The Online World of the Future: Safe, Productive, and Creative

Tony Bailetti, Renaud Levesque, and D'Arcy Walsh

> *"A mind is like a parachute. It doesn't work if it is not open."*
>
> Attributed to Frank Zappa (1940–1993)
> Musician, composer, producer, and director

A safer online world is required to attain higher levels of productivity and creativity. We offer a view of a future state of the online world that places safety, productivity, and creativity above all else. The online world envisaged for 2030 is safe (i.e., users communicate with accuracy and enduring confidence), productive (i.e., users make timely decisions that have an ongoing global effect), and creative (i.e., users can connect seemingly unrelated information online). The proposed view differs from other views of the future online world that are anchored around technology solutions, confrontation, deception, and personal or commercial gain. The following seven conditions characterize the proposed view of the online world: i) global-scale autonomous learning systems; ii) humans co-working with machines; iii) human factors that are authentic and transferrable; iv) global scale whole-brain communities; v) foundational knowledge that is authentic and transferrable; vi) timely productive communication; and vii) continuous technological adaptation. These conditions are expected to enable new social-behavioural, socio-technical, and organizational interaction models.

Introduction

The nature of the online world of the future is best understood by explaining the properties of safety, productivity, and creativity. Understanding these properties requires more than technology debates. Although technology is indeed important, today we have a unique opportunity to shape the future of the online world for the greater good. However, we must understand the underlying causes of the complexity that is emerging as layers of cognition, computation, and connection evolve.

We illustrate our vision as a shift over time towards increased safety and situational understanding. As Figure 1 shows, we are now living in an unsafe world with limited situational understanding. The shift over time shows us reaching the future state by first moving to a safer world with increasing situational understanding (i.e., machines are connected but humans and machines are only loosely connected) and then moving to a safe world that provides more situational understanding (i.e., human-machine convergence, awareness, and autonomy). As a result of this shift, we envision a future

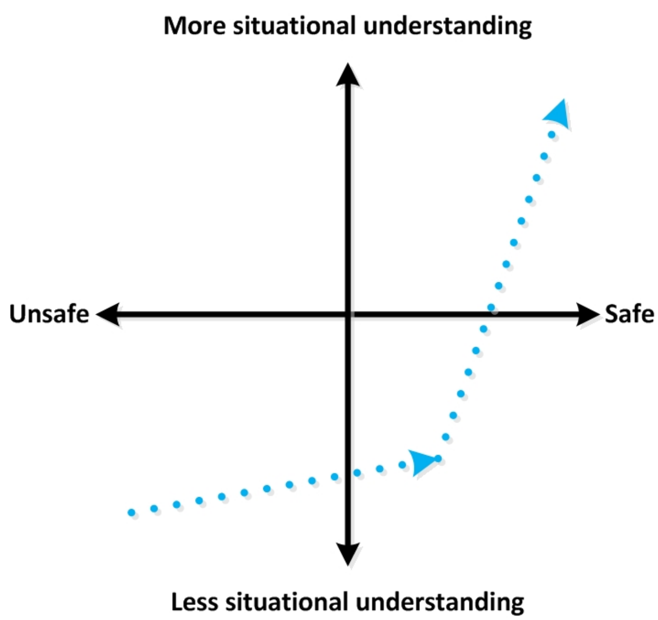

Figure 1. Progression from today's environment to our vision of the future online world in 2030

The Online World of the Future: Safe, Productive, and Creative

Tony Bailetti, Renaud Levesque, and D'Arcy Walsh

environment in which: i) productivity is uniquely enabled through instantaneously and safely connecting information elements and ii) transformational creativity is uniquely enabled through instantaneously and safely connecting together seemingly unrelated information.

In this article, we share our vision of the online world of the future by first describing safety, productivity, and creativity and then identifying the set of key conditions of a safer environment expected to enable unprecedented levels of productivity and creativity in the future. Further, we explore how the key conditions depend on one another and provide an example scenario to illustrate a domain-specific application that satisfies these conditions. Finally, we present the progression from today's environment to our vision of the future online world and position competing views of the future online world in terms of excludability and consumption rivalry using quadrant-style representations.

This article makes three contributions. First, it explicitly links safety properties to significant increases in productivity and creativity. Second, it postulates a set of research questions that should be answerable if the underlying properties of safety, productivity, and creativity are adequately understood. Third, the article identifies a set of key conditions of the online world of the future.

Online World of the Future

This section describes safety, productivity, and creativity in the context of the online world of the future.

Safety

To unleash unprecedented levels of productivity and creativity, the online world of the future must be safe (i.e., enable communication with accuracy and with enduring confidence). To be safe, the online world must be protected from: i) pernicious actors (e.g., individuals, groups, organizations, or nation-states) that strive to undermine and to unjustly benefit from the work of others, and ii) unintended disruption (e.g., user errors that have negative side effects) (Leveson, 2013). If Maslow's hierarchy of needs can be addressed with technology (Gerstein, 2014), information may be utilized as a foundational element that is authentic and is transferrable to others – in a manner that is beneficial to the world at large.

The online world of today is not engineered for safety (Leveson, 2013). We benefit from state-of-the-art knowledge of the theory and practice of safety properties in the context of cybersecurity, especially from a technical perspective. However, it is clear to us that there is no underlying theory that explains cybersecurity-related phenomena within the technical domain let alone associated safety properties that include dynamic and social characteristics, which are widely viewed to be more important than technical ones. Existing theories apply to restricted sub-domains of the overall problem space, such as cryptography, and therefore only explain phenomena within highly restricted contexts that do not have the semantic power or scope to explain other safety-related properties that concern the behaviour of the adversary and the behaviour of those who are under attack (Craigen et al., 2013).

If an underlying theory of safety existed, the following example research questions, amongst many others, would be answerable:

- Under what conditions does an attacker have an advantage over an infrastructure protector?
- Why do many infrastructure protectors and users not adopt effective mechanisms to provide safety and privacy?
- What are the resources, processes, and values to concurrently provide online safety and privacy to users?
- What are the characteristics of the individuals and organizations that are most likely to attack?
- What are the enhanced characteristics of safety through disclosure (i.e., by being open and not by being proprietary)?

Productivity

Productivity is inherently based on association or association by similarity or co-occurrence (Dubitzsky et al., 2012). We adopt the perspective that productivity is related to the efficiency and effectiveness of understanding and utilizing existing connections amongst known information elements. This view implies that information has been pre-selected to serve a purpose that is already defined and whose utility is already appreciated. Supporting technologies focus and simplify information relevant to a user's task that can accommodate discovery but within a relatively closed context. Compared to creativity gains, which are new, surprising, and of value, productivity gains, which are more conventional in nature, happen under routine conditions that are already known (Dubitzsky et al., 2012).

The Online World of the Future: Safe, Productive, and Creative

Tony Bailetti, Renaud Levesque, and D'Arcy Walsh

We foresee a future environment in which productivity is fundamentally enabled through instantaneous and safe connections among information elements. Productivity gains will remain conventional in nature but will happen in a profoundly different way. Users will be able to make timely decisions that have an ongoing global effect when information is available instantaneously, with accuracy and with enduring confidence, and senders and receivers of information are available instantaneously on a global scale. Achieving this level of productivity will require global-scale systems that interact to learn and converge on solutions autonomously when constantly assessing the meaning of connections that are known to exist amongst known information elements.

If an underlying theory of productivity existed, the following example research questions would be answerable:

- How do individuals in groups create reference frames that anchor their actions?
- How can we improve organizational performance through collective knowledge?
- How does communicating with fidelity and with enduring confidence specifically relate to productivity?
- Which communications are urgent or important?
- How are instantaneous communications and timely decisions, which can have a global effect, synchronized?

Creativity

Psychologists and neuroscientists are actively investigating the process of creativity. The work of Andreasen (2005); Csikszentmihalyi (1996); Gilovich, Griffin, and Kahneman (2002); and Kahneman (2011) are examples of well-known research within these two areas. Duxbury (2012) assesses the process of creativity and its relationship to innovation. Cognitive and computer scientists are investigating how computers can be designed to autonomously manipulate abstract concepts while Boden (1999) is concerned with computer models of creativity.

Transformational creativity constitutes the deepest form of creative processes in Boden's (1994) model of creativity. Transformational creativity leads to breakthroughs because established conceptual spaces or thinking styles, which limit types of thought, are transformed so that thoughts that were inconceivable within existing conceptual spaces are now possible (Dubitzsky et al., 2012). This level of creativity requires connecting seemingly unrelated information through computational creativity (Boden, 1999), bisociation (Koestler, 1964), and other approaches. These approaches lead to new, surprising, and valuable breakthroughs when normally distinct and unrelated contexts or categories of objects are mixed in one human or machine mind. Bisociation goes beyond associative styles of thinking that are based on established routines (Dubitzsky et al., 2012).

In the online world of the future, instantaneous and safe connections among seemingly unrelated information will enable transformational creativity. Humans and machines will be able to: i) communicate with accuracy and with enduring confidence and ii) make timely decisions that have an ongoing global effect. Through computational creativity and human-machine convergence, humans and machines will learn together to discover new knowledge and to assess (un)certainty.

If an underlying theory of creativity existed, the following example research questions, amongst many others, would be answerable:

- How do people working in creative domains employ creative thinking to connect seemingly unrelated information?
- What does it mean to combine elements from incompatible domains to generate creative solutions and insight?
- How do you teach humans or machines to be creative?
- How do you develop machine-based solutions that support creative thinking?
- How can machines be used to define and construct artificial conceptual spaces that generate creative insight and solutions?

Seven Conditions and Their Interdependencies

The conditions listed below characterize our view of the online world of the future. Together, they are intended to comprise the circumstances of a safer environment that will foster unprecedented levels of human-machine creativity and productivity. Within this online environment, the intellectual capacities of humans and machines converge for the betterment of humankind through unified knowledge, instantaneous communications, and continuous change, which together lead to transformational creativity. This list has been formulated based on our collective knowledge and experience.

The key conditions of the online world of the future that enables a new level of creativity, productivity, and safety for humans worldwide are:

1. *Global-scale autonomous learning systems:* Systems and networks will continuously learn at a global scale and therefore will adapt their interactions to autonomously interpret new information and to discover new knowledge, including automatically assessing the uncertainty of this new information or knowledge.

2. *Humans co-working with machines:* Humans (providing insight and understanding) and systems/networks (interpreting information at scale) will interwork to assess and to achieve joint goals to predict continuously emerging complex phenomena.

3. *Human factors are authentic and transferrable:* Cognitive characteristics, which indicate how people think, how people interact, and how societies and groups behave, will be inherent within interactions, allowing communication with fidelity and therefore with confidence.

4. *Global-scale whole-brain communities:* Societal formations, which provide human-driven informed insights, will emerge, interact, and disband in a manner that is open and appropriately beneficial to community participants so that the right minds can work on the right problems at the right time.

5. *Foundational knowledge is authentic and transferrable:* Creative and productive outcomes are propagated independently of the lifetime of particular individuals or organizations; the future interpretation of these productive outcomes may happen safely.

6. *Timely productive communication:* Every contemplated interaction can happen appropriately and instantaneously with knowledge of other interactions or previous creative and productive outcomes.

7. *Continuous technological adaptation:* The online world of the future, as a safe system of systems, dynamically evolves to enable creative and productive outcomes, including the incremental transformation of the world of today to a fully digitally enabled society of the future.

We consider these conditions as a starting position. They should be continuously validated, refined, and adjusted as progress is made evolving underlying theories, as technological solutions are researched and developed, and as detailed field trials are conducted over time.

Interdependencies

Figure 2 illustrates how the seven conditions identified in the previous section relate to one another.

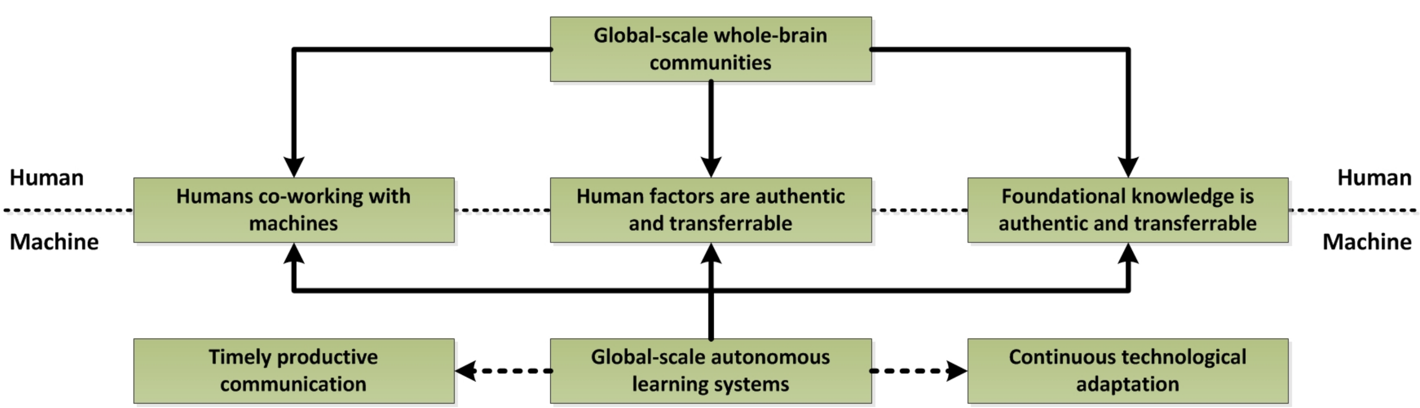

Figure 2. Dependencies among the seven conditions of the online world of the future

The Online World of the Future: Safe, Productive, and Creative

Tony Bailetti, Renaud Levesque, and D'Arcy Walsh

In our view of the online world of the future, Condition 1 (*Global-scale whole-brain communities*) is purely a human-oriented condition. Three conditions are part of the human-machine divide: Condition 2 (*Humans co-working with machines*), Condition 3 (*Human factors are authentic and transferrable*), and Condition 5 (*Foundational knowledge is authentic and transferrable*). Finally, three conditions are purely systems/network conditions: Condition 4 (*Global-scale autonomous learning systems*), Condition 6 (*Timely productive communication*), and Condition 7 (*Continuous technological adaptation*).

Figure 2 indicates that *Global-scale whole-brain communities* and *Global-scale autonomous learning systems* are two control points; the former is driven by humans and the latter is driven by systems/networks. These two conditions depend on each other through their direct dependence with *Humans co-working with machines*, *Human factors are authentic and transferrable*, and *Foundational knowledge is authentic and transferrable*. Within the scope of systems/networks, *Global-scale autonomous learning systems* directly depends on *Timely productive communication* and *Continuous technological adaptation*.

An Example

Here, we offer an example scenario of the online world of the future. The scenario describes the dynamic interoperation of two initially decoupled financial systems that specialize in maintaining knowledge and providing predictions about the energy sector of the economy. Consider two global-scale financial analysis systems – System A and System B – in which value is being created based on the present-value analysis of future cash flows. Each system is, in essence, implementing a future-oriented process that projects current economic performance over a time span applicable to the nature of a given business activity and its market segment. In such projections, there is often a distinction made between shorter-term and longer-term predictions and any analytic outputs may be indicator- or magnitude-based information. In this context, data-driven change that minimizes human intervention and bias must be systematically integrated with human-driven information that is the result of naturally adaptive and perceptive processes.

The clients who use System A are concerned with shorter-term predictions. The clients who use System B are concerned with longer-term predictions. Each system provides results of scenario analyses, knowledge about the energy sector and its conditions, cash flow projections, and valuation assessment for the shorter- or longer-term timeframes. For timeliness, System A projects cash flow and assesses valuations online and in real time. For greater accuracy, System B projects cash flow and assesses valuations offline and on demand.

These two systems are *global-scale autonomous learning systems* that can safely communicate with accuracy and with enduring confidence. Through known connections with known information elements in the financial domain, these two systems discover each other and establish a dynamic connection to interoperate in order to leverage each other's preferred stock predictions. System A is now able to use System B's longer-term predictions to validate its shorter-term predictions. System B is now able to use System A's shorter-term predictions to validate its longer-term predictions. This scenario provides an example of productivity gains through timely decisions that have an ongoing global effect. The predictions made by both systems have now been markedly improved. This interaction has happened autonomously because of *timely productive communication* and the dynamic reconfiguration of each system is an example of *continuous technological adaptation*.

Now consider human-driven information that is the result of naturally adaptive and perceptive processes. Because *human factors are authentic and transferrable* and *foundational knowledge is authentic and transferrable*, the human specialists of System A and System B have not only been alerted to the improved accuracy of their system's predictions but also to the human factors, the cognitive conditions, which led to how and why these new predictions were made. Because the human specialists of System A and System B are *humans co-working with machines*, they may interact with their respective systems to clarify any ambiguities or apparent contradictions and to more deeply understand the implications with respect to how they must adjust, from a human-driven information perspective, their shorter- or longer-term predictions. The new information may be utilized as *foundational elements that are authentic and are transferrable* because the two systems safely communicated with accuracy and with enduring confidence.

Finally, because they now know about each other and understand how and why each other came to the conclusions they came to, a specialist of System A and a specialist of System B, who live in very different parts of the world, start working together as a *global-scale whole-brain community* to assess any remaining ambiguities or contradictions. To resolve one contradiction, for example, one of the specialists has the sudden insight to analyze the situation from a completely different perspective by working with another specialist who is an expert in smart grids and distributed control systems for the energy sector. Acting as a *global-scale whole-brain community*, the three analysts are able to formulate a set of unique hypotheses, which they plan to test at scale through having the financial analysis systems interact in a restricted manner with the energy control systems of the companies that were associated with their financial predictions. This is an example of breakthrough thinking by connecting seemingly unrelated information.

As *humans co-working with machines*, they ensure, through *human factors are authentic and transferrable* and *foundational knowledge is authentic and transferrable* that the shorter- and longer-term predictions of their respective systems reflect this new knowledge and the thinking that was required to understand how and why this was the case.

Differentiation

In this section, we compare our view of the future of the online world and three competing visions: the Industrial Internet (Annunziata, 2013), the Internet of Things (Wikipedia, 2014), and the Internet of Everything (Cisco Systems, 2014). Figure 3 positions the four views of the future of the online world in terms of their excludability and consumption rivalry. These distinctions are important because they guide human action, and humankind can choose what to do with the Internet. For example, humankind can make Internet access similar to:

1. *air:* difficult to exclude, low rivalry

2. *public parks:* easy to exclude, low rivalry

3. *food:* easy to exclude, high rivalry

4. *fish stocks:* difficult to exclude, high rivalry

Today, depending on location, access to the Internet may follow any one of these four analogies.

Figure 3 indicates that the Industrial Internet will exclude many from benefiting from what it has to offer and will increase rivalry among the few. Our vision is represented as air; you cannot exclude people from breathing air and breathing as much air as you want does not take away the air that others breathe. There is the same technological underpinning for both cases, but very different economic models apply.

Consider further that the Internet goes beyond just access. Humankind has more choices to make, because the Internet also encompasses social and cultural issues, including intellectual property rights and ethical concerns. In general, we can think of the Internet, like other systems, as having three layers composed of the cognition, computation, and connection layers (Tibbs, 2013). Today, for Western society, most elements of the connection layer are like food (easy to exclude, high rivalry), most of the elements of the cognition layer are like parks (easy to exclude, low rivalry), and most elements of the computation layer are like fish stocks (difficult to exclude, high rivalry).

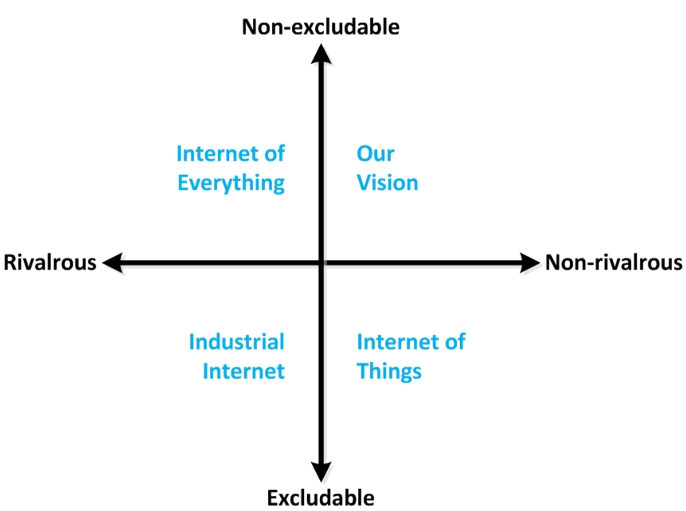

Figure 3. Positioning competing views of the future online world

Conclusion

The safety of the online world of the future is an important precondition for a profound enhancement of human productivity and creativity by 2030. Safety properties of the online world of the future must ensure information elements are authentic and transferable to others at a global scale of interaction. We believe that, through association, enhanced productivity will be achieved by safely and instantaneously connecting known information elements, including by autonomous learning systems that operate at a global scale. We believe that, through bisociation, enhanced creativity will be achieved by safely and instantaneously connecting information elements that were previously viewed to be disparate in nature, including through computational creativity and human-machine convergence.

When making progress towards understanding the scientific underpinnings of the online world of the future, we have presented a set of example research questions that we believe should be addressed or further refined. We have also presented the progression from today's environment to our vision of the future online world and positioned competing views of the future online world in terms of excludability and consumption rivalry using a quadrant-style representation.

Finally, if machines and humans are to interact and collaborate more systematically, we need to start thinking about the ethical values – and not only the creative and productive skills – that will be assigned to these machines when the outcomes of their decisions will apply to human populations, in the sense that solutions that are productive from a collective perspective can erode individual freedoms.

About the Authors

Tony Bailetti is an Associate Professor in the Sprott School of Business and the Department of Systems and Computer Engineering at Carleton University, Ottawa, Canada. Professor Bailetti is the Director of Carleton University's Technology Innovation Management (TIM) program. His research, teaching, and community contributions support technology entrepreneurship, regional economic development, and international co-innovation.

Renaud Levesque is the Director General of Core Systems at the Communications Security Establishment (CSE) in Ottawa, Canada, where he is responsible for R&D and systems development. He has significant experience in the delivery of capability and organizational change in highly technical environments. His career began at CSE in 1986 as a Systems Engineer, responsible for the development and deployment of numerous systems, including the CSE IP corporate network in 1991. In 2000 Renaud went to work in the private sector as Head of Speech Technologies at Locus Dialogue, and later at Infospace Inc., where he became Director of Speech Solutions Engineering. He rejoined CSE in 2003, where he assumed the lead role in the IT R&D section. Subsequently, as a Director General, he focused efforts towards the emergence of CSE's Joint Research Office and The Tutte Institute for Mathematics and Computing. Renaud holds a Bachelor of Engineering from l'École Polytechnique, Université de Montréal, Canada.

D'Arcy Walsh is a Science Advisor at the Communications Security Establishment (CSE) in Ottawa, Canada. His research interests include software-engineering methods and techniques that support the development and deployment of dynamic systems, including dynamic languages, dynamic configuration, context-aware systems, and autonomic and autonomous systems. He received his BAH from Queen's University in Kingston, Canada, and he received his BCS, his MCS, and his PhD in Computer Science from Carleton University in Ottawa, Canada.

The Online World of the Future: Safe, Productive, and Creative

Tony Bailetti, Renaud Levesque, and D'Arcy Walsh

References

Andreasen, N. 2005. *The Creating Brain: The Neuroscience of Genius*. New York: Dana Press.

Annunziata, M. 2013. Welcome to the Age of the Industrial Internet. *TED Talks*. October 1, 2014: http://www.ted.com/talks/marco_annunziata_welcome_to_the_age_of_the_industrial_internet/

Boden, M. A. 1994. Précis of *The Creative Mind: Myths and Mechanisms*. *Behavioral and Brain Sciences*, 17(3): 519-570. http://dx.doi.org/10.1017/S0140525X0003569X

Boden, M. A. 1999. Computer Models of Creativity. In R. J. Sternberg (Ed.), *Handbook of Creativity:* 351-372. Cambridge: Cambridge University Press.

Cisco Systems. 2014. Internet of Everything. *Cisco Systems*. October 1, 2014: http://www.cisco.com/web/about/ac79/innov/IoE.html

Craigen, D., Walsh, D., & Whyte, D. 2013. Securing Canada's Information-Technology Infrastructure: Context, Principles, and Focus Areas of Cybersecurity Research. *Technology Innovation Management Review*, 3(7): 12-19. http://timreview.ca/article/704

Csikszentmihalyi, M. 1996. *Creativity: Flow and the Psychology of Discovery and Invention*. New York: Harper Collins.

Dubitzsky, W., Tobias K., Schmidt, O., & Berthold, M.R. 2012. Towards Creative Information Exploration Based on Koestler's Concept of Bisociation. In M. R. Berthold (Ed.), *Bisociative Knowledge Discovery:* 11-32. Berlin: Springer.

Duxbury, T. 2012. Creativity: Linking Theory and Practice for Entrepreneurs. *Technology Innovation Management Review*, 2(8): 10-15. http://timreview.ca/article/594

Gerstein, J. 2014. Addressing Maslow's Hierarchy of Needs with Technology. *User Generated Education*. October 1, 2014: http://usergeneratededucation.wordpress.com/2014/03/12/addressing-maslows-hierachy-of-needs-with-technology

Gilovich, T., Griffin, D., & Kahneman, D. 2002. *The Psychology of Intuitive Judgment*. Cambridge: Cambridge University Press.

Kahneman, D. 2011. *Thinking Fast and Slow*. Toronto: Doubleday Canada.

Koestler, A. 1964. *The Act of Creation*. New York: Penguin Books.

Leveson, N. 2013. *Engineering a Safer World*. Cambridge, MA: MIT Press.

Tibbs, H. 2013. *The Global Cyber Game: The Defence Academy Cyber Inquiry Report*. Swindon, UK: Defence Academy of the United Kingdom.

Wikipedia. 2014. The Internet of Things. *Wikipedia*. October 1, 2014: http://en.wikipedia.org/wiki/Internet_of_Things

Citation: Bailetti, T., Levesque, R., & Walsh, D. 2014. The Online World of the Future: Safe, Productive, and Creative. *Technology Innovation Management Review*, 4(10): 5–12. http://timreview.ca/article/834

Keywords: future vision, online, Internet, Internet of Things, Industrial Internet, Internet of Everything, safety, security, cybersecurity, productivity, excludability, rivalry, bisociation