


Collaboration Between Cognitive Science and Business Management to Benefit the Government Sector

Glory Emmanuel Aviña 

Sandia National Laboratories, Livermore, CA, USA
gremman@sandia.gov

Abstract. Cognitive science is an interdisciplinary science which studies the human dimension, drawing from academic disciplines such as psychology, linguistics, philosophy, and computer modeling. Business management is controlling, leading, monitoring, organizing, and planning critical information to bring useful resources and capabilities to a viable market. Finally, the government sector has many roles, but one primary goal is to bring innovative solutions to maintain and enhance national security. There currently is a gap in the government sector between applied research and solutions applicable to the national security field. This is a deep problem since a critical element to many national security issues is the human dimension and requires cognitive science approaches. One major cause to this gap is the separation between business management and cognitive science: scientific research is either not being tailored to the mission need or deployed at a time when it can best be absorbed by national security concerns. This paper addresses three major themes: (1) how cognitive science and business management benefits the government sector, (2) the current gaps that exist between cognitive science and business management, and (3) how cognitive science and business management may work to address government sector, national security needs.

Keywords: Cognitive science · Business management · Mission impact · Applied research

1 Introduction

When I first started my career at Sandia National Laboratories (Sandia) in 2006, I was a business analyst in the partnerships development organization. My role was to identify internal and external opportunities and enable management to connect the research capabilities in their area to other collaborators. I worked alongside researchers, engineers, and management to identify opportunities in the government sector addressing evolving capabilities of national security needs. Although partnerships occurred and research deliverables were made, the impact Sandia's capabilities had for meeting the needs of the government sector was not always maximized. There were reasons for this, which will be discussed in this paper.

Five years later, I started my career as an experimental psychologist and joined Sandia's cognitive science program. My role was now to design and execute human-subjects studies in order to examine areas of national security concern, focusing on the

human-in-the-loop and enhancing high-consequence decision-making. I could see the national security concerns at a high level and use quantitative research to examine these concerns [1], for example, quantifying cyber expertise to help train computer security incident response teams as cybersecurity threats arise. [2] But the research my colleagues and I were involved with was not reaching the front lines to improve policy and practices.

Through these two career experiences I have witnessed the disconnect between business management and research, specifically in studying the human element through cognitive science. I have also witnessed the great potential that exists if these two worlds synchronously work together, especially for the greater good of the government sector and national security.

The purpose of this paper is to discuss three major themes in order to not only highlight the potential between cognitive science and business but also encourage the reader to consider both areas when working in the government sector. First, I will discuss how cognitive science and business management benefits the government sector; then, the current gaps that exist between cognitive science and business management, and finally, how cognitive science and business management may work to address government sector, national security needs.

2 Cognitive Science, Business Management, and the Government Sector

The benefits of cognitive science for the government sector are largely under-recognized. As reported by the Wall Street Journal, the greatest threats to national security in 2015 are human-based: cyberattacks, fragmentation of states, massive waves of migration, global economic strains, and enduring human development problems. [3] For cyberattacks, countries are using cyber hacking and warfare to attack one another, as demonstrated by Russia's invasion of Ukraine. The fragmentation of states includes the unrest and power struggles between territories in the Middle East and Africa. Global economic strains continue as trust and collaboration erodes between major economic players such as China, Japan, the US, and the European Union. Finally, the enduring human development problems such as education and poverty are large challenges to be considered when formulating foreign policy. These threats always have a human-in-the-loop and therefore cognitive science is needed to inform potential solutions.

The benefits of business management for government sector are also an area that is underappreciated. The business development process at Sandia helps technical staff, managers, and program developers to understand the business landscape, especially in the government sector, prioritize areas of opportunity, develop capture plans, strength/weakness/opportunity/threat (SWOT) analyses, and strategic maps, execute these plans, and manage customer relationships. The overall goal is to bring well-developed capabilities and solutions to the forefront of application in the government sector. However, quality research and solutions still fall into the "chasm" [4] and do not have the impact desired and required for national security needs.

To emphasize the maximized impact the government sector is missing out on, we need to define national security. One powerful way to define national security is, "the

measurable state of the capability of a nation to overcome the multi-dimensional threats to the apparent well-being of its people and its survival as a nation-state at any given time, by balancing all instruments of state policy through governance, that can be indexed by computation, empirically or otherwise, and is extendable to global security by variables external to it.” [5] If research, especially cognitive science research which addresses the human elements to national threats, and business development are not working hand in hand, the potential for probable solutions to be integrated into the government sector will not reach full potential.

3 The Intersection Between Cognitive Science and Business Management

Multiparty, deliberative processes have become a popular way to increase public participation in public policy choices. Their legitimacy depends on participants’ ability to understand the issues facing them, and to form and express their own positions on those issues. These tasks pose significant cognitive and emotional challenges. This paper argues that decision analysis, informed by behavioral decision research, offers procedures and standards for creating responsible deliberative processes. These involve (a) formal analysis of decisions, identifying the kernel of most relevant information, (b) communication procedures, recognizing the strengths and weaknesses of lay understanding, and (c) interactive elicitation methods, helping individuals to articulate the implications of their values for specific settings. A construct validity criterion assesses the extent to which the resulting valuations are properly sensitive to decision features. Feasible extensions of traditional decision analysis create opportunities to formalize the aspirations of participants and ensure the intellectual content of deliberative processes is worthy of the political hopes vested in them [6].

4 Gaps that Business Development Cares About, but Cognitive Science Addresses

Business development focuses on strengths, weakness, opportunities, and threats that are available in the market to gauge where research capabilities can be most successful. “Crossing the Chasm,” a business phrase Fig. 1 to describe the Adoption Life Cycle [7], has helped researchers and business analysts understand how to navigate technology adoption. In order to penetrate the market with new technologies and solutions, the Adoption Life Cycle informs who to target and how to prime the market for adoption. However, identifying who are early adopters versus late majority, for example, is a time consuming process and difficult to navigate, especially for cutting-edge research. There are three mechanisms within cognitive science, specifically the cognitive science program at Sandia National Laboratories that can help business developers better examine and engage the market:

1. quantitative, efficient methodologies for market research
2. centralizing the human element to bridge the gap between research and market

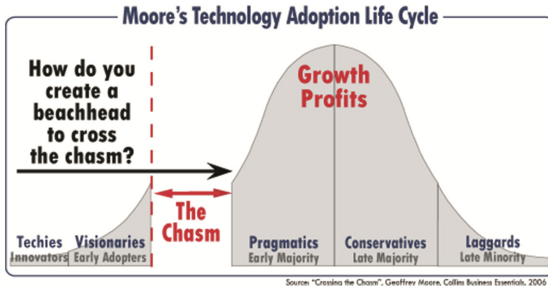


Fig. 1. Moore’s Adoption Life Cycle

- change approaches using personality and communication “types” to dynamic, behavioral models.

4.1 Quantitative, Efficient Methodologies

A business analyst must spend large amounts of time examining and filtering large amounts of documentation and usually uses what is available on the open web as a resource. It is impossible to filter through, synthesize, and process all of the data, especially when there is a limited amount of time to make important decisions. An analyst also faces a number of cognitive hindrances which can limit the quality of market analyses, such as biases, inconsistencies, and limited technical knowledge.

Intelligent web crawling and text analytics together are one methodology that enhances the market research process. Intelligent web crawling works by taking a document or documents that represents a topic of interest. From the document(s), multiple signatures and topic models are quantitatively derived using text algorithms. Using the document signatures and topic models, a web crawler can then be released into the open domain and calculate the relevance a web page has to the source topic of interest using a suite of text algorithms that address multi-dimensional search parameters. A rapid and parallel web crawler can sift through millions of webpages and analyze them for relevancy. From there, only the webpages with some level of relevance are downloaded so that out of millions of webpages, only a small set are brought to the analysts’ attention. Analysts can then make determinations about what is relevant using quantitative metrics of relevancy. A web crawler is also able to highlight and visually represent the information it has determined to be of relevance to the analyst so analysts do not have to sift through pages of text. This enables analysts to rapidly decide which webpages have actual relevancy to the source topic. Using a graphical user interface (GUI), analysts can flag relevant content and then automatically generate a report that only pulls the data deemed to be important for decision-making.

Business analysts do not always have the technical depth, time, or resources needed to locate opportunities in the government sector. A white paper, publication, and/or other documentation describing a new technology or capability could be used to seed a web crawler to locate other similar technologies in the market as well as new opportunities. This could inform capability marketing and differentiation. Overall, methodologies that are being

used in the cognitive science realm, such as web crawling and text analytics to imitate and enhance human analysts, could be applied to benefit business development activities.

4.2 Centralize the Human Element

Business development analysts lead a number of activities to support internal capability development. Strategic planning, SWOT analyses, website creation, partnerships development, and project plans are a few of these activities. Historically, these activities focus on matching capability potential to market need. Market need is defined through potential collaborators' investment plans, expertise gaps, and strategic plans. Academic articles on strategic planning tend to focus the process on securing funding, defining milestones and benchmarks, and developing 5- and 10-year goals for technology and research advancements [8].

In these activities, fundamentals of human behavior are not addressed. The psychology of planning in research discusses relevant cognitive operations in the strategic planning process. For example, how one communicates their idea to potential customers is a critical piece of technology adoption. Emotion regulation and cognitive construal are dynamics studied within psychology and can benefit how research ideas and technologies are presented to potential stakeholders. Theory in emotion regulation and cognitive construal informs researchers and decision-makers how an idea can be communicated or a situation reframed to suppress negative or inflated emotion to influence positive reactions.

One major gap in connecting the government sector to research solutions is that the technical work is not absorbed by program managers and decision-makers. Researchers' response is typically to add more technical depth, but this does not help managers and stakeholders visualize overall impact and benefit. Osburne, Hatcher, and Zongrone discuss the benefits of cognitive restructuring, which is being flexible with one's decisions and plans as new data comes in. [9] As researchers envision the use of their idea and capabilities, business developers can help to update strategy and communication as data gathering reveals new opportunities and market growth. If a strategy and market analyses are static and researchers do not take the time to update their research plan, researchers may communicate in the technology adoption "chasm" and not be able to help managers and decision-makers address their needs.

Overall, dynamics found in cognitive science theory influence business development activities by connecting each step of the development and adoption cycle to basic human need [10] and human behavior.

4.3 Dynamic, Behavioral Models

An ongoing debate in empirical psychology literature is whether personality can be categorized as "type" (a category that an individual is labeled with, such as "Type A" personality) or should be expressed as "traits" (a spectrum to describe personality: more introverted than extroverted). The business world has traditionally adopted that personality can be categorized into types. Many employees are given the Myers' Briggs Type Indicator (MBTI) and/or Social Styles questionnaires to determine what their category

of personality. The MBTI [11] is a type-based personality assessment because it informs an individual, for example, that they are an INTJ, or Introvert, iNtuitive, Thinker, and Judger. Similarly, Social Styles categorizes individuals into Driver, Analytical, Amiable, or Expressive. [12] Personality type questionnaires are beneficial because they provide a framework for work colleagues to discuss dynamics in human behavior. They can be used for team building, to generate innovative thinking, and create cohesion across staff and management levels. However, business practices have adopted these personality theories as a way to predict potential customers' and stakeholders' personality and communication methods.

Empirical literature argues that personality is a multifaceted construct, which points to "trait"-based personality theory. [13, 14] One well-structured definition is that personality is a "stable, organized collection of psychological traits and mechanisms in the human being that influences his or her interactions with and modifications to the psychological, social, and physical environment surrounding them." [15] Business development currently uses type-based personality to teach researchers how to anticipate the communication style of potential customers and fit themselves to others' personality type mold. While this approach can have some benefits, it is more profitable to focus on the environment and provide positive and negative reinforcements to elicit the behaviors desired, such as adoption of innovative technologies. Focusing on individual's personality traits and using the interaction as an opportunity to connect also provides more depth to the conversation instead of mimicking someone's tone and mannerisms.

Ultimately, business development has great intentions for understanding and influencing human behavior. Instead of drawing from famed, type-based personality theories, empirical literature on trait-personality and behavioral reinforcements can provide a more solid foundation for creating an atmosphere for technology adoption.

5 Gaps that Cognitive Science Cares About, but Business Addresses

We have just discussed how cognitive science can serve business development activities. The converse is also true: there are ways that business development practices can serve in gaps that cognitive scientists experience.

5.1 The Research Narrative

Many have heard the phrase, "death by PowerPoint." It is a heartfelt, sorrowful phrase that victims use to describe the experience of sitting with glazed-eyes at a presenter droning through too much information in a short amount of time. [16] The government sector knows this experience well, both as victims as well as perpetrators. In the research, development, and engineering parts of the government sector, this is particularly a frequent crime. Whether presenting to a potential or an existing customer, researchers passionately tell the deep details about their work and expertise but lose their audience in the process. In emerging fields, such as cognitive science, where audiences may not see the relevance or connection to national security, the need to capture the audience is even more crucial. The art of presentation is part of business academia and training.

Business professionals keep the presentation focused on the message (content of presentation) to communicate the overall message of the presentation. [17] They use the “OABC” approach (which stands for the Opening, Agenda, Body, Closing) to frame memorable presentations. [18] Although this stems from psychology’s empirical work on memory and repetition, business analysts are better practitioners of this information.

Another strategy cognitive science can draw from business development is the “research narrative.” Research narratives are used to outline the storyline from hypothesis to methodology to analyses to findings and implication. They also serve as tools for logical thinking. A research project whose narrative does not hang together is in danger of Wolfgang Pauli’s criticism: “What you said was so confused that one could not tell whether it was nonsense or not.” [19] Research narratives are important at the end of a research project, when a paper is being written for the scientific community and posterity. Lavoisier, for example, didn’t “discover” the role of oxygen in combustion until he began to piece together the research narrative associated with his experiments. [20] They are also important at the beginning of a research project. A coarse storyboard is composed of title, abstract, figures, and key references of the anticipated outcome of a research project. This forces many of the research aspects to be clarified, including those that have been hypothesized to be critical sub-components of creativity, such as originality, perceived utility, and surprisingness. [21] Business planners are very good at this level of organization. Cognitive science, especially as an emerging field, can benefit from these principles.

Many popular theories and concepts in cognitive science are either decompositional or prototype theories. [22] The field of cognitive science is also vast as it crosses and overlaps between academic disciplines. The future of cognitive science will be aimed at situated agents, brain-inspired computing, predictive behavioral modeling [23], dynamic training, etc. There is great depth and breadth in research possibilities. But possibility must be joined with opportunity and needs to address national security concerns in the government sector. Business development continues to be a strong navigator to help bridge the gap between possibility and necessity. While strategic plans, market plans, and other business activities can be informed through cognitive science theory and technologies, navigating cognitive science research opportunities can be educated through business development activities.

6 Benefits to the Government Sector

Ultimately, there are national security needs in the government sector that are not being adequately addressed due to the pace of business (both rapid and slow). In addition, decisions are being made with limited information yet high consequences. National security threats will continue to evolve and decision-makers must be equipped with empirical-based solutions. Research must be informative, logical, and easily integrate to resolve complex problems. A critical element to many national security issues is the human dimension and requires cognitive science approaches. However, scientific research is either not being tailored to the mission need or deployed at a time when it can best be absorbed by national security concerns. Cognitive science and business

development can work together by using their areas of expertise to address gaps their counterpart faces. Human-based technology development, empirical research in human behavior, and centralizing the human element make business development more accurate and informative to researchers and potential partners. Business development can help cognitive scientists to communicate effectively and target meaningful research in the government sector. As shown in Fig. 2, the collaboration between these two areas will help to bring solutions to national security concerns at a more efficient pace and will overall serve the government sector.

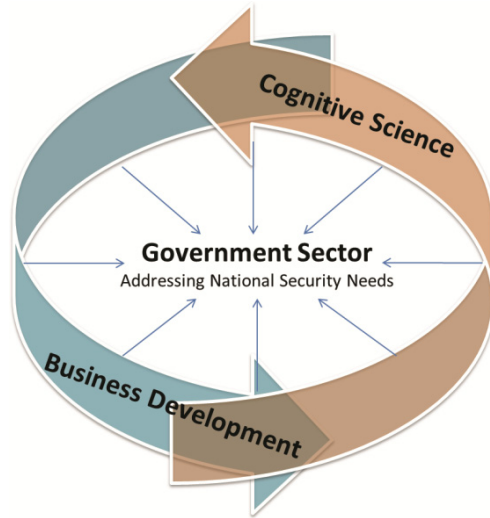


Fig. 2. Collaboration between cognitive science and business development for national security concerns in the government sector.

Acknowledgements. Sandia National Laboratories is a multi-program laboratory managed and operated by Sandia Corporation, a wholly owned subsidiary of Lockheed Martin Corporation, for the U.S. Department of Energy’s National Nuclear Security Administration under contract DE-AC04-94AL85000, Sandia Report SAND2016-1668C. Approved for public release; further dissemination unlimited. This research was funded in part or whole by an Interagency Agreement between the Transportation Security Administration and the Department of Energy.

References

1. The White House: President Obama. The Comprehensive National Cybersecurity Initiative. <https://www.whitehouse.gov/issues/foreign-policy/cybersecurity/national-initiative>. Accessed 23 Feb 2016
2. Silva, A., Emmanuel, G., McClain, J.T., Matzen, L., Forsythe, C.: Measuring expert and novice performance within computer security incident response teams. In: Schmorow, D.D., Fidopiastis, C.M. (eds.) AC 2015. LNCS, vol. 9183, pp. 144–152. Springer, Heidelberg (2015)

3. Katulis, B.: Five national security issues to watch in 2015. *The Wall Street Journal* (2014). <http://blogs.wsj.com/washwire/2014/12/31/5-national-security-issues-to-watch-in-2015/>
4. Moore, G.A.: *Crossing the Chasm: Marketing and Selling Technology Products to Mainstream Customers*. HarperBusiness, New York (2002)
5. Paleri, P.: *National Security: Imperatives and Challenges*, p. 521. Tata McGraw-Hill, New Delhi (2008)
6. Gregory, R., Fischhoff, B., McDaniels, T.: Acceptable input: using decision analysis to guide public policy deliberations. *Decis. Anal.* **2**(1), 4–16 (2005)
7. Moore, G.A.: To succeed in the long-term, focus on the middle-term. *Harvard Bus. Rev.* **85**(7–8), 84–90 (2006)
8. Winckler, G.: Excellence in strategic planning. In: Tayeb, O., Zahed, A., Ritzén, J. (eds.) *Becoming a World-Class University*, pp. 105–116. Springer International Publishing, Berlin (2016)
9. Osburn, H.K., Hatcher, J.M., Zongrone, B.M.: Training and development for organizational planning skills. In: *The Psychology of Planning in Organizations: Research and Applications*, p. 334 (2015)
10. Mumford, M.D., Frese, M. (eds.): *The Psychology of Planning in Organizations: Research and Applications*. Routledge, New York, NY (2015)
11. Quenk, N.L., Hammer, A.L.: *MBTI Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator*, vol. 3. Consulting Psychologists Press, Palo Alto (1998)
12. TRACOM Group: The Social Intelligence Company. Social style: the world's leading interpersonal effectiveness model (2016). <http://www.tracomcorp.com/solutions/by-element/social-style/model/>
13. Bess, T.L., Harvey, R.J.: Bimodal score distributions and the Myers-Briggs type indicator: Fact or artifact? *J. Pers. Assess.* **78**(1), 176–186 (2002)
14. Furnham, A.: The development of single trait personality theories. *Pers. Individ. Differ.* **11**(9), 923–929 (1990)
15. Larsen, R.J., Buss, D.M.: *Personality Psychology*. Naklada Slap, Jastrebarsko (2008)
16. DuFrene, D.D., Lehman, C.M.: Concept, content, construction, and contingencies: getting the horse before the PowerPoint cart. *Bus. Commun. Q.* **67**(1), 84–89 (2004)
17. Stowe, K., Schwartz, L., Parent, J., Sendall, P.: Are business school students prepared to present? The pedagogy of presentation skills in business schools. *J. Acad. Bus. Educ.* **11**, 1–22 (2010)
18. Baker, W.H., Thompson, M.P.: Teaching presentation skills. *Bus. Commun. Q.* **67**(2), 216–220 (2004)
19. Peierls, R.: Wolfgang Ernst Pauli. 1900–1958. *Biographical Mem. Fellows R. Soc.* **5**, 174–192 (1960)
20. Cole, S.: *Making Science: Between Nature and Society*. Harvard University Press, Cambridge (1992)
21. Gottschall, J.: *The Storytelling Animal: How Stories Make us Human*. Houghton Mifflin Harcourt, Boston (2012)
22. Fodor, J.A.: *Concepts: Where Cognitive Science Went Wrong*. Clarendon Press, Oxford (1998)
23. Clark, A.: Whatever next? Predictive brains, situated agents, and the future of cognitive science. *Behav. Brain Sci.* **36**(03), 181–204 (2013)