Making the Case for Cross-industry/Cross-disciplinary MS&V Collaboration 'Cooperation for Mutual Benefit'

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Making the Case for Cross-industry/Cross-disciplinary MS&V Collaboration

'*Cooperation for Mutual Benefit'*

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ABSTRACT

Organizations advocating and promoting Modeling, Simulation & Visualization (MS&V) as a discipline, practice, and technology have existed for some two to three decades. Most have focused on one or more industries or government domains of interest (e.g., DoD) with emphasis on development and sustainment of domain-specific technologies, processes, application guidelines, and, indeed, Modeling & Simulation (M&S) standards. What has been noticeably absent from many of these organizational efforts is focus on the economic, efficiency, and exogenous benefits of collaboration and exchange of ideas and data among diverse and nominally separate application domains (military weaponry, basic research, healthcare safety, training in many domains, etc.). Rarely have organizational efforts been focused on investigation and evaluation of the benefits to be realized by dedicated collaboration amongst organizations, or on investigation of efficient and effective allocation of efforts in areas which are common to application of modeling, simulation, and visualization technologies and capabilities. Yet the benefits of wide-ranging collaborations among diverse organizations and enterprises are potentially huge. Using the healthcare domain as representative of the issues expressed here, this paper addresses and recommends actions and activities for applying MS&V technologies toward mitigation of the serious problem first formally addressed in the seminal 2000 report, "Too Err is Human": errors in patient care, leading to poor patient outcomes. Recommendations for action, based on past work by the Society for Simulation in Healthcare, the Simulation Interoperability Standards Organization, the National Training & Simulation Association, and the National Modeling & Simulation Coalition, will be articulated. Recommendations will address MS&V technology, research, training, and governance.

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> "It should be appreciated that it is nearly impossible for a student lacking either proper mental equipment or proper academic preparation to cope with the medical course of today. Furthermore, it is difficult even for well-prepared students to cope with the course unless they are efficient students. With the advance of medical knowledge, new subjects have been added to the curriculum and the subject matter of almost all the various medical courses has increased year by year. The total amount of information placed before the medical student of today is truly appalling."
>
> A.W. Ham, M.B., and M.D. Salter, M.A., M.D., University of Toronto.

BACKGROUND

Since the creation of the personal computer and development of world-encompassing interconnectivity via the Internet, use of computer-based, internet-based, and simulation-based activity has exploded. It is reasonable to assert that there are very few fields of endeavor not affected by this explosion of technology and creativity. Yet, one may also assert that much of this activity growth has occurred within traditional industries, technologies, and business practices, albeit with huge injection of computation capability. But, the extent of cross-industry, cross-discipline digital exploration, research, and product and services development has lagged markedly behind the growth of 'within-discipline' technology application. The computer commercial gaming industry is one visible exception; gaming companies exploring and adapting technologies, unencumbered by technical, policy, regulatory, and cultural constraints, have shown remarkable innovation in making use of technologies across research domains, across cultures, and across technologies. This paper addresses the question – why has there not been more cross-industry and cross-technology collaboration, and provides an argument that much more intentional, focused effort to harvest the benefits of digital technologies regardless of source discipline is needed. The fields of medicine and health care are used as examples of the opportunities and benefits to be obtained.

THE EXPLOSION IN MEDICINE'S COMPLEXITY

Today's medical practitioners must operate within an increasingly complex medical, business, and regulatory environment, made additionally complex by the explosion of tools, processes, and medical devices that rely on computer algorithms, computer generated visualizations, new drugs, new regulations, new diseases, and new and ever-changing healthcare business models. It is with some justification that M.D.'s Ham and Salter write, the "amount of information placed before the medical student of today is truly appalling." Yet, these words were written 75 years ago, in a treatise addressing "the art of being a medical student" (Ham, 1943). Today, clearly, "see one, do one, teach one" as a basis for training medical professions and maintaining required certifications is wholly inadequate. It has been replaced by increasing use of computer-based, internet-based, and game-based technologies to integrate 21st technologies with the demands of the competent practice of medicine.

CROSS-INDUSTRY COLLABORATION – THE VALUE PROPOSITION

It has become increasingly clear that to best take advantage of digital technologies in the medical domain, both industry and healthcare professionals believe big improvements in patient care and patient safety will come from technology innovations that draw on multiple disciplines, and that success will result increasingly from robust collaboration.

For the purposes of this paper, a definition is needed: Gray (1989) defines collaboration as a process by which "parties who see different aspects of a problem can constructively explore their differences and search for solutions that go beyond their own limited vision of what is possible". Expanding this definition to address multiple collaborators, "Bryson et al. (Bryson, 2006) "takes consideration to this and defines Cross-Sector Collaboration (CSC) as the linking or sharing of information, resources, activities, and capabilities by organizations in two or more sectors to achieve jointly, an outcome that could not be achieved otherwise", further noting that CSC can include collaborations involving business, non-profit organizations (NPOs) as well as philanthropies, governments, communities and the public.

Effective collaboration – linking and sharing - is inherently difficult. While individuals and organizations may share an aligned vision for success, their internal processes, systems, cultures, and energies likely differ. These differences can hinder success if they are not recognized and managed.

Nevertheless, collaboration can be extremely valuable – particularly across industries. In cross-industry collaboration "…already existing solutions from other industries are creatively imitated and retranslated to meet the needs of the company's current market or products. Such solutions can be technologies, patents, specific knowledge, capabilities, business processes, general principles, or whole business models." (Bach, 2017). We in fact like the term used by Enkel and Gassman (Enkel, 2010) in their study of 25 cross-industry collaborations to understand the differences in perspective ("cognitive distance) of participating collaborators: *Creative Imitation*.

The value added by collaboration is likely most obvious when members from two industries unite to solve a problem. For example, within the healthcare industry, the massive influx of digital data capture and reliance on automated digital systems has created a knowledge gap; management of this data is not an educational component for care providers. There is an excellent collaborative opportunity for computer and data science organizations and health providers to make data more valuable at both the individual and community levels. The collaboration between two dissimilar but ever-more-technology-reliant industries can result in not only better care, but also more efficient and effective uses for healthcare data.

INNOVATION AT THE INTERSECTIONS

Breakthrough ideas most often occur at the intersection of different inventive domains. Figure 1 (Markovits, 2017) is an illustration of how a regional hub, such as in Hampton Roads, can serve as a mechanism for creating cross-industry collaboration. A primary role of a hub is to connect cross-discipline/cross-industry entities (companies, government agencies, academic research centers) in ways to promote collaboration among resources - companies, incubators, venture capital funds and other forms of finance, State and regional programs, and regional OEMs – that comprise the ecosystem elements fostering the collaboration. An essential hub role is to gather and connect organizations and their inventors across different clusters (yellow arrows) to encourage and facilitate dialogue that produces new and disruptive ideas leading to new invention, new products, and new services.

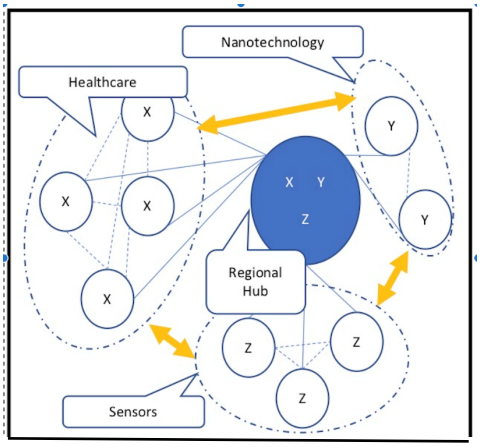

Figure 1. Creating a collaboration ecosystem

A regional example

Figure 1 also represents Collective Intelligence Clusters (Markovits, 2017) as an example of creation of cross-discipline collaboration. Consider the regional hub here is Eastern Virginia Medical School (EVMS), whose research departments conduct research in healthcare, nanotechnology, and biosensors (x, y, & z within the blue oval). The school represents a regional example of successful cross-industry and cross-disciplinary collaboration. Initiatives include research in the following areas: Diabetes and Complications of Metabolic Syndrome, Biomedical Proteomics–Biomarkers, Biorepository, Healthcare analytics and Population Health, Neurosciences, and Women's and Infant Health. Each department works with a set of outside organizations (other university researchers, commercial companies, and perhaps a government laboratory – the x, y, and z organizations within the dotted circles) having similar or complementary expertise. Collaboration and innovation are fostered when one or more EVMS research departments cooperate internally to solve problems, and in turn recruit expertise from one or more outside areas of

expertise (nanotechnology and sensors, for example) to participate in a specific collaboration. Figures 2a and 2b provide general illustration of EVMS' collaborative structure.

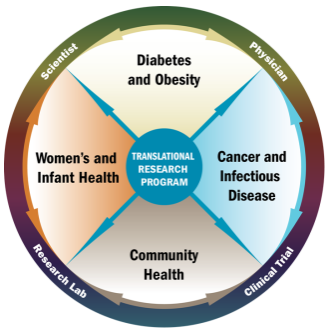

Figure 2a. Example of regional collaboration

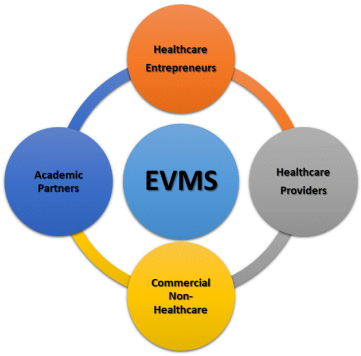

Figure 2b. Collaboration Relationships

Typically termed "translational research" in healthcare fields, EVMS research embodies the spirit of cross-industry and cross-disciplinary collaboration. The school has a long history of co-development and collaboration with other academic institutions, healthcare entrepreneurs, healthcare providers, and even non-healthcare focused commercial companies and organizations – some as far afield as California[1]. As is typical, some of these collaborations were successful, and some were not – evidence that cross-domain and inter-organizational collaboration is challenging.

CROSS-INDUSTRY COLLABORATION – INCENTIVIZING CROSS-TECHNOLOGY INNOVATION

The Challenges

In a sense, motivating and sustaining cross-industry and cross-disciplinary collaboration involves understanding of both diversity and incentivization as critical factors in achieving success. Much has been written about the value of diversity (Campbell, 2016; Phillips, 2014; Surdek, 2016; Zinczuk, 2016) in fostering and sustaining innovation in creation of new knowledge. Stated another way, diversity garners differences of perspective, about which much has also been written (Campbell, 2016; Surdek, 2016; Zinczuk, 2016). *Scientific American* (Phillips, 2014) phrased the issue this way: "The fact is that if you want to build teams or organizations capable of innovating, you need diversity. Diversity enhances creativity. It encourages the search for novel information and perspectives, leading to better decision making and problem solving. Diversity can improve the bottom line of companies and lead to unfettered discoveries and breakthrough innovations." However, putting in place a cross-industry collaboration structure as shown in Figure 1 is not sufficient. Without a central motivation and incentive, too often attempts at collaboration fall short.

Much also has been studied about incentive programs (Abduljawad, 2011; Burwell 2016; Custers, 2008; Doran, 2017; Farnam Street, 2016). Yet much of the literature does not recognize the powerful effects of culture and motivation on the *effectiveness* of incentives. Charlie Munger, long-time vice-chair of Berkshire Hathaway[2], has cautioned, "I think I've been in the top 5% of my age cohort all my life in understanding the power of incentives, and all my life I've underestimated it. Never a year passes that I don't get some surprise that pushes my limit a little farther." At age 94, he has also observed, about business, "the behavior you see is usually the result of incentives you don't see," and "… people will navigate the shortest path to the incentive." (Farnam Street, 2018).

These time-proven observations have lessons for health care. Sylvia Burwell, Secretary of Health & Human Services, 2014-2017, had this to say about incentives, talking about the rise in healthcare costs: "One of the reasons is the long legacy of fee-for-service, widely understood to be one of the main drivers of health care costs. Experts have compared fee-for-service to paying carpenters by the inch of lumber, or plumbers by the foot of pipe. It's easy to understand

[1] Examples of successful EVMS collaboration: patents with this list of co-assignees: Children's Specialty Group, Health and Human Services, ODU, Fred Hutchinson Cancer Research Center, Univ. of Arkansas, and Ciphergen Biosystems, Inc. (a California company). (Source: Markovits, D., IBP, Inc., focused patent search results, 2019)
[2] Sixth largest private employer in the U.S., at 377,000 employees. Source: Wikipedia

why this payment system is inflationary: in a climate where redundancies have no financial downside, paying for the volume of services without regard to outcomes will result in a system that emphasizes the former." (Burwell, 2016). Munger would agree with her comment about the distortion of incentives in health care: "Under a fee-for-service system, each visit, screening, and procedure is rewarded while many of clinicians' most important duties—like reviewing lab tests, corresponding with patients, and communicating with other doctors to coordinate care—go uncompensated. One study found that primary care physicians must address more than three dozen urgent uncompensated tasks every day – tasks like discussing a patient's care plan with a specialist, or working with a nurse to address the side effects of a patient's medications." Munger has characterized this distortion of incentives more directly: "You get what you reward." (Sorkin, 2018). Seen in this light, it is no surprise that the average doctor-patient encounter during an office visit is about 11 minutes – neither doctor nor nurse get reimbursed for time spent in discussion with the patient.

TOWARDS WORKABLE COLLABORATIONS

Another important issue bears on the motivation to collaborate. System level (and organizational level) incentivization is different from the individual incentivization. Individuals want to change and fix things, but the *systems* under which they operate are extremely change averse. Examples abound: Billing – because the system is cumbersome and complicated, and changes create mistakes; Administration – because changes take resources, and unless they save significant money or improve the brand, there is little motivation; Changes to personnel management or staffing – because the workforce already feels overloaded and overburdened, and changes are not trusted unless they pay off immediately at the individual level.

"Healthcare" is arguably a domain that changes only as driven from within by domain leadership. The UK and US healthcare domains (however defined) are much different, but both must operate immersed in what we term the top 5 Change Determinants (CDs): Culture, Policy, Funding, Structure, and Attitude ("CPFSA"). These organizational characteristics drive the relationship(s) between and among Providers and the employment of Technology within the healthcare domain.

Via collaboration (cross-industry, cross-discipline, or other), innovation and technology insertion across a given domain most assuredly change all 5 CDs to varying degrees. But successful collaborations have imposed huge changes on industries, on peoples' day-to-day experience, and on culture. The music industry changed drastically between the 1960's and today, due to digital innovation, the internet, and new distribution, marketing, and sales methods; these same innovations, plus others, have changed communications across the planet across the same 5+ decades. As just one example, who would have thought that much banking in African and Central American countries is done by cell phone?

Changes such as these have provided huge benefits to large segments of populations – benefits accruing from intentional collaboration across disciplines, across industries, and across nations and governments. Common to such changes are technology disruption and big changes in the distribution of costs, in the distribution of revenue (incomes) among various provider groups within the changed domain, and major changes (usually belatedly) to governance (in the U.S. healthcare domain, that would include FDA and a number of Federal departments (Commerce, HHS, etc.)).

Aligning Diversity, Motivation, and Incentive to Drive Collaboration

In addressing health care in this paper, it must be recognized that providers (individuals) and providers (organizations) have different, and at times markedly different, incentives – and very different levels of "freedom to operate." Both groups are limited by federal regulation; the former are agile but relatively poorly resourced, and the latter are usually well resourced but not very agile – and very risk averse, as stated previously. And both groups are subject to the five Change Determinants – CPFSA. Part of the challenge is to show an acceptable value to motivate taking on a collaborative task that is almost always harder than maintaining the status quo, is probably seen as risky, and is likely not appreciated/heralded without an immediate realization of return on investment.

SUCCESSFUL COLLABORATION

Successful collaborations tend to start with two things – a significant intractable problem, and an overriding motivation to solve that problem. The following example (Nguyen, 2017) of a successful cross-industry collaboration between the automotive and health care industries provides illustration of the benefits of diversity of perspective and proper alignment of incentives with desired outcomes.

The intractable problem was Central Line Associated Bloodstream Infections, or CLABSIs. The overriding motivation was two-fold: approximately 250,000 CLABSIs occur annually at hospitals across the country, and treatment countermeasures cost more than $6 billion annually, according to a study published in the *Journal of Infusion Nursing*.

Toyota partnered with Children's Health in Dallas, Cook Children's Hospital in Fort Worth, Children's Hospital in Cincinnati, and Children's Hospital of The King's Daughters, Norfolk, Virginia, all four institutions baffled and frustrated by this persistent issue. Doctors and nurses at each hospital were following strict hygiene protocols, yet, somehow, harmful bacteria as well as other germs were getting past their defenses. Toyota sent a process engineer, Scott Dickson, to observe and record conditions as he found them; his unbiased perspective discovered that healthcare practitioners were following the proper steps to ensure they were germ free, but that the surrounding environment (tables, blankets, other equipment in the vicinity of the patient) was not sterile, and contamination occurred (e.g., a sterile medical device placed on a non-sterile table). The solution, implemented by application of Toyota's problem-solving methodology, was to revise some aspects of provider-patient interaction, and to impose the use of sterile pads to serve as a barrier between a potentially contaminated surface and the medical devices (such as chest tubes) being used to treat patients. The results were startling: "It's now been more than a year and infections are down 75 percent," Dickson reported. "They're absolutely thrilled with the progress we've made and, if at all possible, looking to eliminate these infections all together."

What can be learned from this example: Toyota engineer Dickson expressed it this way: "What they thought was the problem and what was actually the problem turned out to be very different things," says Dickson. "There's no way we would have figured it out if we hadn't spent time at each site and talked with the nurses on the floor." … **"The way we systemically break down a problem was completely foreign to the people at the hospitals**," says Dickson. "In the end, their reaction was: 'Oh, my gosh. We never thought of that.'"

Another example, taken from industry, illustrates alignment of economic incentives and complementary technology for economic development. Here, the shoe company Nike is a developmental Hub entity, the OEM in Figure 3, facilitating & encouraging collaboration among institutions that would otherwise not share knowledge and expertise due to competitive pressures. Figure 3 (Markovits, 2017) shows Nike, the OEM, connecting a subset of its creative, but competitive, suppliers (A, B, C) from different industries into a Co-Development Team (CDT) – an incentivized collaboration. Nike presents all 3 with a design or product challenge that needs to be solved. CDT members must share their knowledge and technological expertise to research and produce a solution[3]. In return, Nike guarantees CDT members right of first refusal at fulfilling orders for the solution before Nike turns to other suppliers. Note that one of the incentives is that any member of the CDT who attempts to "free-ride" (participating without contributing), that supplier is removed from the team, and loses any opportunity for contracting with Nike on the developed solution.

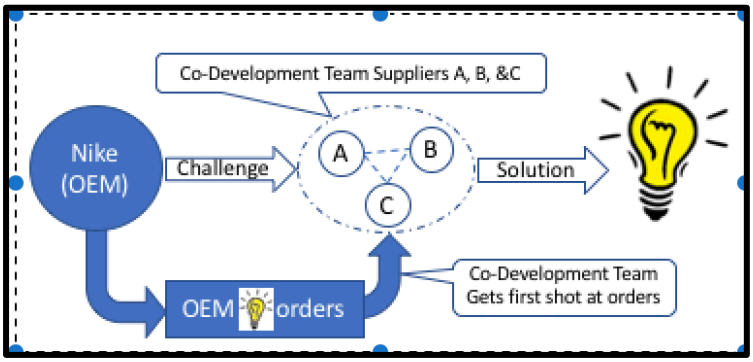

Figure 3. Product development collaboration

Appendix A provides a further example of a need for cross-industry collaboration to solve an ongoing healthcare issue. In this case, the intractable problem is non-clinical infrastructure and operations costs, and the overriding motivation, finding "smart building technologies to drive resource efficiency and increase patient satisfaction."

[3] A real-world example (from Enkel (2010)): Nike Challenge: better shock absorption for sport shoes. Source of innovation: Formula One shock absorption technologies. Result: Nike's Shox shoe with a new shock absorption system. A cross-industry collaboration between two industries: footwear and high-performance car racing.

RECOMMENDATIONS

The foregoing discussion and examples indicate commonalities typical of successful collaboration. Abduljawad and Al-Assaf, in an extensive 2011 study (Abduljawad, 2011) reported observations gleaned from two projects: **"**one targeted primarily to providers to increase the demand for health care services and another targeted at consumers to increase their use of health care and related services. In the all projects, workers reported that to ensure success … the following characteristics should be present: 1) Designed in collaborative manner; 2) Development of realistic goals; 3) Development of indicators that are SMART (specific, measurable, achievable, realistic, and timely); 4) Tailoring of incentives (types and amounts) according to the target population; 5) Putting in place a system to monitor and validate performance, and 6) Development and execution of contracts."

Our research and experience support these formal study conclusions. Additionally, we found that in many cases the incorporation of some method of checking on, or inspecting, behaviors and actions was an essential element in understanding the effectiveness and efficacy of developed incentives and the degree to which inclusion of diversity of perspective was important to the collaborative efforts, whether cross-industry, or cross-disciplinary. In a 2008 study (Custers, 2008) addressing creation of a decision framework for selecting effective incentive structures to promote improved performance, the authors analyzed 9 direct financial incentive models, 3 direct non-financial incentive models, and 2 indirect models (one financial incentive, one non-financial). Only one was found to show evidence of performance improvement beyond "none" or "limited":

"Public Reporting (appeals to intrinsic motivation) was found to lead to performance improvement; however, only for those performance aspects reported upon. Concerns for their public image appear to be a key motivator for improvement. Although professional pride is a motivator, more concrete financial incentive could also be influenced by changes in hospital reputation like for example a hospital's ability to raise funds or recruiting and retaining qualified physicians and nurses. Despite some doubts at the hospital management level in the NHS about the validity of the performance rating system, they found it useful as a lever to influence staff behavior. In general hospitals don't undertake many actions after reporting performance. In particular if the performance is enough in the eyes of a hospital; poor performing hospitals will more frequently undertake activities [to achieve improvement]."

Not present in either of these studies, or in others we came across, was

a) recognition of the differences between individual incentives and motivations, and those of institutions and governing bodies (regulatory authorities, societies, etc.), or
b) explicit research effort to examine the degree to which diversity of experience, perspective, and expertise was included in collaborative projects.

These factors comprise the major recommendation of this paper – that leaders and managers must be intentional and realistic in understanding the real drivers of individual and institutional motivations in when considering cross-industry / cross-disciplinary collaboration, and must be prepared to observe, inspect, and modify incentives and team compositions as collaborative work continues. The benefits of doing so, as illustrated by the Toyota example, are well worth the effort.

ACKNOWLEDGEMENTS

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APPENDIX A

A multi-disciplinary / multi-industry collaboration need – RWJBarnabas Health

In 2018, the New Jersey Innovation Institute (NJII), a not-for-profit New Jersey Institute of Technology (NJIT) corporation, pursued a cross-industry collaboration with RWJBarnabas Health in a 'Smart Hospital Challenge'. In this initiative, NJII were working with one of the largest healthcare providers in NJ to generate solutions to facility management in the healthcare system. As reported by Barnabas Health on their website (url: http://njii.com/rwjb/), "specific interest focuses on capabilities and assets in data integration, data analytics, data visualization, sensors, AI-based learning and decision management, and secure networking and communications that could underpin an integrated facilities optimization solution."

Driving this initiative are the facts that "hospitals across the country are dealing with aging facility information systems – building management systems, patient transport, food management, patient bed boarding, among others — that are hindered by data silos, multiple stand-alone displays, and proprietary protocols. This results in untapped gains in resource efficiency and patient safety. In fact, a Gartner analysis estimated that any building management system that is not fully integrated by 2020 will leave a 30 percent potential savings on the table."

Barnabas Health further states that "health care spending continues to rise and a wealth of innovation has been unleashed to reduce costs and improve outcomes. However, operational costs are often overlooked with the laser focus on clinical issues such as patient care and patient outcomes. Yet, facilities management is a major health care cost driver and essential to patient safety. According to the U.S. Department of Commerce, inefficiency in facility information management costs organizations over $14 billion each year."

This initiative provides a clear example of the need for collaborative engagement of multiple players in different industries having different disciplines to address focused improvements in facilities operations and management that support clinical care.