision making. Rather, this paper is focused narrowly on the intersection of the act of policy analysis and processes of decision-making with the machine computational capacities inherent in information technologies - whether arithmetic or algorithmic - that are deployed principally for the purposes of analyzing data in order to better support decision-making. Simply put: how have policy analysts and decisions makers used ICTs in the policy formulation process during the post-World War II period to better understand public problems and improve policy making?

1 See the paper by Evert Lindquist, in this symposium, that examines the impact and potential of computer-based visualization technologies for analyzing policy, communicating complexity, advising political decision-makers and informing civic dialogue and citizen engagement.
In order to parse the massive e-gov literature and more tightly focus the discussion, a four-quadrant organizing framework is adopted following Dobell and Longo (2011). Starting with the overarching definition of “e-gov” as the application of ICTs to the business of government and processes of public governance, this organizing framework includes the application of ICTs to the public sector activities of:

- outward-oriented stakeholder consultation / citizen engagement and democratic governance (e-democracy);
- internal-to-government knowledge management, policy analysis, formulation and formation (e-policy);
- corporate internal public sector administration (e-management); and
- service delivery to citizens and other outward-oriented public administration functions (e-services).

These broad categories are represented in the four quadrants shown in figure 1, organized along two axes: along the horizontal axis, the distinction is between inside-of-government, closed corporate settings and outside-of-government civic and political settings (this “inside-outside” distinction follows from Dobell, 2003); and a rough approximation of the policy cycle (book-ended by analysis and implementation, represented as a spectrum between “talking/thinking” and “action”) is represented on the vertical axis. As one purpose of this organizing framework is to serve as an aid to understanding the impact of computer technology on both the business of government and the domain of public governance, the distinction between “government” as a corporate activity and “governance” as a procedural domain is also shown with the top two quadrants occupying the “governance” sphere and the bottom two quadrants embodying “government”. The use of four organizing concepts for e-gov (i.e., e-democracy, e-policy, e-management and e-services) provides additional specificity when attempting to categorize elements within the vast e-gov field. This approach also stands in contrast to traditional e-gov organizing frameworks which propose a triplet of e-service delivery, e-democracy and a vague catch-all of e-governance (e.g., Borins et al., 2007).²

Further distinguishing of the vast range of sub-types of e-gov literature, tools, methods and techniques can be shown within each of these four high-level quadrants - each containing its own mini-quadrant using the same inside-outside / talking-action axes. Computer-supported policy analysis - the focus of this present work - is located in the uppermost left-hand hexadecant of figure 1, within the e-policy category.

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² Perri 6 (2004) also employs a four-part e-government definition, though his distinction between “e-democracy” and “e-governance” is less-than-clear.
History

The histories of the modern electronic computer and the evolution of modern public sector governance are strongly entwined, though the dynamics of which has led and which has conformed provides as much ammunition for technological determinism as it does for the alternative theory of the social construction of technology (see Wynne, 2010, p. x). An excruciatingly brief history of electronic digital computers takes as given the influence of Pascal, Jaccard, Babbage (and Lovelace) and Herman Hollerith. One theme that emerges even from this very early history is the mix of private enterprise and government-as-primary-client: Babbage’s solitary quest for an “analytical engine” in the early 19th century enjoyed the enthusiastic support of the United Kingdom government. Hollerith, the father of IBM, invented the punched card as a data-storage medium that could be read by a machine - and went on to sell the idea to the United States Census Bureau in 1890.

During World War II, military requirements in weapons and cryptography gave a boost to earlier developments in calculating machines, and ushered in the era of modern electronic digital computing. The code-names given these room-sized devices - like Zuse, Colossus and Harvard - indicate the awe with which their inventors regarded these machines. In the immediate post-war period, the combined capacity of the welfare state and ongoing military Cold War needs continued to provide a narrow market for the deployment of increasingly powerful computers - following the lead of the legendary ENIAC, the first electronic general-purpose computer and one of the first truly “Turing-complete” devices. The first post-ENIAC generation of computers solidified the “von Neumann architecture” which all current computers conform to.

One of the first commercial computers delivered - a second copy of the Ferranti Mark 1 - was purchased by the University of Toronto at a discount in 1952 after initially being built for the U.K. Government’s Atomic Energy Research Establishment; that contract was cancelled after a change in government (ref?). The LEO I was developed by a British catering company as an aid to office administration in the early 1950s. In 1951, the UNIVAC I was purchased by the U.S. Census Bureau with 45 more UNIVACs being sold over its lifetime. While the first six UNIVAC installations went to government clients, private sector firms soon took over as the primary market (Gammon, 1954). Next came the era of the "IBM Mainframe" and the rest, as they say, is history.

The bipolar transistor replaced the vacuum tube around 1955, leading to a second generation of commercial computers that were smaller, cheaper and consumed less electricity.

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3 One UNIVAC installation was famously used to correctly predict the result of the 1952 United States presidential election using a sample of 1% of the voting population.
As the cost dropped - to the universal shock of economists - demand increased: over ten thousand IBM 1401s were shipped between 1960 and 1964. This period also saw the development of the operator terminal - thus separating control of the device and the computer itself. This concept - which can be said to be the origins of that global network of networked computers, the Internet - provided a means for individual computer users to share data and communicate with other users through their computers.

A "third-generation" of computers, built on the microprocessor, led to the microcomputer and ultimately the personal computer. In the intervening period, processing power has increased, while cost and power consumption have fallen dramatically, making computers ubiquitous. Alterations to the computer metaphor in the present - with hybrid, mobile devices such as the Apple iPad gaining momentum - perhaps portend a post-PC world. For the immediate future, the consumer appears to be king and governments are left as simply one category of consumer with little ability to influence technology (nor appear much interested in doing so).

Note to readers: these next five sub-sections are clearly placeholders. They will be supplemented following the symposium with much more focused literature reviews in each category.

1. Massive Mainframes
   - Basic message: large, very costly installations that essentially replicated what people could do (calculations) but did so faster and reduced the human organizing costs of performing government work.
   “This paper has been concerned primarily with pilot studies and explorations in the application of electronic equipment in the processing of routine information in administrative organizations. There may be possibilities of even more interesting and promising developments in the use of such devices. In recent years there has grown up a new branch of applied mathematics which deals with problems important to management. It has been called variously "formal programming," "linear programming," and "activities analysis." Closely related developments are the beginnings of a "theory of games" and a "theory of information," both of which provide for the formal-logical statement of the best way for a group to achieve an objective. All of these new approaches deal with the problem of obtaining the "best" or lowest-cost system..."
("optimum strategy") for carrying out a large system of operations, where decisions depend on very large numbers of interrelated variables. The tools are a formal-logical approach to simultaneous conditions and the mathematical techniques which have been invented to handle this class of problems. The goal of these approaches is to erect a consistent system of decisions in areas where "judgment" can be reduced to sets of clear-cut rules such as (1) "purchase at the lowest price," or (2) "never let the supply of bolts fall below the estimated one-week requirement for any size or type." Whatever the new developments, there will still remain many problems that cannot be cast into the form to which these formal methods can be applied. Actually, in many cases the problem is much more one of systems, differences in concepts within the organization, and lack of firm program information on which to base a mathematical model or logical formulation than it is a problem of mathematics as such. In any event, there is no real possibility that the executive or the top administrator will become obsolete as the result of foreseeable advances in the use of electronic equipment." (p. 73)

2. Modeling Complex Systems

Computer models are like fashion models. Seductive, unreliable, easily corrupted and lead sensible people to make fools of themselves. (Jay and Lynn, 2011)

Models, in my definition, include any procedure that is meant to help the policy or decision maker and his staff predict the consequences of proposed courses of action. Models may be implicit or conceptual, existing only within the mind of the decision maker (and possibly rife with pitfalls), but we will confine our attention to explicit models designed by others. These latter may take many forms-physical, natural language, mathematical equations, or a computer program, for instance--and the method of prediction may be judgment, physical manipulation, numerical approximation, or simulation, among others. (Quade, 1980, p. 31)

A range of approaches can be placed under this general label of attempts to model complex systems:

- **System Dynamics**: derive from Forrester's early work (Forrester, J. W. 1961. *Industrial Dynamics*. Cambridge: MIT Press,) on the dynamics of industrial systems, mostly

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4 Gammon’s article would have likely remained hidden from any survey of e-gov literature as it, of course, made no use of the term e-government (being written some 40 years before that term emerged) and was only cited once in academic literature. This was rectified in 2011 when Richard Heeks asked via his blog if it can be identified as “the first research paper about e-government” (Heeks, 2011).

- **Simulation tools**: Simulation techniques pre-date computer technology, having their origins in modern military training. Military exercises from World War II gave a boost to the computer-based simulation that has become ubiquitous in engineering and business management, followed by many scientific applications aimed at increasing understanding of complex systems. As simulation techniques evolved, they developed into two distinct approaches: as the basis of a gaming exercise; and as a tool for modeling and predicting the functioning of a complex system. Recent advances in simulation modeling have brought those two streams back together through efforts to create policy games based on complex systems models. Social and economic simulation techniques were developed in the 1960s, with the two objectives of advancing theoretical inquiry and assisting educators. The most important advances prior to the 1970s centred on problems associated with urban planning, where complex computer models of urban settings were developed as tools to predict the consequences – primarily focussed on transportation and land use – of policy decisions. However, enthusiasm for large-scale simulation models diminished during the 1970s as theoretical limitations in modeling coupled with data deficiencies made the predictive capacity of simulation tools suspect. But as a tool to facilitate role-playing games, simulations remained as a staple technique in training and conflict resolution. Advances in computer technology (including the spread of desktop computers and the development of graphical user interfaces), modeling theory and data resources during the 1990s have expanded the use of and enthusiasm for simulation tools. See also Axelrod, R. 2003. *Advancing the art of simulation in the social sciences.*" *Japanese Journal for Management Information Systems.*

Prior to the entry of graphical user interfaces for computers in the early 1980s, simulation tools tended to be limited to use by experts as part of the process of crafting policy advice. During this period the direct exposure to simulation tools tended to stop with the expert user, with the interpretation and translation of those outputs being the task of the policy analyst. As recipients of distilled policy advice, political decision makers would not have nor want first-hand access to the tools or their outputs.

It seems reasonable to assume that the arcane complexity of the simple alphanumeric interface and the expertise required to interact with the models meant that only those
having the time and capacity necessary to learn the requisite programming skills would feel the need to actually touch the keyboard or look at the output.

When only experts had access to simulation tools, those experts were presumably in a position to understand the limitations and weaknesses of the model and to judge the outputs accordingly. While the policy analyst may have used simulation results to lend opaque authority to policy advice, simulation modelling was still the domain of experts possessing a relative level of analytical sophistication. Thus, despite their basis in rigorous analysis, simulation results derived from expert interface systems should have ultimately ended up in the same category as other factual evidence assembled into non-expert policy advice.

This general proposition does find a counterpoint in the late 1980s U.S. Congress, where non-GUI expert simulation modelling found both a niche and a willing audience. During that period, analysts were said to be busy all hours of the day and night preparing estimates of the budgetary and program effects for a number of proposed bills (each of which contained as many as fifty separate provisions), and providing comparisons of estimates between proposed bills and the current law (Citro and Hanushek, 1991). Federal law required at that time that cost estimates be projected for five years, as well as estimates of which population groups would be affected by the various bills and whether those groups would gain or lose under each proposal. In the social policy field alone, analysts in the Congressional Budget Office and the Congressional Joint Committee on Taxation, and several executive level departments were busily preparing alternative estimates which would become the central debating tools as the proposed bills jockeyed for position in Congress. All this activity produced a wealth of numbers upon which “policy makers throughout Washington are making decisions about the government’s role in social policy.” (Citro and Hanushek, 1991, p.24). Simulation modelling reached its apex in this context with the Congressional Budget Office (CBO) concept of “scoring” (Starr, 1994). With the U.S. federal government facing significant budget deficits at the time, and Congress seeking to discipline itself through balanced budget requirements, the CBO provided a score for legislative proposals that projected the proposal’s future impact on the deficit; a poor score meant the effective end of the proposal. In this “deficit politics” environment, the CBO’s score trumped all other arguments.

**Operations Research:** The origins of operational research and systems analysis are important techniques which derive from wartime efforts to mathematically model complex systems. Traditional systems analysis assists decision makers in choosing a course of action by analyzing the problem, investigating objectives and alternatives and
comparing those alternatives under an appropriate framework to assess various consequences (Quade and Boucher, 1968). Such analysis assigns numerical values to the variables under consideration (e.g., costs, benefits options and objectives) and computes an optimal solution using mathematical programming, decision theory or other systems techniques.

- Operations research has since split into this “official” paradigm and a more radical alternative paradigm. The alternative approach uses rational analysis but grounds it in real world observation (rather than models of the world). Rosenhead (1989) characterizes the alternative paradigm as: “non-optimizing relying less on “hard” data; simple and transparent; involving people as active subjects; facilitating bottom-up planning; and accepting of uncertainty, i.e., making judgements that can be re-opened in the future. The objective is to enhance the decision making process, rather than optimize the decisions resulting from that process.” Hodge (1995) provides a helpful review of modern systems theory (see appendix IV): modern systems theory deals more with “systemic processes of learning related to problems or issues with ill-defined objectives” (p.IV-17) than with optimization.

- **Location-based analysis - GIS:** Over the past 25 years, advances in geographical information systems (GIS) technology and theory have earned it a well deserved reputation as a powerful tool for planning and management because of the technology's abilities to store, display, query and overlay data. Spatial Decision Support Systems (SDSS), adapted from traditional Decision Support Systems (themselves an adaptation from Management Information Systems), are designed to supplement these capabilities with structures, models of systemic interactions, analytical routines and a decision making interface. These models of system interactions based on spatial analysis of a distinct unit (either having a natural or administrative definition) have the potential of being helpful tools in policy analysis and more directly in decision making. Spatial decision support systems are designed to assist decision makers in addressing spatial problems involving complex human system and ecosystem variables and their spatial interactions. They are particularly helpful where it is difficult to model all objectives mathematically or where not all objectives are formally defined (Canessa, 1997).

settings, evaluate policy options, and assess their appropriateness to a particular situation. But they cannot design policy."


- **Policy models and algorithms**
  - Estrada, Mario Arturo Ruiz. 2011. “Policy modeling: Definition, classification and evaluation.” *Journal of Policy Modeling* 33 (2011) 523–536. Estrada (2011) defines “Policy modeling” as “an academic or empirical research work, that is supported by the use of different theories as well as quantitative or qualitative models and techniques, to analytically evaluate the past (causes) and future (effects) of any policy on society, anywhere and anytime.” (p. 524)
• United Kingdom, 2000. “Adding it up: Improving Analysis & Modeling in Central Government." Performance and Innovation Unit Report. Cabinet Office. This report surveyed the extent of microeconomic modeling in the UK Government and offered suggestions for reform and extension of those techniques. Among its recommendations were an expanded central microeconomics team in the Treasury and the “bringing in and bringing on talented specialists.”

Global Modeling:


• van Steenbergen, Bart. 1994. “Global Modeling in the 1990s: A critical evaluation of a new wave." Futures, 26(l) 44-50. After a ‘golden decade’ in the 1970s and a period of decay in the 1980s, the author suggests the 1990s will see global modeling making a comeback, though this is tempered with an emphasis on technique over social justice issues.


3. Decision Support Tools and Management Information Systems

• Putting the specialized tools in the hands of the decision makers. Early attempt to bypass the policy gatekeepers.

• Ministerial Information Systems: The MINIS system (Management Information System for Ministers), introduced under U.K. Department of Environment Secretary of
Michael Heseltine. MINIS was an executive information and decision support system designed to keep Ministers better informed about activities within their departments and to stimulate officials to review their activities in order to improve efficiency. This deep involvement of the Minister in the detailed administration of the department’s activities led to a debate about the proper role of the minister and the optimal channelling of their efforts. See Likierman, Andrew. 1982. “Management Information For Ministers: The MINIS System In The Department Of The Environment.” Public Administration Vol. 60 Summer 1982 (127-142): Likierman summarizes the main features of the system and analyses some of the issues arising from its introduction. See also Ennals, Ken. 1981 “The management information system for ministers in the department of the environment.” Local Government Studies, 7:1, 39-46:

**Project Cybersyn:** a Chilean attempt, based on the architecture and implementation of British operations researcher Stafford Beer, to create a real-time computer-controlled planned economy. Attempted under the government of President Salvador Allende (1971-1973), Cybersyn consisted of a network of telex-linked production facilities connected to a central computer in the capital, Santiago. System control was based on the principles of cybernetics.

**The Use of Dashboards in Government:** Ganapati, Sukumar. 2011. “The Use of Dashboards in Government”. Washington, D.C.: IBM Centre for the Business of Government. Dashboards: “the visual display of the most important information needed to achieve one or more objectives; consolidated and arranged on a single screen so the information can be monitored at a glance” (Few, S. 2006. Information Dashboard Design: The Effective Visual Communication of Data. O’Reilly Media., p.34). Dashboards summarize key performance metrics of organizations. They typically integrate data from different sources and display performance measures through informative graphics. The visualization allows readers to understand complex data in less time than it would take to read similar material located in the text of a full report. Dashboards can be static (e.g., PDF files) or dynamic, providing metrics in real time (e.g., interactive web dashboards). In terms of their use, dashboards can be of three types: operational (for monitoring in real time); tactical (for analysis and benchmarking); strategic (for tracking achievement of strategic objectives).


Considering Uncertainty: Henrion, Max, M. Granger Morgan, Indira Nair, and Charles Wiecha. 1986. “Evaluating an Information System for Policy Modeling and Uncertainty Analysis.” Journal of the American Society for Information Technology. Vol. 37(5): 319-330. The authors review the Demos system, a nonprocedural modeling system designed to encourage policy analysts to deal more effectively with uncertainty, and encourage more systematic sensitivity analysis, a probabilistic treatment of uncertainty, exploration of alternative model formulations, and clearer communication of model assumptions and implications. They suggest that the system can be useful for expert analysts but its power also opens up pitfalls for novices.

Counterpoint: Angell, I. O. and B. Straub. 1999. “Rain-Dancing with Pseudo-Science.” Cognition, Technology & Work 1:179-196: By comparing the application of IT methodologies with ritual behaviour within human social institutions, the authors propose that the so-called rationality of management science, with concepts of benchmarking,
auditing, categorization and performance measurements etc., is actually a pseudo-science. (p. 179) “The basis of decision taking has shifted from objective knowledge to a categorical and numerical justification. And the lust for such abstract solutions is spreading: information has become a resource!” (p. 184)

4. The Proliferation of Desktops


๏ The MS Office hegemony: Outlook, Word, Powerpoint, Excel
  • the email culture: sharing (or being seen to be sharing) without collaboration
  • shift from typists to self-production; word-smithing
  • briefing “decks”: Tufte is a leading critic of PowerPoint (using a PowerPoint presentation, no less). Other criticisms of PowerPoint and similar slideware presentations have emerged. Critics argue that the hierarchical bullet points in the presentations tend to ignore the richness of the larger context, and that PowerPoint “stifles discussion, critical thinking and thoughtful decision-making” (Bumiller, 2010).

๏ Spreadsheets: expanding the ability to do computer modeling into the hands of the amateur and onto the desktop. Graphical representation of data (pie charts) as an element of briefing decks.


5. The Networked Policy Analyst

๏ email: internal and external - connecting the policy analyst to colleagues, stakeholders and citizens.

๏ Proliferation of government websites as external communication mechanisms.

๏ Document sharing and collaboration - attempts to improve the efficiency of the policy process.
Knowledge management systems - linking up disparate parts of the organization; improving corporate memory retention.


**Stakeholder management systems**: Bots, Pieter W.G., Mark J.W. van Twist and Ron van Duin. 1999. "Designing a Power Tool for Policy Analysts: Dynamic Actor Network Analysis." *Proceedings of the 32nd Hawaii International Conference on System Sciences.* Argues that, for policy analysts, knowledge about the values and opinions stakeholders are more important than knowledge about the policy factors. The authors present a conceptual modeling approach to actor network analysis, and a computerized support tool under development.

**Collaborative Scenario Building**: Wimmer, Maria A. and Melanie Bicking. 2011. "Collaborative Scenario Building for Policy Modeling." iGov Workshop ’11 (iGOV11) March 17 – 18 2011, Brunel University, West London. OCOPOMO (Open Collaboration in Policy Modeling) is a European Commission project on collaborative scenario building and policy modeling using an integrated ICT toolbox. The authors discuss evidence-based stakeholder generated scenarios that are transformed using conceptual models into formal policy models. The approach combines collaborative on-line scenario building with modeling and simulation.

**Access to data**: OpenData (see below) is as much about making data available across government as it is about providing public access.

**Gov2.0**: Web2.0 is built on the technologies of the first generation web and represents a continuation from earlier experiences. Despite this, the use of the Internet has undergone a fundamental shift in recent years with the adoption of technologies collectively called Web2.0. I use the term Web2.0 to describe recent changes in the use of World Wide Web technology and web design that facilitate enhanced communication and opportunities for participation. Gov2.0 is defined here as instances where Web2.0 approaches and technologies are applied to public administration, service-delivery, democracy and policy–making functions.
Future: Policy Analysis 2.0?

This final section is an attempt to briefly consider the possible future implications for practicing policy analysts as a consequence of three emerging phenomena:

- first, a phenomenon dubbed the **massive data era** is considered. Web2.0 (the social web) and Web3.0 (the semantic web) technology and their applications (Dobell, 2010), and the continued growth of masses of rich data from the expanded deployment of instrument clusters (Barnes et al., 2011), “location-based services” (Ratti, Pulselli and Williams, 2006) and the increased routinization of data collection, continue to increase the flow and stock of data available to support problem identification and analysis. These advances have led to an situation alternatively labelled the “firehose of data”, the “data deluge” or the era of “massive data” (Brown, 2009; Science, 2011).

- next, the **open data movement** is reviewed. As a political movement, calls for greater openness in government-held data have generated significant momentum in a short period (Ginsberg, 2011). Propelled by the general advances of Web2.0 and the expectations of Internet users that have developed alongside, the movement was given a significant boost by Tim Berners-Lee, the inventor of the World Wide Web, who challenged governments to share their data repositories through an open, linked architecture in an often-cited presentation to the TED Conference (Berners-Lee, 2009). Today, there is a widespread and growing expectation that governments provide free Internet-based access to data collected by public agencies.

- lastly, the longer-term **“artificial intelligence”** project is assessed, and the implications of this technology for the policy analysis function are considered. The formal field of AI research is just over fifty years old, and its goals remain elusive. Nonetheless, continued incremental advances seem likely.

In reading any previous attempt to predict the future implications of emergent or imagined computer technology, one is struck by how naive some earlier accounts often seem in retrospect. This paper itself will surely appear so in years to come. Nonetheless, I conclude with an attempt to understand how recent advances (and speculated future developments) in ICTs and their application might affect the practice of policy analysis in future.

**Massive Data: The End of Policy Theory?**

Massive data can serve to revive positivist policy traditions and lead to a new generation of computer-supported policy analysis. Though the route to better policy is unclear: the data deluge phenomenon has raised questions about the future of theoretical inquiry in the sciences.
(Anderson, 2008). Does massive data allow for continual micro-experimentation in order to propose, pilot, test, evaluate and redesign policy interventions? Some possible approaches:

- **Agent-based Modeling**: Agent-based modeling and simulation (ABMS) is an approach to modeling systems composed of autonomous, interacting agents. Computational advances, new modeling know-how, and specialized agent-based modeling toolkits have enabled the development of agent based models spanning the full range of application domains. Such progress suggests that ABMS could have the potential to have far-reaching impact on the use of models, whether the impact is on business and government use of computers to support decision-making and policy analysis or whether it is on scientists' use of agent-based models as electronic laboratories for extended experimentation beyond what is possible in the traditional laboratory setting. Some even contend that ABMS is a “third way of doing science” whereby knowledge discovery proceeds through computational experimentation to augment traditional deduction and induction. See Macal, Charles M. 2010. "Keynote Presentation: The Future of Agent-Based Modeling and Simulation." *Simulation 2010 Conference*. See also Bankes, Steven C. 2002. “Tools and techniques for developing policies for complex and uncertain systems.” PNAS May 14, 2002 vol. 99 suppl. 3 7263–7266. See also Lempert, R. 2002. “Agent-based modeling as organizational and public policy simulators.” *Proceedings of the National Academy of Sciences of the United States of America*. 99 (3): 7195-7196. See also Desouza, Kevin C. and Yuan Lin. 2011. "Towards Evidence-Driven Policy Design: Complex Adaptive Systems and Computational Modeling." *The Innovation Journal: The Public Sector Innovation Journal*, Volume 16(1).


- **Counterpoint**: Quade, E.S. 1980. “Pitfalls in Formulation and Modeling.” Chapter 3 in Giandomenico Majone and Edward S. Quade (eds.) *Pitfalls in Analysis*. IIASA and John Wiley & Sons: “Analysis without the use of some sort of model, explicit or otherwise, is impossible. Many analysts, unfortunately, tend to view modeling as identical with analysis and even with policy making itself. But models are only one ingredient and modeling only one step in policy analysis; searching out the right problem, designing
better alternatives for consideration, and skillfully interpreting the computations from the model and relating them to the decision maker's problem are equally significant" (p. 31).

The Open Data Movement: Who/What/Where Is a Policy Analyst?

Governments collect, generate and compile vast amounts of digitized data continually - e.g., census and survey work by public statistics agencies (Dillon, 2010), or the monitoring of system conditions across a range of domains from the natural environment to public health (Hodge and Longo, 2002) - as a purposeful data-collection activity aimed at fueling policy-oriented research. In addition, as governments do the things that governing entails - e.g., collecting vital statistics, administering the tax system, recording government operations activity, managing public infrastructure and natural resources, surveying and recording public and private lands, processing regulatory requirements or managing social service delivery - a wealth of digital data is amassed as a result (Cate, 2008). Today, an “opendata” movement continues to grow, with the expectation that governments provide free Internet-based access to these databases.

Expanded policy networks for knowledge creation: by making the raw evidence base widely available, open data has the potential to unleash an civic army of data-fueled “public” policy analysts that can substantially increase the limited policy analytical capacity in government (Bertot et al., 2010; Eaves, 2010a). Allowing non-government analysts (whether researchers in organized policy-oriented think tanks and civil society organizations, academics, journalists or citizens operating independently or connected through collaborative tools) access to raw government data, coupled with the proliferation of powerful data analysis software, cross-tabulated and assessed in previously unconsidered ways, holds the promise of previously unrevealed insights emerging from a collective policy capacity (Napoli and Karaganis, 2010). To draw on a phrase that supports the open software and mass collaboration movements: "given enough eyeballs, all bugs are shallow", which is taken to mean that as the number of testers and developers increases, most every software problem will be identified and solved (Raymond, 2000). A corollary in the policy realm might be “given enough eyeballs analyzing enough data, all public problems are solvable.” A related stream focuses on advances in data visualization and geolocation capabilities through which access to massive datasets expands the possibilities for the drawing of inferences from a visual representation of data (Viégas and Wattenberg, 2010; Lindquist, this symposium).

The professional policy analyst will likely read this through a “barbarians at the gates” lens. But to criticize this as opening the doors too widely to amateur policy analysis would appear self-serving when argued from a public sector or policy studies perspective (see, e.g., Ginsberg, 2011). As Clay Shirky has noted (e.g., 2011), Web2.0 represents as socially-disruptive a technology as Gutenberg's printing press: in that instance, the inability of the Catholic Church to
maintain its control over written communication and literacy led to a subversion of the Church’s role as the principal social organizing entity in western Europe. If the social web represents a new type of printing press revolution, is it tenable to argue that the policy analysis clergy should continue to control the data and the debate concerning the public and its problems (Dewey, 1927)? Drawing on the “policy networks” literature (Rhodes, 2008), the answer would appear to be a resounding “no”; the open data movement reinforces that evaluation, and now provides the foundation (massive data + powerful analytical tools) for realizing an ideal of evidence-based, analytically-driven policy networks.

It is clearly problematic to argue that policy analysis should be strictly the domain of “policy analysts” in the civil service or even in policy communities, especially in the post-positivist era when what it means to do policy analysis is constantly in doubt (Fischer, 2003). Part of the response will come to focus on calls for a re-investment in government’s policy capacity (Howlett, 2009; Lindquist and Desveaux, 2007) and for a strengthening of formal policy analysts’ skills (Clark, 2008). There is too much to be addressed in this respect (touching on subjects such as what is policy analysis, what is data analysis, and what is the appropriate relationship between data, knowledge, expertise and legitimate public discourse) in the space available here. But we would be remiss if we were to ignore the lessons from policy analysis history, to forget that policy analysis is more than the production of statistical outputs (Paquet, 2009) and data visualizations (Grammel, Tory and Storey, 2010) and that policy wisdom represents more than the result of data impressively distilled (Prince, 2007). “Policy analysis is about making the inevitable weaknesses in the formulation of public policy - theoretical aridity, organizational rigidity, historical passivity, into sources of strength… Analysis is what information systems are not, not protectors but correctors of error, not maintainers but changers of preferences, not neglecters but protectors of history.” (Wildavsky, 1978, p. 77)

“Have you met Watson⁵, our new policy analyst?”: Are Policy Analysts Going the Way of the Typist?

Artificial intelligence - the science of developing thinking machines - is focused on developing technologies that exhibit characteristics such as understanding natural language queries, perceiving its environment, embodying commonsense knowledge, learning through interaction, thinking creatively, planning, engaging in deductive reasoning and problem solving and interacting “socially”.

Policy analysts perform a core function of government, their work broadly concerned with the processes of identifying and analysing public issues, the means by which a collective course

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⁵ The reference is to the IBM supercomputer "Watson" which appeared on the TV game show Jeopardy in early 2011. The computer defeated two human contestants.
of action (or inaction) is taken by an authoritative decision making body in response to perceived public problems, how effect is given to that course of action, and what effect the entire process has on the issue or problem being addressed. The literature in policy studies has illuminated much that surrounds public policy analysis - what its purpose and role is, how it should be conducted, how it interacts with politics and administration. Policy analysts (as their title implies) analyze policies. And they provide support for decision making - hopefully contributing to better decisions than would be taken in the absence of their analysis (Quade, 1976). Policy analysts play many roles in the policy formulation process - as information agent, knowledge manager, coordinator and collaborator, boundary agent, advocate and gatekeeper. But as artificial intelligence improves, allowing decision-makers to directly query computer systems using natural language (Blanning, 1984) and visualize data bases and create models through which to process that data, what legitimate role do policy analysts play other than the care and feeding of intelligent machines?

- **Counterpoint**: Why human editors are still better than news aggregators  [http://blogs.hbr.org/cs/2011/05/seven_things_human_editors_do.html](http://blogs.hbr.org/cs/2011/05/seven_things_human_editors_do.html)

- See Sunstein, Cass. 2001. *Republic.com*. Princeton: Princeton University Press. N.b.: written before Google, ten years ago, but prescient. Search is becoming more personalized (part of Google strategy) and may blind you to alternative viewpoints. In order to manage the data flood, you may be closing yourself off to alternative viewpoints.

### Concluding Thoughts

Any attempt to anticipate the future of the computer and its impact on policy analysis will most certainly be wrong; nonetheless, currently incorrect and prospectively humorous predictions for the future of technology are offered at three scales:

- **near-term**: Moore’s Law, that the number of transistors on an integrated circuit doubles approximately every two years, was coined in 1965 and was predicted then to last for another ten years; this “law” shows no signs of abating for another 10-20 years. Assuming that, we can anticipate further reduction in the price of memory, the size of computing devices and reductions in power consumption. This will be offset by the increasing commodification of computers and the creation of new devices as perceived necessities, which will serve to keep total spending on computer devices (whether by individuals, corporations or governments) stable.

- **near-future**: the implications of Moore’s Law, and innovations which build on it, will result in ubiquitous, powerful computing, increasingly mobile and integrated - i.e., near-invisible - into everyday life. The subject of this paper - computer-supported policy
analysis - will become increasingly difficult to determine, as any line between where computer-support ends and human intervention picks up will become increasingly blurred.

- **far-out future**: concepts such as DNA-based computing and quantum qubit computing portend a brave new world unlike anything we are familiar with today. As Eric Schmidt, former CEO of Google, *said* in 2010: “I spend most of my time assuming the world is not ready for the technology revolution that will be happening to them soon.”

As for policy analysis, a field already beset by “ambiguity, relativism and self-doubt” (Lawlor, 1996: 120), we will be challenged to respond to basic questions such as whether policy analysts need be found inside government at all, and - if found there - what their value is. The advance of technology will likely not clarify the stalemate between the rational-practitioner’s offer of a promise of precise answers – however inaccurate – and the post-positivist’s hand wringing over uncertainty about unknowable outcomes. We might just as well ask whether we are witnessing “the end of policy analysis” (Kirp, 1992).

Drawing on the three emergent phenomenon discussed above, an additional three predictions are offered:

- **The flood of data will continue to grow**. The challenge for policy analysis will partly be to find ways of intelligently ignoring unimportant information (6, 2004) and using emerging semantic algorithms and data mining tools (Till, Dobell and Longo, 2011) so as to not have to analyze all that data.

- **Data wants to be free**: the opendata genie will not easily be put back in the bottle. And the growth of outside-of-government policy analysis will mirror the growth of sabermetrics outside of baseball’s anointed, and result in much of the same type of friction witnessed there⁶. Whether the alternative policy evidences that emerge from the

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⁶ With apologies for dropping in this vague reference at this late stage, sabermetrics is the mathematical and statistical analysis of baseball records. A heated debate has emerged since the attempts in the mid 1970s to develop a statistical approach to baseball management have clashed with traditional and instinctual notions that continue to dominate the sport. While much of the evidence produced by sabermetricians is elegant and persuasive, the field is still criticized by detractors as finding patterns where none exist. See Lewis, 2003.
opendata movement result in a clash of facts\(^7\) or a marketplace of ideas, the professional policy analyst will have to up their game in order to compete in this increasingly public forum.

- On the implications of true artificial intelligence for the future of policy analysis: What skills are necessary for the policy analyst (indeed, any information worker) in this future? Where facts are instantly available to anyone, does possessing knowledge becomes irrelevant? Do thinking, creativity, connectivity and other human attributes become more important? And is the long-held regard for the ability to “ask the right questions” increasingly important? I simply pose these questions, because I don’t know what the answers might be. Honestly, I have no idea how this could turn out. Other than it’s frightening. And exciting.

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\(^7\) Will open, massive, data, lead to a situation where “everyone now is entitled to their own facts” - challenging the widely admired quotation of the late U.S. Senator Daniel Patrick Moynihan, who is reported to have said, “everyone is entitled to their own opinions, but not their own facts.” For example, Borins (2000: 26) uses the Moynihan quote to support the argument that “the goal of policy research is to establish facts that all can take as a point of departure.” See, however, Burhauser: “But the issue is more complex. Facts are only relevant within some context. Much of what we do as evidence-based policy analysts is use, and in some cases collect, data to determine if a given policy has or will satisfy a set of success criteria. But decisions must be made along the way with respect to what data to select, how it relates to the success criteria, and most importantly what are the success criteria against which the data on outcomes are being measured.”
References


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