Chapter 3
Creating a Data-Driven Global Society

Daniel J. Power

Abstract Data is captured and analyzed for many purposes including supporting decision making. The expansion of data collection and the increasing use of data-driven decision support is creating a data-driven, global political, economic and social environment. This emerging global society is highly interconnected and many people rely on information technology to support decision making. This chapter explores the impacts that have and might occur as decision support technologies improve and continue shaping global society in new directions. Better understanding of the decision support and analytics phenomenon may help predict future societal changes and consequences. The goal of this analysis is to formulate hypotheses about the impact of decision support for further testing and speculate about long-run consequences. The increasing volume, velocity and variety of data is important to building new decision support functionality. Data collection expansion is part of a self-reinforcing decision support cycle that results in collecting more data, doing more analyses, and providing more and hopefully better decision support. Overall, nine hypotheses are proposed and briefly explored. More research is needed to test and verify them, but anecdotal evidence indicates analytics, business intelligence and decision support are creating a global society that is a data centric, real-time, decision-oriented socio-economic system. Data and decision scientists and technologists should anticipate and ponder the consequences of creating a more pervasive, data-driven global society.

Keywords Data-driven society • Decision support theory • Anticipating consequences • Globalization

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3.1 Introduction

Computer-based analysis and decision support began impacting global society in the early 1950s (cf., Power 2008). According to Friedman (1999), globalization has resulted from the democratization of finance, information and technology. Global society refers broadly to an interconnected political, business, economic and social environment. By 1995, the Internet and the World-Wide Web were facilitating wider deployment of analytics and decision support. Smart phones and new data capture technologies like radio frequency identifiers (RFID) have speeded up the changes. Sixty years of decision support technology progress has had many impacts on what managers and decision makers do, how organizations operate, how people think, and what is considered important by people. Organization decision-making is linked to data from many sources and analysis of data is viewed as important. Managers want insight into customer behavior, more predictability in the supply chain and faster, more agile responses in changing, competitive situations. Political and military leaders want more predictability and more agile responses to situations as well. Analytics and decision support are providing solutions for managers in public and private organizations and are creating new capabilities for individuals.

Change related to decision support is definitely occurring in our global society (cf., Power and Phillips-Wren 2011). Some changes like social networks are perhaps minor and seemingly insignificant. Other changes linked to mobile computing and "smart" software seem more disruptive. The forces creating the changes like adoption of predictive analytics are difficult to discretely identify. We live in a multi-causal world of pressures that are tugging, pushing and interacting. One cannot say definitively that the Internet or social networks or even computers are having or have had a profound impact on how we live and work. Perhaps we do live in an emerging hyper-connected, digital, information age. By chance or design we are creating a data-driven, global society and the change process has just begun. Because of information technologies we can certainly interact more easily with people from most countries and often in real-time. Most data is now digital and we are creating and capturing enormous amounts of data.

This article explores the present and future of decision support and analytics and the impacts that have and might occur as decision support technologies change and continue shaping global society. Understanding the decision support phenomenon may help predict future changes and consequences. The goal of this analysis is to formulate hypotheses for further testing and speculate about future consequences. Presently, society is coping with increasingly large and diverse data bases called by some commentators and vendors "big data" that can be and are increasingly used for decision support. Technology progress and the information needs of leaders and managers creates a self-reinforcing cycle of increasing data capture and analysis.

A short essay can only begin to explain what is occurring. The next section explores the large expansion of data available for analysis and decision support and the self-reinforcing decision support cycle, the third section develops hypotheses about what has changed and how society has been reshaped, section four speculates about what might occur and identifies a need to monitor the impacts of decision

support technologies and compile speculative literature related to decision support, the final section summarizes conclusions and raises concerns about some technology paths and notes the need for data and decision scientists to both facilitate change and study the changes that have and are occurring as a result of analytics, business intelligence systems and computerized decision support.

3.2 Data Expansion and Decision Support

There has been a significant change in how much and what types of data organizations capture, retrieve and store. Some call the present the era of "Big Data". Big data is more a term for a marketing phenomenon than a descriptor of data, but it underscores the magnitude of change. Each day, every one of us generates very large amounts of digital data—email, online purchases, using Google Docs, uploading photos to Facebook, using Google Search, and paying bills online. This data and much more from our daily activity is recorded and often backed-up in the Cloud. Most likely someone is or will analyze data from our personal and organization activities.

Organizations store employee created and inputted data, customer and user generated data from Web forms, social media, and even video games, and digital device generated data. Computers and other devices generate digital data. Increasingly there is information technology in everything.

Machine data is a major contributor to the data expansion. Machine data is all of the data generated by a computing machine while it operates. Examples of machine data include: application logs, clickstream data, sensor data and Web access logs (cf., Power 2013b). According to an IBM estimate (2013), each day we create 2.5 quintillion bytes (2.5 Exabytes) of data generated by a variety of sources—from climate information, to posts on social media sites, and from purchase transaction records to healthcare medical images. The estimate is that globally 50,000 Exabytes of data will be generated each year by 2020. The data expansion is increasing exponentially.

Provost and Fawcett (2013) define big data as "datasets that are too large for traditional data-processing systems and that therefore require new technologies" like the Apache™ Hadoop® project that develops open-source software for reliable, scalable, distributed computing (cf., http://hadoop.apache.org/). Ehrenberg (2012) first used the term "big data" in 2009 to label a new ventures fund for "tools for managing large amounts of data and applications for extracting value from that data". That narrow definition morphed into a broader, more amorphous social phenomenon denoting both great potential and concerns about privacy.

Digital data is extremely high volume, it is "big". Data comes from both new and old sources and the increased volume of data led some vendors and industry observers to proclaim the era of 'Big Data'. IBM researchers (Zikopoulos et al. 2013; IBM 2011) describe big data in terms of four dimensions: Volume, Velocity, Variety, and Veracity. Veracity refers to accurate and "true" data and that dimension is the most suspect and controversial. All data captured is not accurate.

Many observers including Aziza (2013), Ehrenberg, Franks (2013), Morris (2012) and Mayer-Schönberger and Cukier (2013) have argued that the potential of using big data to improve our personal lives, help businesses compete, and governments provide services is unbounded. According to Ehrenberg, "Greater access to data and the technologies for managing and analyzing data are changing the world." Somehow big data will lead to better health, better teachers and improved education, and better decision-making. How data is analyzed and presented can change behavior. More data should not however be our goal, rather the goal should be better analysis and decision support using data (cf., Devlin 2013a, b).

Nobel laureate Herbert Simon spent his entire career studying decision making in organizations. He argued in a 1973 article that in a postindustrial society, the central problem will not be how to organize to produce efficiently, but how to organize to make decisions—that is, to process information. Data expansion means more processing of data to create information and a greater need to organize tasks and people to use the information in decision making. Managers in a decision-centered organization must identify, document and track decisions that are made. A data-driven, decision-making organization should encourage and reward use of facts and data by employees. Using facts and data to make decisions in organizations has long been a goal of many managers and academics. The desire for more facts led to the extensive collecting of data.

Decisions are made about many issues in business, non-profit and government organizations using available data. The issue may be operational and hence frequently occurring or strategic and novel and non-routine. Decisions get made with the facts at hand. Even if a manager does not make an explicit decision, ignoring a decision situation or choosing not to decide is a decision. Decision making is an important task in our lives. Ideally decisions should be made more explicitly and with facts, but this ideal is often hard to realize. In a decision-centered organization, managers are and will consciously improve decision processes and will explicitly make decisions. More analytics and decision support enables the creation of decision-centered organizations, and ultimately a decision-centered, data-driven society.

Data is ubiquitous. Data may be streaming to a decision maker or retrieved from a historic data store. Figuring out what data is relevant and what the data means in a decision situation if often however challenging. Data can overwhelm a decision maker and can mislead. Data-driven decision making requires anticipating data and analysis needs and providing the opportunity for people to request analyses of additional data. Analytics involves processes for identifying and communicating patterns, derived conclusions and facts. Raw facts gain additional meaning from analysis.

To be transformative, using data must become part of an organization's decision-making culture. The quest to capture and make available appropriate data and relevant analyses must become an urgent requirement and ongoing priority in the organization. A data-driven organization survives and hopefully prospers based on the quality, provision and availability of data to decision-makers. If data is captured where it is generated and it is appropriately stored and managed for use in decision-making, then analytics and data-driven decision support can become the norm for decision making. Managers are creating data-driven organizations.

Creating a data-driven decision making organization has both technology and human resource challenges. The technology issues continue to evolve and will hopefully be resolved as more data and better, easier to use analytic tools become available. The human resource challenge involves retraining and motivating current employees in analytics and model-driven and data-driven decision support. The human resource challenge is greater than the technology challenge.

For many years managers have been on a journey to capture and analyze data to support decision making. The cycle of data capture, analysis and decision support has produced good results and technology continues to improve and facilitate innovation. Whether intentionally or not, technology forces and managerial desires and needs are creating data-driven organizations and a data-driven society. Figure 3.1 (below) diagrams the self-reinforcing decision support cycle that results in collecting more data, doing more analyses, providing more and better decision support, and hopefully resulting in good outcomes for society.

Figure 3.1 suggests a number of hypotheses that can and should be tested. Data and decision support expansion and proliferation seems inevitable so examining the

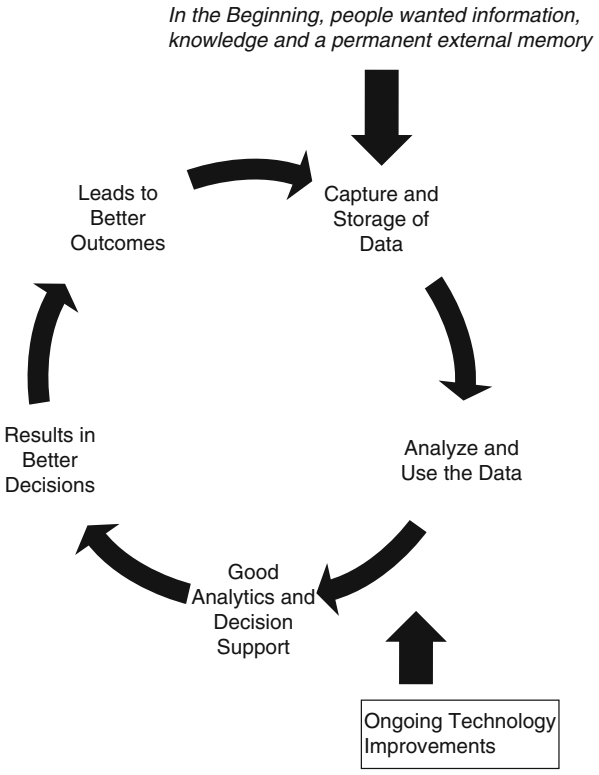

Fig. 3.1 The self-reinforcing decision support cycle

links in the cycle continues to be important. The decision support cycle is anchored in technology innovation and that creates ongoing challenges. For organizations to effectively provide and analyze high volume, high velocity, and high variety data it is necessary to manage and improve: (1) the platforms for storing and accessing data, (2) the analytics, BI and decision support capabilities, and (3) the policies and procedures for governing and managing data including issues of privacy, ethical use and retention (cf., Dyche 2013). Dyche asserts the hard part of big data is managing it. Analyzing big data and making results available in decision situations is also a major challenge. Good analysis and decision support requires data and decision scientists.

The ongoing challenge for decision support and information technology researchers is identifying use cases or user examples for analyzing the large volume of semi- and unstructured data that is accumulating. The decision support cycle continues because managers perceive and anticipate better outcomes as a result of fact-based decision making. So how has analytics and decision support shaped and changed society in developed and developing countries?

3.3 Looking at Today

Modern businesses and many governments have implemented information technologies for decision support. Our global population continues to grow and business and governments encounter increasingly complex decision situations. The rate of adoption varies in organizations, but overall trends can be analyzed. The following are some hypotheses about what has changed because of the decision support cycle and the impact of analytics, BI and decision support on society. Confirming the hypotheses will help validate conclusions in the previous section.

Hypothesis 1 Organizations capture and analyze significantly more data than in the pre-decision support era by many orders of magnitude adjusted for population increases.

McKinsey Global Institute and McKinsey's Business Technology Office studied data volumes in five domains—healthcare in the United States, the public sector in Europe, retail in the United States, and manufacturing and personal-location data globally. The research by Manyika et al. (2011) estimated that, by 2009, "nearly all sectors in the US economy had at least an average of 200 terabytes of stored data (twice the size of U.S. retailer Wal-Mart's data warehouse in 1999) per company with more than 1,000 employees".

According to an Economist Special Report (2010), "There are many reasons for the information explosion. The most obvious one is technology. As the capabilities of digital devices soar and prices plummet, sensors and gadgets are digitising lots of information that was previously unavailable. And many more people have access to far more powerful tools." The article "Data, Data Everywhere" based on an interview with Kenneth Cukier notes "data are becoming the new raw material of business: an economic input almost on a par with capital and labour. "Data capture is increasing for many reasons, but especially because managers hope the data will be useful.

A recent IDC study, reports that researchers in companies and organizations analyze and gather insights from approximately 1 % of the world's data.

Hypothesis 2 Expenditures on decision support technologies are increasing even as the cost per technology unit (per processor, speed of processor, memory, etc.) of capability for hardware falls.

According to Kalakota (2013), Gartner estimates BI and Analytics expenditures grew 16.4 % to USD $12.2 Billion in 2011. A Gartner survey reported at bpmwatch.com "projected that the organizations around the world will spend $2,700 billion in the year 2012 on IT products and services. There is an increase of 3.9 % when compared with 2011. According to Gartner, "Information Technology plays a leading role in the shaping of politics and economy across the world. It has become the leading driver of growth in business."

So computer prices continue to decline and processor capabilities continue to improve. Better computing capabilities should facilitate better computerized analytics, BI and decision support.

Hypothesis 3 Analysis of large quantities of data becomes easier and faster each year even with the increasing volumes of data.

Walker (2013) notes In-Memory Data Grids (IDG) "allow organizations to collect, store, analyze and distribute large, fast-changing data sets in near real-time. … Research shows that organizations using IDG's are able to analyze larger amounts of data at faster speeds than competitors." Contemporary computing capabilities support better and faster data analysis. Remember it doesn't matter if your dataset is "big" or not, what matters is having the capability to analyze the data and turn it the analysis in to actionable recommendations.

Hypothesis 4 Analysts and decision makers can extract and analyze data in real-time and use decision support tools that were not available prior to the advent of wireless and cellular technologies.

Since January 9, 2007, when Apple® introduced the iPhone there have been significant changes in decision support. Decision support on-the-go changes what is possible and what is expected. Managers assume that data and analyses will be available at any time when it is needed.

Hypothesis 5 The total cost of ownership (TCO) of decision support technologies per employee user in constant dollars is lower than at any prior point in the decision support era and the functionality has dramatically increased.

In 2008, a PC had 700 times the capability at the same price as 1977. According to an HP report, "Industry analysts report that only 30 % of IT expenses are hardware-related. The other 70 % are related to costs such as support, maintenance, consumables, end of life and energy." Griliches (2009) notes in a report "A good total cost of ownership (TCO) model incorporates hardware and software costs, installation and license tracking, warranties and maintenance agreements, as well as vendor financing options. It must also include operational expenditures." Many of the costs are fixed costs and evidence suggests the percentage of users in companies is rapidly increasing. Companies are adopting new decision support technologies and incurring more costs. For example, computereconomics.com reported in 2011 "that 28 %

of organizations are currently investing in predictive analytics solutions compared to 22 % that have the technology in place." BUT, the real cost per employee using decision support has declined. Fixed decision support costs are spread over more users and variable costs per user continue to decline.

Hypothesis 6 Much more is now known about customers and citizens. Organizations use the data for data-driven analyses to target activities.

Predictive analytics are increasingly important in large and medium sized organizations. As organizations capture more and more data, it becomes important to analyze and use the data to enhance business results and justify costs. All of the major software vendors market predictive analytics packages and development software packages. For example, IBM advertises "make better decision with business analytics." An IBM web page states "IBM Business Analytics Software takes the guesswork out of business decisions. One company example is MarineMax®, the world's largest boat retailer, that started using IBM Cognos software to inform their inventory decisions. As a result, "their demand planning cycle dropped from 3 months to 3 weeks, leading to a 48 % reduction in costs." Customer Relationship Management (CRM) and predictive analytics have led to extensive collection and analysis of customer data. Managers can identify buying behaviors and patterns using data.

Hypothesis 7 In some situations, information and decision support technologies have reduced information asymmetry.

In multiparty decision situations, one party often has better information than another. These situations commonly involve a purchase/sales transaction or a principal agent situation where a person acts on behalf of another and the principal attempts to monitor and control the agent. Information symmetry means all parties in a decision situation have the same information, an ideal goal. Asymmetric information creates a difficult situation for one or more parties. The problem is harmful when one party has different information and/or better information than another. Deceit, obfuscation and misdirection are all part of the problem. A common example involves selling a car, the owner is likely to have full knowledge about its service history and its likelihood of breaking down. The potential buyer will have less information and may not be able to trust the car salesman. This explains why CARFAX (http://www.carfax.com/) was created and has been successful.

Hypothesis 8 Businesses that use analytics, business intelligence and decision support are more successful and more profitable.

Managers want to believe this hypothesis to justify the large expenditures made on decision support technologies. Establishing a direct causal link between the amount of decision support and profitability is challenging. An indirect indicator is measuring the success of companies where employees are active in decision support vendor users groups like Teradata Partners. One would expect above average returns in these firms that are visible in the decision support community if this hypothesis is true.

Hypothesis 9 Quality of life has improved as a result of analytics, business intelligence and decision support.

This is the proverbial "leap of faith" hypothesis. Many people hope or wish that decision support technologies have improved the quality of life. Proving this hypothesis is difficult. An indirect indicator is whether or not people feel that information and decision support technologies helped them make better personal and organizational decisions.

More research is needed to test and verify these hypotheses, but anecdotal evidence indicates analytics, business intelligence and decision support are shaping global society as a data centric, real-time, decision-oriented socio-economic system. Global society is extremely dependent upon data and data-driven decisions are increasingly the norm in organizations. Business managers want more data and more analyses. The working assumption is that organizations where fact-based, data-driven decision making occurs will have higher profits and better outcomes.

3.4 Looking Forward

Increasingly we live in a crowded world struggling to cope with a growing shortage of physical resources by substituting information technology. The number of 'things' connected to the Internet generating data is increasing dramatically. Cisco says there will be 25 billion things online by 2015; IBM says one trillion. Technology continues to improve and support faster analysis of more and more data in real-time. Technology is enabling change and people are adopting new technologies because of how a specific technology might improve or favorably alter their lives. Also, leaders and managers are relying on technology to understand increasingly complex decision situations.

Change is not directed by a small group of decision makers or controlled. Technologists do not know how a technology like analytics and decision support and its direct application and use in human decisions will alter society. People decide to adopt and use technologies for reasons hidden from careful inspection and review by others. Information technology changes human decision making. Academic researchers have a role in investigating current and future uses of decision support capabilities, but decisions about the implementation of the technologies is decentralized among many people. Researchers do not make choices about whether people or organizations should adopt new decision aiding tools. Those who do make the decisions are primarily considering the impact on their organizations in the next 3–5 years or on themselves in the next year or two rather than considering any long-run consequences for global society.

Decisions about using information technology seem to primarily focus on analyses of short-run financial and operational consequences. Managers and technologists will continue to innovate and adopt new technologies, but researchers need to find a balance between systematizing what we know and speculating about what will result from decision support technology adoption. Decision support researchers should more consciously act to shape the evolving data-driven society rather than accept that social change resulting from our research is a random product of myriad

uncontrolled, interacting events and developments. Perhaps researchers can shape outcomes of technology innovation.

Technology continues to improve and support faster analysis of more and more data in real-time. Also, the computing technology for creating realistic visual simulations has improved tremendously in the past 20 years. For example, Second Life supports an incredible fantasy world where avatars, the representations of the user, can fly, walk through transparent walls, and teleport to imaginary castles, shopping malls and even IBM's robot maze. Avatars and virtual worlds may be part of our decision support future.

Researchers need to better understand the impacts of decision support technologies and stimulate excitement to move the field of decision support in new directions. In 1965, Robert Anthony speculated about the development of large planning data banks. Big data advocates are trying to realize that vision in corporations and government organizations. Computerized decision support, computing and information technologies can improve planning and performance in business organizations, but potentially these technologies will reshape society in negative as well as positive ways. Government and social planners as well as business planners need to use data to support decision-making ethically and appropriately.

Analytics and decision support technologies are changing and reshaping society. Some would say society is being transformed and permanently altered. Perhaps we are creating smarter cities and a smarter planet. The broad question is does decision support make a positive, significant difference in people's lives and perhaps equally important could academics stop the transformation that is occurring if we determined it was important to do so?

To answer these questions it is necessary to engage in speculation about first and second order consequences, to systematize prior research so we can teach our findings, and perhaps to differently organize what we know to change how developers and adopters evaluate decision support options. Helping managers make informed choices about decision support is part of the responsibility of researchers and developers in this field of study.

Technology speculation has been occurring for many years, but future fiction literature is considered entertainment rather than content that might contribute to our understanding of both intended and unintended consequences of adopting decision support or other technologies. Stories by authors like Isaac Asimov and Robert Heinlein are both entertaining and useful to researchers and technologists.

In a story by Heinlein (1964) titled "Beyond this Horizon" that was initially published in Astounding Science Fiction magazine in April 1942-May 1942, we read of a future earth where science and technology have transformed and reshaped society. A computer system with data on all of the financial transactions of a continent predicts economic activity and recommends changes in "the subsidy on retail transfers of consumption goods" and changes in "the monthly citizen's allowance" to maintain a stable social equilibrium (cf., p. 7). The computing system supports decision making, but its predictions are accepted as true and political decision makers have no real choice but to accept the "recommendations".

Isaac Asimov, a prolific science and science fiction author, wrote the Foundation trilogy in the 1950s. The story revolves around the consequences of developing a

decision support model that predicts the future. Mathematician Hari Seldon proposes and then creates a psychological model and a science called psychohistory. The computer model combines data and equations about history, sociology, psychology, and mathematical statistics to make general predictions about the future behavior of very large groups of people. Seldon explores many alternative futures that span thousands of years and tests various interventions that change outcomes. It turns out as the story develops that his predictions are uncannily accurate until chance and human mutation alter the course of predicted events. In the short run, a few hundred years, the decision support forecasting model is accurate, but ultimately people must respond and act more independently to survive.

In Mack Reynold's novela "Computer War" (1967), the world is divided into two nation states. Only one, Alphaland, has computers. The computer predicts victory, but the war goes on without explanation. For some reason the computer's conclusion of Alphaland's economic superiority over Betastan does not lead to a single world state. Computer support and rational analysis was not able to help the leaders of Alphaland defeat a seemingly irrational and unpredictable human foe.

British author John Brunner wrote "Stand on Zanzibar" (1968) about an overpopulated dystopian world of 2010. A major plot element is a supercomputer named Shalmaneser that can listen and scan conversations for key words. In the novel there is discussion of whether Shalmaneser is self-aware. It seems unlikely that a supercomputer like Shalmaneser can solve humanity's future problems.

Perhaps the best known supercomputer in science fiction is HAL 9000. HAL is a star of Arthur Clarke's (1968) novel and the associated movie directed by Stanley Kubrick titled "2001: A Space Odyssey" (1968). The movie and novel deal with many issues including humanity's move beyond computer decision support to artificial intelligence and its possible consequences. HAL 9000 has some type of breakdown or malfunction on a space voyage and acts to defend itself. Ultimately HAL kills some crew members and so the mission pilot and scientist Dr. David Bowman disconnects Hal's processor core. A thinking machine intended to help people inexplicably harms them and must be disabled.

There are many scenarios that are worth considering. Sun Microsystems cofounder Bill Joy's (2004) Wired article, "Why the Future Doesn't Need Us" warned of the catastrophic potential for twenty-first century technologies like robotics, genetic engineering, and nanotech. Subsequently, he called for technological relinquishment or giving up new technology. Perhaps the future is a Cybertron-like Earth (ala the Transformers), or a society watched over by benevolent machines, or a future where humans and computational machines work together to make the world a better place.

Many more novels, novellas and short stories speculate on the impact of computerized decision support and artificial intelligence on human society. After reading many such stories, it is challenging to recall a decision support innovation that led to a uniformly positive set of consequences and outcomes for humanity. Managers and technologists seem faced with difficult choices of development, adoption and implementation. Compiling scenarios about alternative decision support futures can potentially assist business and political decision makers as they grapple with funding research and purchasing systems to assist in military,

government and business decision situations. The future is unknown, but it is worthwhile contemplating what might happen in the long-term if various decision support and analytic technologies improve substantially and are adopted.

3.5 Conclusions and Commentary

Many years of improvements in computing technology has led to faster computation, faster transmission of data and larger storage capacity. The information age is still at its beginning, but decision automation, technology adoption and decision support applications have increased dramatically. Will smart machines run the world? Will people be relegated to menial, make work tasks? Will decision automation change the world? Today in some situations, computer software does make better decisions than human decision makers. Our future reality is unlikely to be The Matrix (1999) where sentient machines run the world and most people are comatose directly connected to a virtual world, but the development of thinking machines like Hal 9000 is increasingly likely.

Results from a poll at thinkartificial.org (2007) suggest some serious concerns about decision technologies. The respondents were primarily Digg (http://digg.com/) readers. Readers were asked: Do you, for some reason, fear the current and/or future increase of artificial intelligence? 1,002 respondents (16.7 %) checked Yes, I find the idea of intelligent machines frightening. 27.1 % indicated No, I don't find intelligent machines frightening (1,632 votes). Finally, 3366 respondents (56.3 %), indicated I'm not afraid of intelligent machines, I'm afraid of how humans will use the technology. The perceived threats to privacy are real and should be an ongoing concern. Data collected for one purpose can be used for other less noble purposes, and data analysts and data scientists do mistakenly interpret data sets.

Some academics have been skeptical of the vision of creating comprehensive databases for planning and strategic decision making. For example, Harvard Professor Robert Anthony (1965) argued "It is because of the varied and unpredictable nature of data required for strategic planning that an attempt to design an all-purpose internal information system is probably hopeless. For the same reason, the dream of some computer specialists of a gigantic bank, from which planners can obtain all the information they wish by pressing some buttons, is probably no more than a dream (p. 45)." Perhaps Anthony and others are wrong and we can expect much more powerful data-driven decision support with gigantic data banks to assist with strategic planning and operations management. Analysts like Nigel Rayner seem to think so.

Rayner (2011), a Gartner analyst, speculated that "In the next 40 years analytics systems will replace much of what the knowledge worker does today. In other words, systems like IBM's Watson will be your boss and humans—especially the species known as middle management—will go extinct." Rayner argued many tasks middle managers do today will be automated.

According to Rayner, "We are at a tipping point in the evolution of the 'Information Age,' but business culture is holding back the use of IT. In the future,

decision making will be automated and managed by machine-based models far better than any human could manage." If this transformation happens, there will be many changes to business, society and the economy.

Thinking machines are part of the hope for dealing with complexity. Watson (IBM ForwardView 2012), a natural language processing system from IBM, demonstrated in 2011 on a TV game show that machine processing of English phrases has great potential. Watson searched through millions of documents and returned a correct answer in a few seconds. So perhaps middle managers have cause for concern.

Are we at the tipping point? The Kurzweil (2005) singularity? Perhaps. The technological singularity is when artificial intelligence will exceed human intelligence, radically changing civilization. Faster computation, faster transmission of data, and larger storage capacity is a reality and the improvements are continuing. Managers can obtain more data about more topics in real-time. But the desire for more decision support does not necessitate decision automation and thinking machines. The path can lead to improved human decision making supported by technology.

There is a problem associated with making decisions. Evidence indicates many people are poor decision makers much or most of the time. People make bad choices. The goal of decision support has always been to help people make better decisions rather than automating decision-making. Currently, some pundits hope that training more data and decision scientists will help business and government leaders cope with the increasing complexity of decision making in a data rich environment. The new term data science refers to a more sophisticated and systematic analysis of data by experts (Davenport and Patil 2012). Data Scientists will supposedly use "Big Data" and create a context and story that is useful 500 (cf., Power, 2013a,c,d).

The role of data and decision scientists and technologists should include anticipating and thinking about the consequences of creating a more pervasive, data-driven global society. What can now be concluded about how analytics and decision support has and is reshaping society?

First, global society is extremely dependent upon data and data-driven decisions are increasingly the norm in organizations.

Second, technology forces and managerial desires and needs are creating a data-driven society. Data and decision scientists will create new information technology capabilities to analyze the data of the future.

Third, the decision support cycle continues because managers perceive and anticipate better outcomes from more data and more decision support.

Fourth, the ongoing challenge for decision support and information technology researchers is identifying use cases or user examples for analyzing the large volume of semi- and unstructured data.

Fifth, more research is needed to test and verify the nine hypotheses developed about changes that have occurred due to information technology and decision support.

Sixth, managers and technologists face difficult to development, adoption and implementation of innovative decision support.

Seventh, Government and business planners need to use data to support decision-making ethically and appropriately. Compiling scenarios about alternative decision support futures can potentially assist them.

Eighth, data and decision scientists need to help decision makers develop policies about privacy, data retention, security, and data access.

Ninth, we all need to think about the consequences of more and better analytics and decision support. Thinking about the future is useful.

The experiences and developments of past decades show that technology progress has its own often unpredictable timeline and yet the speed of technology and decision support innovation seems to be increasing exponentially. Trends and speculation suggest we humans have many reasons to be hopeful and fearful about the prospects of developing more sophisticated analytics, decision support and thinking machines.

Is a data-driven global society desirable? Technology progress is not a smooth path. Spinoza noted in 1677 "There is no Hope without Fear, and no Fear without Hope."

Biography

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