

A THEORETICAL FRAMEWORK FOR INTELLIGENCE¹

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There is no explicit holistic theory of intelligence encompassing all individual humans, their social groups their machines, or the environmental data that is the “grease” for this Whole Earth system of systems.³ More problematic still is the fact that there is no accepted definition of intelligence that spans individual and collective human activity. Consequently, much of the discourse surrounding the government intelligence function, particularly as it relates to national security and defence activity, lacks intellectual profundity and thus contributes to practical paucity within the overall craft of intelligence. Believing that theories and definitions cannot simply be plucked out of thin air, this paper argues the necessity of first identifying the boundaries of an appropriate theoretical framework. It suggests a three dimensional theoretical framework that could be applied to the crafting of a credible definition of intelligence and the subsequent development of a sound comprehensive theory of intelligence.

INTRODUCTION

A number of eminent American, British and Canadian intelligence scholars participated in a workshop sponsored by the United States Office of the Director of National Intelligence (ODNI) and the RAND Corporation in 2005, to discuss how theories underlie intelligence work and how they might lead to better understanding of intelligence. The lead off session addressed the question: what is intelligence theory?⁴ Workshop participants generally agreed that a good definition is a prerequisite for sound theory, but beyond that there was no unanimous agreement on any of the definitions of intelligence discussed. Some argued that a workable theory should be applicable at all times in all contexts, but discussion of those contexts remained limited to the traditional boundaries of government and military intelligence activity. In the end, workshop participants were divided over whether a theory of intelligence could be developed, in any form, at all.

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 3. The Whole Earth system of systems idea comes from the work of Robert Steele, a long time champion of true open source intelligence. I thank him for contributing to the review of this paper.
 4. Gregory F. Treverton, Seth G. Jones, Steven Boraz, and Phillip Lipsky, *Toward a Theory of Intelligence: Workshop Report* (RAND: National Security Research Division, 2006), iii.

Prior discussions of a theory of intelligence have identified two fundamental impediments to comprehensive and innovative discussion of this topic. There has been a reluctance on the part of academics to attend to “gray literature” or unindexed professional publications by intelligence practitioners. On the other hand there continues to be a modest disdain by practitioners of academics.

In 2009, Peter Gill, Stephen Marrin and Mark Phythian edited a very useful collection of essays by scholars involved in the debate about the role and utility of theory in intelligence studies. It provides a feast of interesting ideas, some of which explore notions of intelligence beyond the bounds of state activity. This appears to be the first totally academic and properly indexed discussion in the English language. No such discussion or debate can be found elsewhere in Canadian literature – so far.

Throughout much of Canadian academia, and across the federal government, there is no serious consideration of intelligence theory. Only the Canadian Armed Forces has developed and published a comprehensive intelligence doctrine.⁵ However, this doctrine recognizes nothing about intelligence beyond its doctrinal role and legislated boundaries. Other government departments exercise an intelligence function, but most have neither promulgated an explicit doctrine nor explored intelligence in any theoretical way. The Privy Council Office has established a pan-government intelligence training effort, but it too has no theoretical content.

Accordingly, motivated by the limited extent of Canadian intelligence doctrine and picking up from where the RAND workshop apparently left off, I argue that in order to develop an overarching theory of intelligence, it is necessary to first define a broad theoretical framework to house such a theory. This paper develops a three-dimensional theoretical framework, within which a holistic theory of intelligence can exist and evolve. The theoretical framework is interdisciplinary and multi-dimensional, going well beyond traditional boundaries of government and military perceptions of intelligence activity, to include recognition of the fundamental biological roots of human intelligence and encompass three principal domains of intelligence, each of which is supported by its own distinct literature and field research programs.

Research for this paper focused on primary and secondary literature in the fields of intelligence studies, artificial intelligence, anthropology, biology, business studies, history, neuroscience and psychology. Sources consulted can be considered as reasonably, but only, representative of the intelligence related material in each field. This was sufficient for the purpose of this paper, which is to determine the outline boundaries of a relevant theoretical framework. Significantly more in-depth research and analysis will be done as work on a universal definition and theory of intelligence proceeds.

This paper proceeds as follows. After this introduction, the next section establishes the premise that there is one fundamental form of intelligence and that therefore only one theoretical framework is required to house any overarching theory. A third section parses dictionary definitions of intelligence to identify three principal domains of intelligence that collectively occupy one dimension – the horizontal – of a theoretical framework. The three domains are

5. Department of National Defence, *Canadian Forces Joint Publication (CFJP) 2-0, Intelligence* (October 2011).

further examined in sections four, five and six, wherein an additional dimension of depth is identified, consisting of conceptual components of intelligence. As well, a subsequent section draws attention to four levels of intelligence in the vertical plane. Graphical depictions of the theoretical framework are found in four appendices, to which readers may wish to refer as they follow this text. Concluding remarks review the material.

ONE FRAMEWORK

Most military and government intelligence practitioners seem not to be interested in theory. In particular, military practitioners demonstrate little interest, perhaps because theoretical study “does not appeal to the pragmatic nature of military professionals, who sometimes fail to see its relevance to their world of action and dismiss theoretical work as irrelevant academic pilpul.”⁶ Moreover, theoretical thinking is hard work. As observed by Samuel Huntington, understanding any phenomenon requires theory. Theory requires abstraction and abstraction requires the simplification and ordering of reality.⁷ Busy people have other things to do.

At a very practical level, theory – or an analytic conceptual framework for reflecting on all that we do – is how we ensure that we cover the full panorama of possibilities. “Monkey see monkey do” tends to perpetuate biases and limitations. True theory is a mirror for evaluating the degree to which practitioners are pursuing all possible inquiries, using all possible skills, to all possible ends.

So, the lack of a universally agreed comprehensive intelligence theory is problematic because sound theory is essential to a full understanding of any field of endeavour. Consider, for example, the field of medicine, composed as it is, of many sub-fields of specialization, all of which are ultimately joined in an overarching theory of medicine. Law is another field in which a variety of specializations are brought together under a broad theory of law. In this respect, the field of intelligence should be no different. If the practice of intelligence is to have any credible claim to professionalism and if intelligence studies hope to consolidate into a legitimate interdisciplinary field of study, there will have to be both an accepted definition and theory of intelligence upon which a wide body of intelligence knowledge can coalesce.

While conceptual intelligence may be rooted in human intelligence (HI), some wonder whether there is more than only one form of intelligence. A central debate persisting throughout much of the literature on psychology asks whether there is one general biological HI factor – termed *g* – or *multiple intelligences*, manifest in such distinct behaviours as solving mathematical problems, playing musical instruments, excelling at certain sports or solving intricate problems.⁸

6. Michael I. Handel, *War, Strategy and Intelligence* (Totawa, N.J.: Frank Cass and Company, 1989), 5.

7. Samuel P. Huntington, *The Soldier and the State: The Theory and Politics of Civil-Military Relations* (Cambridge, Massachusetts: Belknap Press of Harvard University, 1957 and 1985), vii.

8. Charles Spearman (1863-1945) introduced the term *g* in “‘General Intelligence,’ Objectively Determined and Measured,” *American Journal of Psychology* 15 (1904): 201-293, at <http://psychclassics.yorku.ca/Spearman/>. The concept of multiple intelligences is championed by Howard Gardner, in *Frames of mind. The theory of multiple intelligences* (New York: BasicBooks, 1983); also *Multiple intelligences: The theory and practice* (New York: BasicBooks, 1993); and *Intelligence Reframed. Multiple Intelligences for the 21st Century* (New York: BasicBooks, 1999).

Military intelligence doctrine also claims to have identified a number of different intelligences, based on the sources of the information from which intelligence is derived. Thus *signals intelligence* (SIGINT) is derived from information collected from the global information grid; *imagery intelligence* (IMINT) results from the analysis of images captured by cameras mounted on vehicles, aircraft or satellites; and perhaps somewhat confusingly, we have *human intelligence* (HUMINT) derived from information provided by human agents and sources.

All these apparent forms of intelligence notwithstanding, there is only one fundamental form of intelligence, which in its essence, is the same as the root biological form of HI. One should not mistake adjectives for nouns. *Intelligence* is the noun. Any descriptor before the word *intelligence* is simply an adjective. No matter the source of information or character of the intelligence produced, all assessments share the common character of being a learned and reasoned expression of foresight for the purpose of enabling advantageous action.

The ability to learn, reason and act with advantage is the fundamental form of intelligence common to all ‘multiple’ intelligences. On examining claims of multiple forms of biological human intelligences more closely, it becomes apparent that the fundamental form of intelligence found in playing an oboe well, or scoring a hockey hat-trick, or solving the Sunday morning crossword puzzle in a quarter-hour, is not so much the distinct skill displayed, as it is the degree of learned and reasoned behaviour that has produced the capacity to perform in an advantageous manner. Gardner’s *multiple intelligences* might be more correctly seen as *skills* or *aptitudes*. Spearman’s *g* reflects the central notion that there is only one fundamental form of intelligence.

Given only one fundamental form of intelligence, rooted in the biological HI process, it is further suggested that there is a need for only one theoretical framework of intelligence, presuming it can be crafted sufficiently comprehensively to cover all manifestations of intelligence. Accordingly, this paper casts a wide net. The theoretical framework for intelligence developed here has three dimensions. The horizontal vector reflects the three principal domains of intelligence: HI; *collective intelligence* (CI); and *artificial intelligence* (AI). Levels of intelligence are stacked on the vertical vector, from the policy level (highest), through, the strategic and operational levels, to the tactical level (lowest). A third-dimensional depth vector displays six conceptual components of intelligence: environment, people, process, organization, product, and advantage – all of which are found in all three domains and all four levels.

There is an argument that prefers the term *machine intelligence* (MI) in lieu of AI, because MI encompasses machine augmentation of HI and CI and the independent machine learning and autonomous reasoning favored by the AI camp. I have chosen to retain the AI concept in this paper because I think it is a more useful abstraction at this point. This does not take away from the idea of MI, but that is perhaps a discussion for a subsequent paper.

All this material covers a significant amount of interdisciplinary ground. Nonetheless, before intellectually ranging far and wide, we should begin with a focused dissection of the term intelligence itself, in order to recognize working domains of intelligence that comprise the first dimension of intelligence of a theoretical framework.

FIRST DIMENSION OF A THEORETICAL FRAMEWORK – INTELLIGENCE DOMAINS

Parsing intelligence

The notion of intelligence began life as one idea, but over time seems to have acquired a number of pseudo-identities (e.g. emotional intelligence, social intelligence, swarm intelligence, military intelligence, criminal intelligence, security intelligence, competitive intelligence, and business intelligence, to name only a few). These different costumes, while enabling significant *intradisciplinary* study, have hindered comprehensive and cohesive academic investigation of intelligence as a single, *interdisciplinary* phenomenon. Accordingly, rather than continue the traditional habit of exploring various perceived forms of intelligence independently, this paper examines intelligence as a single entity, based on components that operate in fundamentally consistent ways in different domains and at different levels, to produce essentially identical products.

The etymology of intelligence reveals the first, original notion of intelligence was that of the biological human intelligence function.⁹ Indeed, literature related to the history and development of human intelligence goes back to Plato (*circa* 428-348 B.C.).¹⁰ Beyond the fact that intelligence comes from the Latin verb *intelligere*, to understand, there is no universal agreement on a more contemporary or comprehensive definition of intelligence. Nonetheless, today's dictionaries provide a convenient, if not entirely adequate, start point. An example of a common dictionary definition defines "intelligence" as:

1. The faculty of understanding; intellect.
2. Understanding as a quality of admitting degree; *spec.* superior understanding; quickness of mental apprehension, sagacity. ...
- 3.a. the action or fact of mentally apprehending something; understanding, knowledge, cognizance, comprehension (*of* something). [author's spacing]
- ... 5.b. esp. applied to the communication of spies, secret or private agents, etc. ...
- 7.a. Knowledge as to events, communicated by or obtained from another; information, news, tidings; *spec* information of military value. ...
- c. the obtaining of information; the agency for obtaining secret information; the staff of persons so employed, secret service. ...
- d. *Comb.* (sense 7c) *intelligence agency, corps, officer, operator, service*, intelligence department, a department of state organization or of a military or naval service whose object is to obtain information (esp. by means of secret service officers or a system of spies)¹¹

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9. *Online Etymology Dictionary* "Intelligence, late 14c., 'faculty of understanding,' from O.Fr. *intelligence* (12c.), from L. *intelligentia* 'understanding,' from *intelligentem* (nom. *intelligens*) 'discerning,' prp. of *intelligere* 'to understand, comprehend,' from *inter-* 'between' + *legere* 'choose, pick out, read.' Meaning superior understanding, 'sagacity is from early 15c. Sense of 'information, news' first recorded mid-15c., especially 'secret information from spies' (1580s)," at <http://www.etymonline.com/index.php?search=intelligence&searchmode=none>.
 10. "Plato," *Human Intelligence* (13 February 2014), at <http://www.intelltheory.com/plato.shtml>. The reader can acquire a general overview of historical human intelligence research literature by perusing Indiana University's *History of the Influences in the Development of Intelligence Theory and Testing* (Indiana University, 2013), at <http://www.intelltheory.com/map.shtml>.
 11. *Oxford English Dictionary Online*, at http://dictionary.oed.com.proxy.bib.uottawa.ca/cgi/entry/50118615?query_type=word&querywor

And a more recent example:

The ability to acquire and apply knowledge and skills: *an eminent man of great intelligence; they underestimated her intelligence* ... A person or being with the ability to acquire and apply knowledge: *extraterrestrial intelligences* ...

The collection of information of military or political value: *the chief of military intelligence; the intelligence department* ... People employed in the collection of military or political information: *French intelligence has been able to secure numerous local informers* ... Military or political information: *the gathering of intelligence*¹²

Note the eventual and typical bifurcated nature of these definitions, featuring both a context of human intellect and a context of physical information products produced by people, traditionally in government and military organizations. Here, two principal domains of intelligence are apparent. First, as argued earlier, the root notion of intelligence, from which all other notions of intelligence are derived, is that of biological HI, the first principal domain of intelligence.

Collective intelligence (CI) is the second principal domain of intelligence. If we follow the natural human inclination to socialize, when forming purposeful social organizations like governments and armies, humans generate a collective intelligence effort that attempts to replicate the individual HI effort in a social group. David Kahn, a noted American historian of cryptology, has claimed, “the roots of intelligence are biological,” and that at its most fundamental level, intelligence is essential to survival, but that the human need to hunt and flee predators has driven our intelligence to higher levels of significance.¹³ He goes on to suggest that the idea of intelligence ranges from neural sciences to international politics, anchored in at least two fields – individual human intelligence and purposeful social organizations like armies and governments.

There is another principal intelligence domain not seen in modern dictionary definitions of intelligence. Just as one can follow an intellectual path from HI to CI, there is another separate path from HI to AI, on the route to cognitive and computer sciences. Here, humans seek ways to make their lives easier by providing intelligence to machines and robots so they can do increasingly complicated work. The ultimate goal of the AI effort is to develop computer programs that can solve problems and achieve goals in the world as well as, or better than, humans can.¹⁴

d=intelligence&first=1&max_to_show=10&sort_type=alpha&result_place=1&search_id=QeDf-tfjehD-3474&hilite=50118615.

12. Oxford Dictionaries, at http://www.oxforddictionaries.com/definition/american_english/intelligence.

13. David Kahn, “An historical theory of intelligence,” in *Intelligence Theory: Key questions and debates*, Eds., Peter Gill, Stephen Marrin, and Mark Phythian (London and New York: Routledge), 4.

14. John McCarthy, “Basic Questions,” *What is Artificial Intelligence* (Stanford University: Computer Science Department, 12 November 2007), <http://www-formal.stanford.edu/jmc/whatisai/node1.html>.

However, while AI research seeks to understand how the human brain works and how it might be replicated in computers, there is another important issue not addressed by common definitions of intelligence. We know the brain generates behaviour, but what is it that makes the brain produce *a particular* behaviour in *a particular* way? Or does the brain produce behaviour at all?

Contemplating the source of intelligence

One contentious view suggests the existence of a non-material *mind* being separate from the physical brain, producing a debate that has become an important in HI studies.¹⁵ The philosophical position that a person's mind, or *psyche*, is responsible for behaviour is called *mentalism*, meaning "of the mind." Aristotle thought the non-material psyche was responsible for human thoughts, perceptions, and emotions and for such processes as imagination, opinion, desire, pleasure, pain, memory, and reason. In time, Charles Darwin's scientific theory of *natural selection* produced another view called *materialism* – the idea that rational behaviour can be fully explained by the workings of the brain and the nervous system, without any need to refer to an immaterial mind.¹⁶ This view has been influential in guiding contemporary research and evidence supporting this idea gained the status of a theory – the *brain theory* – as presented by Canadian psychologist Donald O. Hebb (1904-1985), Chair of the Department of Psychology at McGill University, in 1949:

Modern psychology takes completely for granted that behavior and function are perfectly correlated, that one is completely caused by the other. There is no separate soul or life force to stick a finger into the brain now and then and make neural cells do what they would not otherwise.¹⁷

However, this latter position has recently been challenged by Mario Beauregard, an Associate Research Professor in the Department of Psychology and Radiology and the Neuroscience Research Centre at the University of Montreal:

The brain can be weighed, measured, scanned, dissected, and studied. The mind that we conceive to be generated by the brain, however, remains a mystery. It has no mass, no volume, and no shape, and it cannot be measured in space and time. Yet it is as real as neurons, neurotransmitters, and synaptic junctions. It is also very powerful.¹⁸

It is important to consider the concept of a mind here because, as will be seen in later sections, there are important issues of *environment* that influence the nature and function of intelligence in all domains. While the debate over the primacy of brain or mind in determining behaviour may be well known and developed in the HI fields of neuroscience and psychology, there has been no equivalent recognition or exploration of associated ideas, in either quality or extent, in the CI

15. An interesting introductory discussion of the mind-brain issue can be found in Mario Beauregard, *Brain Wars: The Scientific Battle Over the Existence of the Mind and the Proof That Will Change the Way We Live our Lives* (Toronto: HarperCollins Publishers Ltd.), 8-15.

16. Bryan Kolb and Ian Q. Whishaw, *An Introduction to Brain and Behaviour*, 3rd ed. (New York, N.Y.: Worth Publishers, 2011), 11.

17. Donald O. Hebb, *The Organization of Brain and Behavior, A Neuropsychological Theory* (New York, N.Y.: Wiley and Sons, 1949), iii.

18. Beauregard, *Brain Wars*, 5.

domain. Interesting questions arise when considering organizational policy-makers or decision-makers as being the equivalent of a *mind*, and subordinate executives, headquarters, operations or intelligence staffs as the *brain*. Can either really exist independent of the other? Can either be effective without the other? This paper does not attempt to answer these questions, but it does recognize the existence of the brain-mind conundrum and insists it must be catered for somewhere a theoretical framework for intelligence.

Regarding that framework, to this point then, our clinical examination has revealed three principal domains of intelligence – HI, CI and AI. These three domains comprise the initial horizontal dimension of a theoretical framework for intelligence, and are depicted graphically in Appendix 1. It is time to move on to the second dimension.

SECOND DIMENSION OF A THEORETICAL FRAMEWORK – CONCEPTUAL COMPONENTS OF INTELLIGENCE

Four initial components of intelligence

Another close look at the dictionary definitions of intelligence reveals at least four conceptual components, which collectively can be considered a second dimension of the theoretical framework for intelligence. The first component is *people*, either individually or collectively (HI or CI). Without people there would be no intelligence, human, collective or artificial. Second, there is *process*, either intellectual or physical, of acquiring, collating or producing information and intelligence. In HI, biological intelligence processes lead to advantageous behaviour. In CI group processes coordinate unit activity. Computer processes form the basis of AI. Then we see *organization* as a conceptual component – individual or social – that houses process. The brain is an ‘organization’ of biological parts. Social groups are ‘organized’ to achieve some end. The fourth conceptual component is a *product*, the desired end result of HI, CI or AI intelligence processes.

While these four components can be found in all three domains of intelligence, they appear in very different forms. In the HI domain, the people and process components are self-evident. Organization too is self-evident in CI, but in HI, it is found, for example, in the neural structures involved in connecting the brain and central nervous system.

Surprisingly, the product component is not consistently developed in field literature. HI literature appropriately discusses the application of reason to biological impulses to produce behaviour, the ultimate point of which is to satisfy original life-impulses. However, the product component is not an enabler for just any behaviour, its point is to enable decidedly advantageous behaviour. This idea is somewhat captured in the CI literature, but not consistently. Within CI, *organizational intelligence* (OI) literature speaks of “achieving goals,” “successfully adapting to the commercial environment,” or “acting effectively,” but does so in a manner that seems more directional than functional. If goal-oriented behaviour is not advantageous, it will not be effective in satisfying the impulses that generated the behaviour. The same issue exists in the AI literature, which talks extensively about learning, adapting and acting, but says little about enabling advantage.

So, from a simple dictionary definition we can see that overall the intelligence function is composed of at least four conceptual components – people, process, organization, and product – which when added as a depth dimension to each domain of intelligence, provides an early hint of an emerging theoretical framework for intelligence, as shown in Appendix 2.

In future, when developed and presented for general agreement, any definition and holistic theory of intelligence might be expected to be true anywhere within and throughout this framework.

A closer examination of the three domains and four components provides further insight into the structure of the theoretical framework. The sections that follow discover two additional components and identify a vertical plane of at least four levels.

Biological Human Intelligence – the centrality of advantage and environment

HI research seeks to understand links between the brain and intelligent behaviour.¹⁹ There is a rich and mature body of literature dealing with HI.²⁰ An early twentieth century idea of HI was offered by Louis Leon Thurston, an eminent American psychologist who wrote *The Nature of Intelligence* in 1924.²¹ Thurston based his views of HI on the premise that all behaviour originates in an actor (her)himself, as opposed to being generated by the environment. He identifies self-preservation and self-contentment as the two fundamental *life-impulses*, which all behaviour aims to satisfy.²² Every entity in its elementary and natural state has instinctual *life-impulses* for self-preservation, to protect itself from predators or other pathologies, and to seek nourishment. The environment has a secondary, but shaping, impact on thought and behaviour. Intelligence is the capacity to satisfy these life-impulses effectively and efficiently by producing behaviour that adapts to the environment and gains advantage in achieving satisfaction. The essence of Thurston's view of intelligence involves learning from experience in a way that enhances the entity's ability to adapt to the environment and act advantageously.

The idea of adapting to the environment runs through virtually all of the literature on HI. In fact, it is essentially the story of mankind, as explained in Darwin's theory of natural selection.²³ However, not just any old adaptation will do. Species that have survived over time

19. See an outline of the field provided by the Beckman Institute for Advanced Science and Technology, University of Illinois at Urbana-Champaign, at <http://beckman.illinois.edu/research/themes/biointel>.

20. See Footnote 9. Two particularly authoritative texts are Robert J. Sternberg, *Handbook of Human Intelligence* (New York: University Press, 1982); and Earl J. Hunt, *Human Intelligence* (New York: Cambridge University Press, 2011).

21. Leon Louis Thurston, *The Nature of Intelligence* (London: Kegan Paul, Trench Trubner and Co., 1924).

22. *Ibid.*, xv-xvi and 11. In a more general, but more complex way, the urge to thrive can be characterized as behaving in conformity with Maslow's Hierarchy of Needs, which escalates from basic sustenance up to self-actualization. See W. Huit, "Maslow's hierarchy of needs," *Educational Psychology Interactive* (Valdosta, GA: Valdosta State University, 2007), accessed 2 March 2014, <http://www.edpsycinteractive.org/topics/regsyst/maslow.html>.

23. Charles Darwin, *The Origin of Species by Means of Natural Selection*, 6th edition (London: John Murray, Albemarle Street, 1873), at [http://en.wikisource.org/wiki/The_Origin_of_Species_\(1872\)](http://en.wikisource.org/wiki/The_Origin_of_Species_(1872)).

have adapted in a manner that provided them with advantage in their environment and over competitors. It is also important to note that, no matter the species, adaptation occurred in a *contested* environment filled with life-threatening conditions, events and predators. This stands to reason because if a benign environment offered to no challenge to life-impulses, there would be no need to adapt. Humans have always had to fend their way through life, adapting to act with advantage within the contested environment of nature. So prominent are the ideas of adaptation within a contested environment and of advantageous behaviour throughout studies of HI, they can be considered as two additional components of intelligence, extending the depth axis of the theoretical framework for intelligence, alongside people, process, organization and product. Appendix 3 offers a graphical representation of the enhanced theoretical framework.

Recognizing the fundamental nature of HI is just the first step in coming to grips with a workable theoretical framework for intelligence. Throughout the history of humankind, intelligence followed the human urge for social interaction and the formation of purposeful groups, producing what is generally referred to as *collective intelligence* (CI). In fact, one researcher believes that humans should first be viewed as social animals and only secondarily as individuals, and that therefore important parts of HI could reside in network properties.²⁴ The next section examines CI more closely.

COLLECTIVE INTELLIGENCE

The concept of CI as “noosphere” originated with Pierre Teilhard de Chardin in his 1922 work *Cosmogensis*, which presented all human brains as an ethereal aggregate, all connected, all working together. An alternative concept of the World Brain emerged in 1936 and was rooted in the idea of a universal encyclopedia in which all that could be known was accessible by all. In modern times a synthesis of the two concepts can be found in the idea of CI, which continues to carry the burden of huge expectations, fed by anticipation of a *Global Brain*.²⁵ Collaboration made possible by the Internet and social media feed the hype. True to form, there are different definitions of CI in use. Lévy suggests it is a “form of universal collaboration and competition of many individuals.”²⁶ Woolley and Fuchs see it as “the general ability of a group to perform a wide variety of tasks.”²⁷ Tom Atlee, the foremost American on this topic and founder of the Co-Intelligence Institute, see open human sharing as the path to extreme democracy rooted in public wisdom.²⁸

Here I borrow from a recent literature review on collective intelligence in humans by Juho Salminen, which identifies three levels of abstraction in the domain of CI – the micro-level;

24. Alex Pentland, “On the Collective Nature of Human Intelligence,” *Adaptive Behaviour* 15, No.2 (2007):189-198.

25. The term was originally coined in the book Peter Russell, *The Global Brain* (Palo Alto: J. P. Tarcher, 1983).

26. Pierre Levy, *Collective Intelligence: Mankinds’ Emerging World in Cyberspace* (New York: BasicBooks, 1997).

27. Anita Williams Woolley and Erica R. H. Fuchs, “Collective Intelligence in the Organization of Science,” *Organization Science* 22, No. 5 (2011): 1359-1367.

28. The Co-Intelligence Institute, <http://www.co-intelligence.org/>.

the macro-level; and the level of emergence.²⁹ The micro-level consists of interest in the enabling factors of humans, whereby collective intelligence is seen as a combination of psychological, cognitive and behavioural elements. At the macro-level, dealing with the output of collective systems, collective intelligence becomes a statistical phenomenon, as seen in “the wisdom of crowds” effect, where, under certain conditions, large groups can achieve better results than any single individual in the group.³⁰ Lying between the micro- and macro- levels is the level of emergence, related to the question of how system behaviour on the macro-level emerges from interactions of individuals at the micro-level. It examines how local interactions can evolve into global patterns.

Spanning these three levels of abstraction I detect at least two sub-notions of collective intelligence. First, there is *swarm intelligence* (Si), which features a group “solution to a cognitive problem in a way that cannot be implemented by isolated individuals.”³¹ Swarm intelligence is generally used throughout the field literature to denote the collective behaviour of groups of cognitively simple agents such as insects, robots and simulation algorithms, reserving the term collective intelligence for groups of agents with high cognitive capabilities – e.g. humans.³² This distinction would seem to equate collective and swarm intelligence as two equivalent domains, but if we consider swarm intelligence as a ‘dumbed-down’ version of collective intelligence, it is then reasonably seen as a sub-domain.

Second, if the idea of a ‘dumbed-down’ sub-domain is accepted, it follows that there could be another ‘smartened-up’ sub-domain, where group intelligence is purposefully enhanced to the degree that it works toward, not just the natural common interests of a social group, but to determined and focused objectives of a group leader. Such a sub-domain is known as *organizational intelligence* (Oi) and it is particularly important to any study of government or military intelligence practices.

Organizational Intelligence

What is important ... is that the direction and effectiveness of policy – reasonable standards for judging the performance of administrative leaders – are in some degree affected by the quality of intelligence and its flow from the source to the user. A man who knows is alert to more opportunities and consequences. And an executive who understands the problem of intelligence, who grasps the limitations and contributions of men of knowledge, is more likely to temper power with wisdom.³³

29. Juho Salminen, “Collective Intelligence in Humans: A Literature Review,” *Proceedings, Collective Intelligence Conference 2012* (Cambridge, Massachusetts: Massachusetts Institute of Technology, August 2012).

30. James Surowiecki, *Wisdom of Crowds* (New York: Anchor Books, 2005).

31. Jens Krause, Graeme D. Ruxton, and Stefan Krause, “Swarm Intelligence in Animals and Humans,” *Trends in Ecology and Evolution* 25, No. 1 (January 2010): 28-34.

32. Salminen, 1.

33. Wilensky, xi.

Oi is found in directed social organizations such as governments, security establishments, military forces, and increasingly, in the corporate sector.³⁴ Early study of Oi was championed by Harold L. Wilensky, in his 1967 book *Organizational Intelligence: Knowledge and Policy in Government and Industry*, in which he aimed to “provide a perspective for the study of problems in the organization of the intelligence function common to all complex social systems.”³⁵ Oi, according to Wilensky, “denotes the information – questions, insights, hypotheses, evidence – relevant to policy. It includes both scientific knowledge and political or ideological information, scientific or not” and must be clear, timely, reliable, valid, adequate and wide-ranging, traits not unknown to government and military practitioners.³⁶ Later, Halal defined Oi as “the capacity of an organization to create knowledge and use it to strategically adapt to its environment.”³⁷ However it may be defined, Oi is simply man’s attempt to replicate the HI process in a social group.

A key difference between Si and Oi is that the first strives to make the most of aggregated brains in the moment, while the second strives to create an enduring whole greater than the sum of the parts. Si focuses many minds on a single issue at a point in time; Oi creates an intelligence greater than any individual intelligence, and lives on beyond the swarm that created it.

This brief review of CI and its Oi sub-domain serves to confirm the presence of now six conceptual components of intelligence throughout the domain. Moreover, it shows that the environment component is not benign. Particularly in the Oi sub-domain, national security organizations, militaries and corporations must function in a contested environment, challenged by natural or human (organizational) adversaries of some sort. However, it might be noted that the contested nature of the environment is usually, in some way, a product of a certain direction and agenda of the social group in question. One need not have adversaries if one is not intent on acting a certain way, or coveting a particular thing. Life is neither passive nor benign and Darwin’s notion of natural selection applies as much to collectives as it does to individuals.

Since the mid-twentieth century, concurrent with the modernization of human organizations, there has been a fascinating eruption of interest in the replication of HI in computers and machines, a field of study that has come to include examination of a variety of cognitive forms. Philosophically, one wonders if it is possible, or even right, to hope machines will someday act as intelligently, or more intelligently than humans. Nevertheless, the march of artificial intelligence is proceeding briskly.

ARTIFICIAL INTELLIGENCE

34. William E. Halal, “What is it, and how can managers use it?” *strategy+business* (Booz and Company, 1 October 1997), accessed February 23, <http://www.strategy-business.com/article/12644?gko=4a546>. See a recent exploration of OI by Richard Veryard, *Building Organizational Intelligence* (Leanpub, Ruboss Technology Corporation, 2013), at <file:///Users/Home/Downloads/orgintelligence-sample.pdf>.

35. Wilensky, x. Here Wilensky also asserts that “Most organizational behavior, however, is purposeful.”

36. *Ibid.*, viii-ix.

37. Halal.

As humans moved along the HI-CI continuum, some attempted to (relatively recently) augment or replicate HI capabilities and performance in machines. The idea was founded on the claim that a central property of HI – the sapience of *homo sapiens* – could be enhanced and ultimately simulated by a machine. The ultimate goal is to develop computer programs that can solve problems and achieve goals in the world as well as humans.³⁸

Somewhat neglected is the argument that no machines exist – or are likely to exist in our lifetime – that are capable of ingesting, processing, and making sense of *all* data in all languages and mediums in real time or even over centuries. Most data are not digital, and for all the data that are digital, there is a low probability of achieving what is called exascale processing power, in our lifetime.

Nonetheless, research has resulted in the development of the computer and the field of AI, a term coined in 1955 by John McCarthy, who described it this way: On the one hand, we can learn something about how to make machines solve problems by observing other people or just by observing our own methods. On the other hand, most work in AI involves studying the problems the world presents to intelligence rather than studying people or animals.³⁹

The field of AI is a branch of computer science that has also been defined as “the study and design of intelligent agents,” where an intelligent agent is a system that perceives its environment and takes actions that maximize its chances of success.⁴⁰ AI research addresses the fields of reasoning, knowledge, planning, learning, communication, perception and the ability to move and manipulate objects.⁴¹ Given this focus on human cognition, AI research eventually led to the development of an even broader field of *cognitive science*, the interdisciplinary scientific study of the mind and its processes, which incorporates many research disciplines, including anthropology, artificial intelligence, linguistics, neuroscience and psychology.⁴²

Can we say that the domain of AI includes all six components of intelligence, as they have been found in the HI and CI domains? I think so. Considering that AI’s *raison d’être* is to serve humans as they are served by HI, and that AI aims to replicate HI in machines and computers, it follows that complete replication would involve all six components of intelligence, as they are found in HI and CI.

38. John McCarthy, “Basic Questions,” *What is Artificial Intelligence* (Stanford University: Computer Science Department, 12 November 2007), at <http://www-formal.stanford.edu/jmc/whatisai/node1.html>.

39. Ibid.

40. David Poole, Alan Mackworth, and Randy Goebel, *Computational Intelligence: A Logical Approach* (New York, NY: Oxford University Press, 1998).

41. See all these fields covered in Stuart Russell, Peter Norvig, *Artificial Intelligence: A Modern Approach*, 2nd ed. (Upper Saddle River, NJ: Prentice Hall, 2003); and George Luger, William Stubbenfield, *Artificial Intelligence: Structures and Strategies for Complex Problem Solving*, 5th ed. (The Benjamin/Cummings Publishing Company, Inc., 2004).

42. Paul Thagard, “Cognitive Science,” *The Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta, (Fall 2008), at <http://plato.stanford.edu/entries/cognitive-science/>.

We have now arrived at relatively complete horizontal (three domains – HI, CI, and AI) and depth planes (six components – environment, people, process, organization, product, advantage) of a theoretical framework for intelligence, which is shown at Appendix 3. While this enhanced framework begins to show the true extent of the concept of intelligence, there is yet more to do. The horizontal plane of intelligence domains is clear enough and the depth vector is clearly populated by the conceptual components of intelligence. A third dimension – the vertical plane – remains to be examined, a task taken up in the next section.

LEVELS OF INTELLIGENCE

A brief examination of each of the three principal domains of intelligence reveals a hierarchy of discreet elements, many of which can be considered levels of study. Given the time and space available, I have intentionally generalized (and maybe oversimplified) the characterization of various levels presented here. HI and AI scholars do not usually think of their areas of research in a hierarchical fashion, but work in both fields might at least be viewed as extending from micro- to macro-level subjects. A full examination of relevant levels of study would produce much more granular descriptions and perhaps more differentiated levels than are offered here. However, I do think the four overall levels identified in this section are correct and sufficient for initial study.

HI is an important concern in the fields of neuroscience and psychology. Neuroscience considers the macro-level combination of brain and behaviour – how does an organ (brain) generate activity (behaviour). ‘Below’ this level, the central nervous system is studied, then the constituent parts of the central nervous system down to the level of microscopic synapses. This all leads to an examination of how these processes are translated into bodily action.⁴³ Complicating all this is the question of the mind and whether it is hierarchically senior to either the neocortex or brain. Whatever the answer, the fact remains that HI, in neuroscience, can be seen as being studied on at least four levels – mind, brain, central nervous system, and resulting behaviour.

In psychology too, there are different levels of HI study, although not necessarily hierarchical. Study of the mind and its impact on behaviour might be one level. Separate study of the brain as a source of Thurston’s life-impulses could be another level. HI can also be studied as an overall process, functioning throughout the central nervous system in what Thurston referred to as the [complete] *psychological act* – impulse, awareness, perception, reason, decision, behaviour, evaluation, satisfaction.⁴⁴ Finally, the study of consequent behaviour itself may be a downstream level. While accepting that more work needs to be done in this area, I have chosen, for purposes of this paper, to ‘stack’ these levels on a vertical plane, as part of our evolving theoretical framework, and identified them, as in the preceding paragraph, from higher to lower as mind, brain, central nervous system, and behaviour.

CI and *Oi* lend themselves more easily to levels of study. Earlier it was noted that Salminen identified three levels of abstraction in the *Oi* literature – macro-level (the group), micro-level (the individual as a member of the group), and level of emergence (an inclination to

43. A useful introduction to neuroscience is provided in Bryan Kolb and Ian Q. Whishaw, *An Introduction to Brain and Behaviour*, 3rd ed. (New York: Worth Publishers, 2011).

44. Thurston, 13.

act as a group). The range of these levels encompasses equivalent levels of modern government, military and corporate activity. Western democratic governments and their military establishments, at least from the time of the Treaty of Westphalia (1648), have acted generally on three levels: at the policy level where policy is decided by legitimate political authorities, who identify desired political objectives; at the strategic level where Ministers and Generals develop military strategy to meet related strategic objectives derived from political objectives; and at the tactical level, where engagements or other ground-level activities are carried out in accordance with strategic direction. In the nineteenth century, an operational level of warfare was developed and later, after being formalized by the Soviet Union in the twentieth century, was embedded in the military doctrines of NATO nations, to coordinate all tactical activity within a campaign plan. So, here too, we can perceive four general levels of intelligence study, listed from higher to lower as policy, strategic, operational, and tactical.

A similar hierarchical arrangement is found in the commercial corporate context, perhaps not surprisingly because modern production methods and systems had their origins in military practices. Consistent with the work of Drucker, Porter, Fahey and Fuld, corporate organizations operate at the enterprise/market, business/profit centre, and sales/transaction levels, which roughly equate to the strategic, operational and tactical levels, outlined above. Corporate leadership is also routinely engaged in ‘visioning’ that results in corporate policy and guidance.⁴⁵ The various equivalent levels of CI intelligence are most clearly seen in *Oi* and can be identified as, from higher to lower, policy, market, profit centre, and sales.

There are different levels of study in AI too. However, while they are less clearly matched to CI/*Oi* terminology, they do have a ‘higher-to-lower’ character. AI research calls on *systems thinking*, which (from ‘higher’ to ‘lower’) comprises study the purpose of a system as a whole; the study of component parts of the system, including their inputs and outputs; followed by study of processes within each of those components, influenced by inputs and resulting outputs. Finally, as in other domains of intelligence, we arrive at the level of behaviour, action, or, in the case of computers and robots, output and product. These levels can be seen as rough equivalents to policy, strategic, operational and tactical levels.

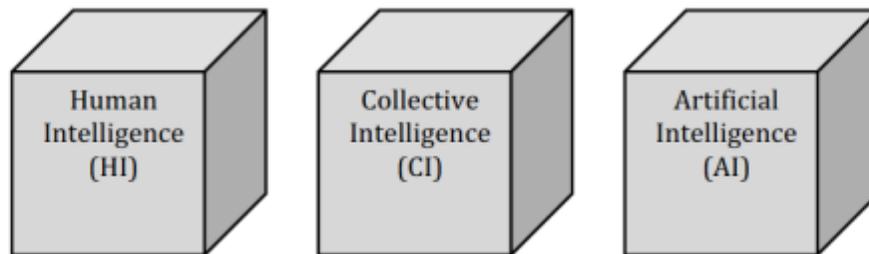
Although described here in outline only, the point has been made that all domains of intelligence invite different levels of study, from the higher, enterprise or system level, down through major component, function and activity levels. For convenience and simplicity, I have chosen to adopt the *Oi* (government and military) terms of policy, strategic, operational and tactical to represent four levels of intelligence that can now be added to complete the theoretical framework, by providing a third dimension in the vertical plane, as presented in Appendix 4.

45. A somewhat more dense description of management levels see Peter F. Drucker, with Joseph A. Maciariello, *Management*, Rev. ed. (New York: HarperCollins, 2008). A detailed description of the various levels of competitive intelligence activity is available in Liam Fahey, *Outwitting, Outmaneuvering, and Outperforming Competitors* (New York: John Wiley and Sons, Inc., 1999). For an interesting description of corporate strategy aimed at achieving competitive advantage see Michael E. Porter, *On Competition* (Boston: Harvard Business School, 1998). Fuld provides an “Intelligence Pyramid” showing levels of study of competitive intelligence in Leonard M. Fuld, *The New Competitor Intelligence* (New York: John Wiley and Sons, Ltd., 1995).

CONCLUSION

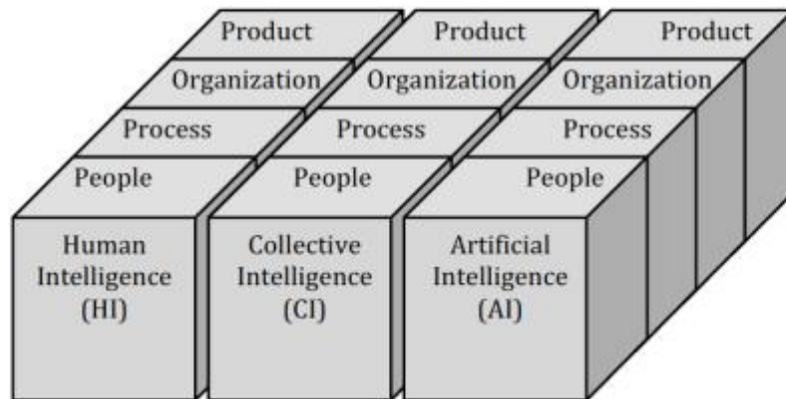
Motivated by a traditionally limited view of intelligence in government and military organizations, and a consequent lack of consistent intellectual depth across fields of intelligence studies, this paper recognizes the absence of a universally agreed definition and holistic theory of intelligence. However, before tackling the challenge of crafting a definition and subsequently creating a theory of intelligence, it has argued that it is first necessary to establish the boundaries of a sound theoretical framework, within which any such definition or theory could reside. The paper develops an interdisciplinary three-dimensional theoretical framework that could be used to guide work on creating a credible definition of intelligence and the subsequent creation of an academically sound comprehensive theory of intelligence. The theoretical framework provided here recognizes the fundamental biological roots of human intelligence. It features three principal domains of intelligence in the horizontal plane, six conceptual components of intelligence in the depth plane, and four general levels of intelligence in the vertical plane. The complete three-dimensional theoretical framework for intelligence developed here can now be used as the *field boundaries*, in any academic field, for the study of intelligence, especially the development of an agreed definition and a sound theory. Any definition or holistic theory of intelligence that may be developed should expect to be true and relevant anywhere within and throughout this framework.

APPENDIX 1
to *A Theoretical Framework for Intelligence*



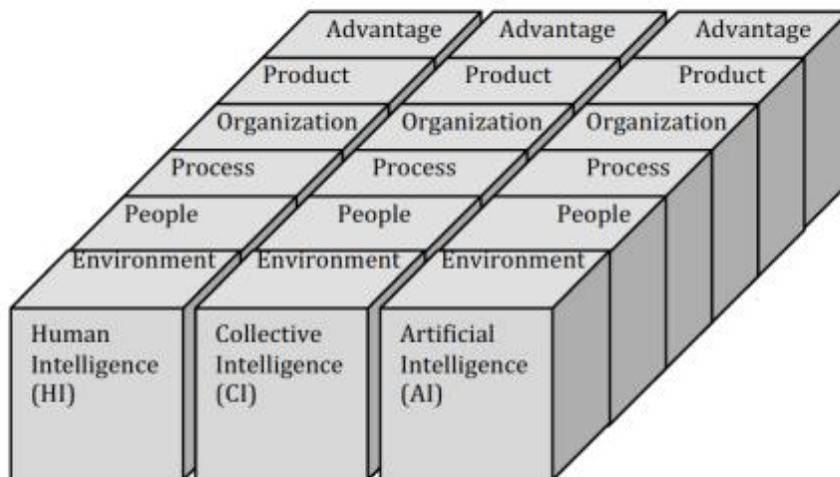
Three principal domains of intelligence comprising the horizontal axis of a theoretical framework for intelligence

APPENDIX 2

to A Theoretical Framework for Intelligence

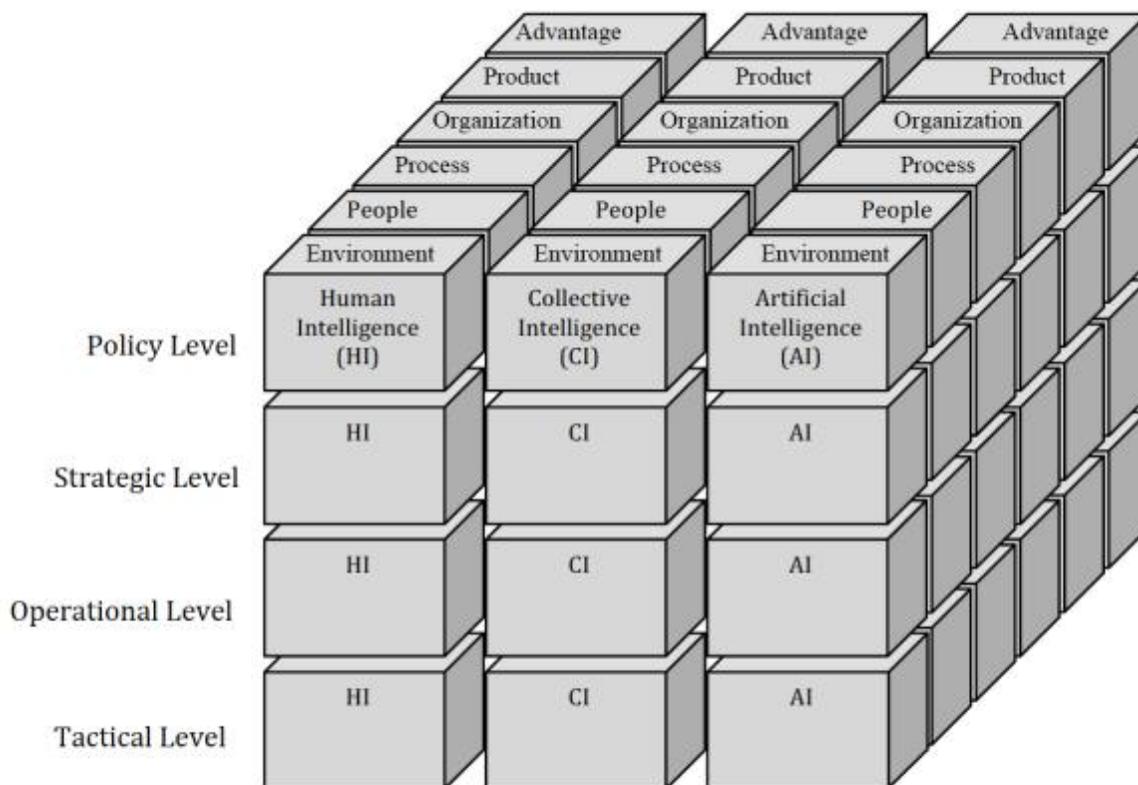
Three principal domains and four conceptual components of intelligence comprising the horizontal and depth planes of a theoretical framework for intelligence

APPENDIX 3
to *A Theoretical Framework for Intelligence*



Three principal domains and six conceptual components of intelligence comprising the complete horizontal and depth planes of a theoretical framework for intelligence

APPENDIX 4

to A Theoretical Framework for Intelligence

A theoretical framework for intelligence comprising: in the horizontal plane, three principal domains of intelligence - HI, CI, and AI; in the depth plane, six conceptual components of intelligence – environment, people, process, organization, product and advantage; and in the vertical plane, four levels of intelligence – policy, strategic, operational, and tactical

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