Moving the Facilities and Infrastructure Industries Into the Information Age

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Abstract:

While implementation of BIM has been a major industry focus of recent years, our vision must shift to look at the broader vision of Asset Management, Virtual Design, Construction, and Operations (VDCO) and high-level metrics. We shall bring all the strategies, tools, and technologies together to profoundly reduce waste, significantly improve productivity, reduce total cost of ownership, and create a sustainable environment for continuous future improvement, all of which will make the needed changes attractive to investors to accomplish rapidly. This white paper is intended to identify what actions are imperative in moving the facilities and infrastructure industries forward in this country and around the world. It is to these ends that we must dedicate all future effort.

Keywords:

Contents

The Challenge

The Facilities and infrastructure industry account for a significant percentage of the energy, water, raw material use, and municipal solid waste in this country and the world. These industries contribute about $7 trillion annually, or 10%, to the world's $70 trillion GDP. Despite efforts to date, partially due to population increases, we have not made a statistically important improvement in the overall rate of global decline. To compound the issues, productivity in the facility and infrastructure industries is decreasing. All of these issues are encumbered currently with an estimated 50 percent of waste. Our task is to elevate substantially the level of awareness of the issues, determine baselines and goals, and to implement immediate action to reverse the trends that are all contributing to the rapid sickening of our planet. We will attack the problem on four fronts. We shall first identify how we can:

- Profoundly **reduce waste**,
- Significantly **improve productivity**,
- **Reduce total cost of ownership**, and
- Create a sustainable environment for **continuous future improvement**.

These actions will make the needed changes attractive to investors to accomplish rapidly. The goal for the United States to reverse current trends should be 2021 – six years from today based on the Vision 2021 document produced by the National Institute of Building Sciences. That gives us just one year to plan and five years to implement prodigious change.

A Higher Level of Thinking

Focusing on all the exciting new technology is no more than a passing fancy, as improvements are made daily, as are the application tools we use to apply the technology such as CAD, BIM, and GIS. It is the outcome that is most important to the owner and worthy of his notice and investment to accomplish. Along those lines, we must elevate our strategic thinking in order to attract the attention of the owner to center on asset and facility management. There are two international standards available to support this viewpoint, ISO 55000 for asset management and ISO 41000 for facility management. ISO 55000 is relatively new, ISO 41000 is still under development. Hence, we now have the consensus tools to start of our road to common and comprehensive international implementation. Both standards demonstrate a higher-level need for coordination in the facilities and infrastructure industries around which all can rally. The benefits of asset management are directly aligned with our overall goals and the outcomes we seek to deliver. The benefits can include, but are not limited to, the following:

- **improved financial performance:** improving the return on investments and reducing costs can be achieved, while preserving asset value and without sacrificing the short or long-term realization of organizational objectives;
- **informed asset investment decisions:** enabling the organization to improve its decision making and effectively balance costs, risks, opportunities and performance;
- **managed risk:** reducing financial losses, improving health and safety, good will and reputation, minimizing environmental and social impact, can result in reduced liabilities such as insurance premiums, fines and penalties;

- **improved services and outputs:** assuring the performance of assets can lead to improved services or products that consistently meet or exceed the expectations of customers and stakeholders;
- **demonstrated social responsibility:** improving the organization's ability to, for example, reduce emissions, conserve resources and adapt to climate change, enables it to demonstrate socially responsible and ethical business practices and stewardship;
- **demonstrated compliance:** transparently conforming with legal, statutory and regulatory requirements, as well as adhering to asset management standards, policies and processes, can enable demonstration of compliance;
- **enhanced reputation:** through improved customer satisfaction, stakeholder awareness and confidence;
- **improved organizational sustainability:** effectively managing short and long-term effects, expenditures and performance, can improve the sustainability of operations and the organization;
- **improved efficiency and effectiveness:** reviewing and improving processes, procedures and asset performance can improve efficiency and effectiveness, and the achievement of organizational objectives[1].

All in a Title

Building Information Modeling (BIM) will remain a major tool in our toolbox for affecting change, and we shall not abandon it. However, based on the diversity of information modeling in general with terms such as CIM, BrIM, etc. now in our vernacular, it is clear we need to have a more holistic view of our solution set as there are many more tools that we must bring to bear in effecting the profound change needed in the facilities and infrastructure industries. In addition, this must occur far more effectively and quickly than we have been able to do thus far. Virtual Design, Construction, and Operations (VDCO) is a more comprehensive term to help bring together all aspects of the facilities and infrastructure communities. Simply stated, all seek to build facilities and infrastructure projects virtually first and work out any potential issues before we build them physically. This allows more efficient and effective stewardship of our time, materials, and our environment. The planet is on a countdown to destruction and it appears we are simply fiddling around and not affecting true change.

Transformation

It is safe to say the United States, and many parts of the world, are now largely a digital society. As with every improvement, there are issues, not covered by this paper; however, virtually every facet of our lives is affected whether we participate directly or not. Many industries have seen profound change in their business processes. Amazon, for example, can now deliver many products to your door the same day you order them in many large cities[2]. That is still not good enough for Amazon, as they would like to

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[1] Excerpt from ISO 55000
[2] https://www.youtube.com/watch?v=tMpsMt7ETi8 accessed July 1, 2015.

use drones to deliver the package even faster[3]. This will certainly come in time, once the details can be worked out at a micro level for the air corridors. If you look at the video of their fulfillment center, you can see the level of design that has gone into that infrastructure.

Automobile manufacturing has also undergone significant change where robotics have taken over the process to a large part although likely because of union rules some people still play assembly line roles[4]. A human simply cannot be as accurate, or operate as fast for 24 hours a day seven days a week. It will be very soon that autonomous automobiles will be available to the public. It is still big news if one has an accident in the millions of miles they have been tested, while we barely hear about accidents in self-driven cars unless there is significant loss of life[5]. Agriculture has been transformed over the years to the point where autonomous tractors can now plow fields and send back soil tests to determine if specific chemicals should be added to the soil, thus only adding what is needed instead of over-fertilizing. This increases yields and decreases the impact on the environment[6].

In the banking industry, you can now take a picture of both sides of a check with your smartphone and spend it immediately, once you are a trusted customer of your bank. Moreover, smartphones, those wonderful pocket devices that do hundreds of tasks, one of them still being a phone are now in nearly everyone's possession. The format has shrunk amazingly in their short life span, to the point where a wristwatch can now perform many of the functions, especially when it can draw on the capability of the phone in your pocket.

Yet it seems the facilities and infrastructure industries continue to struggle with entry into the digital age. We have many good test cases now to use as examples, but we have had little impact thus far in truly transforming or making a significant impact. A case in point is that of the 5 million commercial buildings in the United States, only 0.6% of them have been affected by green programs such as LEED, Energy Star, or Green Globes, this translates to just 3.5% of total square footage[7]. To be a little forgiving, most of the facilities in the United States are residential and I believe the primary impact of saving energy is been absorbed by the public; therefore, energy is being saved in the residential sector, although it is not tracked as it is primarily based on individuals seeking to reduce their monthly energy bills. Bottom line is we have no meaningful or significant energy saving yet in place through activities of the facilities industry. We do have examples of net zero buildings and residential facilities and therefore, if properly resourced, we do know how to implement those capabilities. However, more research is indicated before full implementation is recommended, as we do not truly know the life-cycle impact of these test cases.

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[3] https://www.youtube.com/watch?v=Le46ERPMlWU accessed July 1, 2015.
[4] https://www.youtube.com/watch?v=8_lfxPI5ObM accessed July 1, 2015.
[5] https://www.youtube.com/watch?v=P1tfOeChenQ accessed July 1, 2015
[6] https://www.youtube.com/watch?v=D7xc45LyhoU accessed July 1, 2015
[7] https://www.dropbox.com/s/7sdhks4xftuy8sc/Our%20Impact%20Thus%20Far%20Is%20Too%20Small.pptx?dl=0 accessed July 1, 2015

Facility and Infrastructure Statistics

These statistics are provided as a baseline of our thinking as it relates to the facilities industry. The facilities and infrastructure industries, which include buildings, electric power, water and wastewater, roads, bridges, rail, seaports, and airports, contribute about $7 trillion annually, or 10%, to the world's $70 trillion GDP. The facilities and infrastructure market in the United States alone accounts for 5.5% of the $14.7 trillion U.S. GDP.

Based on April 2009 information from the Environmental Protection Agency, in the United States there were 223,114 businesses in the facilities industry, representing more than $531 billion in annual revenues, nearly $62 billion in annual payroll, and more than 1.7 million employees in 2002. Nearly 128 million residential housing units existed in the U.S. in 2007. Approximately 7.188 million new housing units were built between 2005 and 2009. Nearly 4.9 million office buildings existed in 2003 in the U.S. Every year, approximately 170,000 commercial buildings are constructed, and nearly 44,000 commercial buildings demolished (1995).

Buildings accounted for 38.9 percent of total U.S. energy consumption in 2005. Residential buildings accounted for 53.7 percent of that total, while commercial buildings accounted for the other 46.3 percent. Buildings now account for 41 percent of energy use while Industrial use is 30 percent and all of transportation is only 29 percent. Buildings accounted for 72 percent of total U.S. electricity consumption in 2006 and this number will rise to 75 percent by 2025. 51 percent of that total was attributed to residential building use, while 49 percent was attributed to commercial building usage. Out of the total energy consumption in an average household, 50 percent goes to space heating, 27 percent to run appliances, 19 percent to heat water and 4 percent goes to air conditioning. Buildings in the United States contribute 39 percent of the nation's total carbon dioxide emissions, including 21 percent from the residential sector and 18 percent from the commercial sector (2008). Building occupants use 13 percent of the total water consumed in the United States per day. Of that total, 25.6 percent is used by commercial building occupants, and 74.4 percent by homeowners (1995).

Between 1950 and 2000, the U.S. population nearly doubled. However, in that same period, public demand for water more than tripled! Americans now use an average of 100 gallons of water each day. Currently, about 8 percent of U.S. energy demand goes to treating, pumping, and heating water. Building-related construction and demolition (C&D) debris totals approximately 160 million tons per year, accounting for nearly 26 percent of total non-industrial waste generation in the U.S. Combining C&D with municipal solid waste (MSW) yields an estimate that building construction, renovation, use and demolition together constitute about two-thirds of all non-industrial solid waste generation in the US.[8] The bottom line is that if we can get energy, water, and waste from facilities under control, we will be well on our way to making a significant impact on the overall stewardship of our environment.

Defining Business Process

The facilities and infrastructure industries are looked at as a hard nut to crack, largely because they are extremely large and very fragmented. They are not like the automobile, aeronautical, or other industries

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[8] http://www.epa.gov/greenbuilding/pubs/gbstats.pdf accessed June 27, 2015.

where there are a relatively few number of providers, manufacturers, and suppliers. The facilities and infrastructure industries have literally millions of construction materials used by hundreds of thousands of design and construction firms and practitioners. Yet there are recognized business processes, certainly with some variations, that to this point have not been captured in a business process model. While some parts are beginning to be captured in various IDM and MVD efforts—and that is a step forward—it too is just a drop in the bucket in solving the entire issue. The truth is that we are walking when we should be running by now. We must figure out a way to get this ball rolling far faster than it currently is. This can be done by bringing together the disparate sectors by focusing on some metrics that all can rally around. We must identify what business processes are actually making a difference. We need those statistics in order to get the proper level of investment truly to affect change.

Business Opportunity

There is significant hope for the future from the demonstration projects that have been accomplished, but they certainly are not the mainstream standard of practice yet. Offsite construction and other lean construction techniques potentially have the highest level of benefit. These strategies will allow for parallel construction of major components, application of robotics, pre-testing, safer working conditions, plus a better ability to re-use and recycle raw materials. The concepts are being applied from bridges in Accelerated Bridge Construction (ABC) to mechanical and electrical systems; hospital bathrooms; headwalls; and ceiling plenums. Modularization and off-site construction is also being applied in housing and house renovation for kitchens and bathrooms. Therefore, modular construction and assembly is very much a part of this overall strategy.

There are examples of brilliance of all aspects of the facility and infrastructure business processes, yet no one has brought those together into a complete package that could demonstrate how we could start to connect the dots. Hence, one of our initial efforts would be to begin to bring together the various sectors of the industry who are working to improve their aspect and combine those to see what the total benefit potential could be.

Data-Centric Thinking

A key component of applying these strategies is moving to a data-centric approach. While paper will likely be around for quite a while, the thinking must move away from it as being the outcome. When paper is the outcome and the method used for information transference, significant information is lost as handoffs are made between various players. If the focus is simply shifted to data, then the paper products are spin offs from the data and the data stream continues to accumulate information as time passes. Producing paper products throughout the life cycle does not degrade the information stream. There is currently
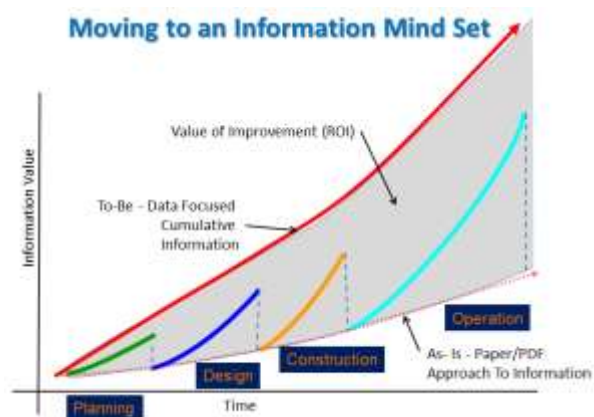
a significant amount of information re-collection in the current approach and in almost all cases that leads to the infusion of error. It is important that the information creators information be incorporated and that metadata is created identifying who entered what data when and what decisions were made by whom. This one action will nearly eliminate or certainly significantly reduce the number and duration of legal claims during and following the completion of a project.

This is a significant waste of another dimension. Further, many have demonstrated that change orders can all but be eliminated by using 3D modeling and BIM because it also fosters a higher level of communication and collaboration, should the contracting tools and technology allow that to occur[9]. So, contracting methods should also be revised to support a data- or information-centric approach. A true end-to-end information technology architecture will be required to tap fully all the potential of the information. The current strategy being applied is business process modeling to improve information flows through the definition of Information Delivery Manuals (IDM) and Model View Definitions (MVD). While they can help document the current information silos, as has been demonstrated in the steel industry, they do not allow for cross -industry connections unless designed for that situation. The Construction Operations Building Information Exchange (COBie) has begun to allow the industry to shift to a life-cycle, data-centric approach prior to having an information architecture, but only for one purpose. It is an appropriate stopgap approach prior to the industry having the resources to correctly product a business enterprise architecture.

Metrics for Management

In order for the country to measure progress and improvement, we must adopt a set of high-level metrics. These should be accumulated from a roll up of detailed metrics. Through improved, effective, efficient, and proven business practices, the facilities and infrastructure industries believe they can cut delivery time by 50 percent, reduce total cost of ownership by 50 percent, total comingled waste by 50 percent, and carbon footprint by 50 percent while increasing the percentage of net zero buildings by 20 percent by 2021. While this will take a herculean effort, we are talking about saving to the facilities and infrastructure industries of a minimum of $800 billion a year. The problem is that that number is broken down into the potential savings from each project, and the owners currently simply want to pocket that amount for themselves, and do not want to make the investment, because the industry has not yet presented itself in such a way as to demonstrate a coordinated effort to improve. Hence, the purpose of the remainder of this paper is to lay out a plan to accomplish this and identify the investment costs needed to accomplish the transformation of the facilities and infrastructure industries.

Shift to a Focus on Metrics

Current - United Kingdom
- Reduce cost by 33%
- Reduce Time by 50%
- Reduce Carbon Footprint by 50%
- Improve AEC Exportability by 50%

Proposed - United States
- Reduce Total Cost of Operation (TCO) by 50%
- Reducing delivery time by 50%
- Reducing the land fill waste and increasing recycling by 50%
- Reducing the carbon footprint by 50%
- Increase percentage of Net Zero Buildings by 20%

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[9] http://www.brikbase.org/sites/default/files/Pages%20from%20jbim_fall10-6.cannistraro.pdf accessed July 1, 2015

Roadmap to the Future

In looking around the world at transformation efforts that are beginning to succeed, one sees the following 10 items as foundational to the true transformation of the facilities and infrastructure industries. In some cases they are being started; in others, work has not yet begun. That being said, change is occurring, but to what level of success we will be able to achieve worldwide, as well as in this country, is still an unknown because we have yet to accurately track progress.

There have been countless efforts in the past that showed promise only to never be truly realized because we did not take into account the deep-seated cultural changes that also needed to occur to allow a strategy and its supporting technology to be fully implemented. In order to effect true change we also need committed leaders with a common vision. We have many competent leaders in the industry today. However, there is currently no common cause that they are all striving to achieve, thus we remain in our silos only able to improve single aspects of the total picture.

Again, I point to the steel industry as an example. They have been using an open standard for some time called CIS/2 and most of the software vendors in that sector had implemented it. They had also worked on identifying the steps required to accomplish their business. This business process mapping had identified several steps where information was output to paper and used as the information exchange to the next party. Once CIS/2 was implemented, the industry realized it would be more effective if they could pass information to parties outside their domain, but the likelihood of converting others to change to CIS/2 was low. As IFC (Industry Foundation Class ISO – 16739) began to mature and be used throughout the industry they felt that moving to that standard would be more effective. In making that move, it also gave them a chance to look at the second generation of their business process and they found they could focus on the data stream and completely eliminate un-necessary steps. In fact, they could go directly from an IFC model of the structural steel to CNC (Computer Numerical Control) commands that drive robotic fabrication tools: Tools that can work 24x7x365 without error. This model is one that every facet of the facilities and infrastructure industries must implement with significant potential. The only thing missing is the overall architecture identifying how all the pieces connect. In order to do that we need these ten capabilities in place:

1. Education transformation

We start with this step, as it is the most important in the long-term transformation of the industries on many levels. It prepares students with the necessary knowledge, skills, and abilities (KSAs) for the work place as well as providing the opportunity to do the research necessary to identify the best paths forward. These research and implementation strategies developed in academia will ensure a sustainable approach to continuous improvement that the facilities and infrastructure industries desperately need. The Academic Interoperability Coalition (AIC) has been looking at how education is transforming over the past nine years. It is a source of great information regarding how this transformation is occurring in schools throughout the world. The AIC is also undertaking an effort to identify the knowledge, skills, and abilities needed to ensure transformation occurs and the students are prepared to enter the workforce as knowledgeable of capabilities as practitioners and the potential leaders of the future. This approach is not the complete solution but more a coordinating effort at this point. For it is still up to the individual schools to develop the curriculum to ensure

students are prepared. In addition, accreditation efforts have a major impact on what and how the schools collectively prepare students. They need to be aware of the AIC effort and use it to adjust future accreditation requirements. The efforts initiated by this group of 40 universities will continue to shape the future practitioners and leaders.

2. buildingSMART International Global BIM Guide Wiki / Research compendium

Today in the facilities and infrastructure industries worldwide there are many efforts under way to support the practitioner and help implement the various technologies around approaches such as BIM. The problem has been that few were aware of all the efforts underway, so when people wanted to develop a new guide for how they were going to implement the technology, they started from a blank page or a document that they might have become aware of from friends in the industry. This approach was terribly limiting and few were aware of work, that in many cases, had

progressed far beyond the limited set of information that owner may have used for their guidelines for implementation. This is true for national efforts such as the National BIM Standard-United States™ as well as guidelines set up for one owner who may or may not have a large portfolio of facilities. The goal is, as more people use an approach, that a consensus can be achieved, and then standards can emerge. As standards emerge, then software vendors can make the decision to implement those standards with less risk to their investment. In any event, this is a slow but necessary process. The Global BIM Guide Wiki

Welcome to the BIM Guides Project

was recently established to identify the work being accomplished around the world and key metadata is being collected for each document in the wiki. This tool will not only help practitioners but also researchers, as it will minimize duplication of effort and move the industry forward more quickly. There is still much work to be accomplished, but it is gaining momentum rapidly and the potential is significant. You can currently access the Global BIM Guide Wiki at this URL:
http://bimguide.vtreem.com/bim/view/main

3. Open Standards

As mentioned in the previous section, the need for standards is fundamental to working collaboratively as each party needs to be aware of what the other is planning. So in the case of transforming the facilities and infrastructure industry these standards are paramount to success. A standard indicates that most practitioners are using a similar approach. Anyone can develop a "standard" and many have to include software vendors who have tried to use standards to lock one into using their products. In a collaborative life cycle wide approach, there is simply no one vendor that does it all, so we must be interoperable across the industry and therefore adopt open standards. Standards should be generated by a group of experts and then consensus gained by continually expanding the circle of users. They may also come into being as "ad hoc" standards that

have come from practice already in place used by a majority of practitioners, as was the basis of the United States National CAD Standard™. However, sometimes this approach may favor one vendor and adjustments will need to be made to ensure usability by all software tools before it becomes truly open and widely used.

The ideal situation would be international standards (ISO) that all can agree to, allowing software companies to confidently invest the necessary resources to support the broadest set of users. If there are many "standards," then less will be available to be invested because the market is more fragmented and more alternatives must be accommodated. In addition, there will be less confidence in making the investment and the process of transformation will be slowed. A list of the current guidelines and standards is available from the author, indicating that there are already over 30 ISO standards developed, however, not all have a broad sector of the industry following them yet. A link to this document can be found here: https://www.dropbox.com/s/jygdgv4lk95f1mk/Compendium%20of%20BIM%20Related%20Standards%20and%20Guidelines%20V1-2.xlsx?dl=0

4. IT architecture

An information architecture is a commonly used Information Technology (IT) approach to defining complex relationships of data and systems to support that data. The complete architecture includes some of the things we are already doing; however, we are not yet really looking at the holistic view of the industry on all fronts. For example, one aspect is in fact a data dictionary, and as you will see below that effort is underway, although the content is not yet being populated on a broad scale in the United States. However, one aspect of the architecture, an activity node tree, was initiated several years ago, but no further work has been done, since the initial version.

An IT architecture is comprised of many parts and there are many approaches to generating an IT architecture. The classic approach first creates an overall "as-is" business process model indicating a baseline of where things stand today. Since we do not really have an existing concept this step would likely not be of value. Therefore, the "to-be" model should really be the focus of our efforts. IDM's and MVD's are being used to look at parts of the industry, but we do not yet have the needed high-level vision of the industries. We do not yet know how we conceive of information flowing and all the parties participating in the facilities and infrastructure industries. Again, we can look at COBie, as it is a microcosm of this vision for information supporting facility managers.

The current issue is that all information is not seen as important to the process, and a focus is being put on only the information needed for the aspects of facility management being implemented. This may need to go through several iterations before all can agree on who does what and when. The architecture can be set up in "swim lanes" identifying the interaction of several major threads of information throughout the facilities and infrastructure industry. The complete information architecture will be a very complex diagram, which will need complex tools to build. The Department of Defense (DoD) built a successful business enterprise architecture and it cost over $1B

to develop. The facilities and infrastructure industries are arguably even more complex than the DoD architecture[10].

5. buildingSMART International Data Dictionary

Not only do we need to understand the relationships between items in a model and define each term and how it is used by each practitioner throughout the facility life cycle, but we also need to understand the interrelationships. This current stand-alone effort is on target for supporting the IT architecture in the future, and in fact is a basis for the synonyms used for various building products, such as "CMU", "concrete masonry unit" or "concrete block". It also provides the basis for translations to other languages and dialects, such as an "elevator" in the United States is called a "lift" in the UK. While many countries have made a significant investment in developing content for the Data Dictionary, the United States has not yet taken that step[11].

6. Defining Business Processes

While this is a very important part of the whole picture, and defining and re-defining business process is how we will progress, having the previous items in place is likely just as important, if not more so. While aspects of your business process may be proprietary, we do need to, as an industry, agree on how the large blocks fit together and what information they should exchange. The handover of information is a key aspect of an information of architecture, as mentioned before so is the metadata. It may be that you are simply handing over data and you may not have interacted with it during your part of the business process. As could be expected the IT industry has put together their overall model and issued it as an ISO standard. This does not preclude people taking certain sections out and adjusting them for their own needs as long as you receive the inputs and output the outputs as they have been defined. This way you can protect your intellectual property while still participating in the overall flow of information throughout the industry[12].

7. Common Guidelines Based on the Global BIM Guide Wiki

There are two independent uses for the Global BIM Guide Wiki, this is the second and deserving of its own section. The entire facilities and infrastructure industries around the world are all undertaking efforts to develop guides for their organizations in delivering projects using BIM, especially ones with significant portfolios. Currently this is causing significant chaos. Many owners perceive themselves as needing their own "version" of information. I saw this phenomenon in the accounting industry years ago. Many businesses developed their own accounting software or modified existing packages at significant expense. In the end, businesses realized that all they really needed was to do their accounting in a standard way that could be audited and so they could pay their taxes and know how much profit they were making. While many have diverse needs, we also need to have some commonality so that standards can be formed and software be developed to do

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[10] http://dcmo.defense.gov/products-and-services/business-enterprise-architecture/ accessed July 1, 2015
[11] http://www.buildingsmart.org/wp-content/uploads/2014/10/April-2014-New-Version-of-Data-Dictionary-Launched.pdf accessed July 1, 2015

[12] https://en.wikipedia.org/wiki/ITIL accessed July 1, 2015

the repetitive work to free humans up to do the creative work. Information for the most part is fact. How many doors are in the building, and once a door is defined, it can be counted. Once defined, it should be counted the same way so that everyone comes up with the same answer. When is a door not a door also needs to be defined. The Global BIM Guide Wiki will be a repository where all can come to as a starting point to create their guidelines. Over time there should be an effort made to identify what are good guidelines and which ones have not worked so well for the owners who implemented them. While we may never have best practices, preferred practices should emerge so that we can develop something similar to the Information Technology Infrastructure Library (ITIL) in the IT industry. Sadly, this may sound like blasphemy to some, but it must be the rule for us to achieve success.

8. Global Product Library

Common information about manufactured products is another one of the major building blocks for collaboration and to making BIM and VDCO work well. One should not need to enter data about products that come from manufacturers. It should be supplied by the manufacturer. In addition, one should be able to use common data elements to select a product to meet your needs. While we do this with many products today, this capability has not yet come to the facilities and infrastructure industry in a comprehensive way. The United Kingdom, is taking a leadership role currently, but some say that the information being provided is slightly software vendor specific, which is not a good thing.

The information must be free of any bias. In advertising, it is common for a supplier to highlight some facets of their product that sets them above others, while minimizing those aspects where it may not be competitive. The designer and contractor, however, simply need the facts to provide the best all-around product to the owner, and make those value decisions for the owner in selecting the product. One approach may be to let the user community comment on the suitability of a product. How often do you read the customer reviews on a product on-line before you buy? Those comments can make or break a purchase decision. The United States has not yet initiated an open product library, while some are in place for specific vendor software. It is hoped either these will become open, or a service will step up to make that product information open for all to use.

9. R & D to Ensure Sustainable Outcome

We rely largely on academia to select thesis topics for the research in the facilities and infrastructure industries. There are a few notable exceptions, such as the Pankow Foundation in California who funded some projects at Penn State and Georgia Tech, as well as the Federal Highways Administration (FWHA), which funds a project on Bridge Information Modeling (BrIM). In any event, funding is dismal for an industry that makes up 5-10% of the GDP. We clearly need a more coordinated and a better resourced R&D effort for the facilities and Infrastructure industry.

10. Next Generation Software Linking All Spatial Aspects

In the end, I believe that a next generation set of tools will be required to merge the artificial divide between the facility and geospatial worlds. This divide occurred because computer technology was not powerful enough to deal with the breadth of the spatial issues. That new software also needs to

focus on total cost of ownership so that true sustainable decisions can be made. Currently there are a number of software sectors at work approaching problems more holistically. It is important to note that there is not only the division between GIS and BIM, but also between two parallel BIM efforts, one for facilities and the other for the industrial industries who are more focused on total cost of ownership. This split is seen in the groups who use ISO 16739 (IFC) and ISO 15926 (iRING). Once all four of these sectors come together, will the software vendors understand the scope of the true market and be willing to invest in one effort for the spatial industries of facilities and infrastructure. This is a question yet to be answered.

A Vision to Focus the Industry

The National Institute of building Sciences under the volunteer leadership of Chris Moor put together a vision document that should be a guiding light for our efforts[13]. Chris solicited articles from 33 of the industry thought leaders and the Institute contributed Stephanie Stubbs, a talented writer to pull all of those articles into a single story of what life should be like in 2021 for the facilities industry. This effort identified some 20 strategies, technologies, and approaches that need to come together to frame our world in now six years from now. We will only be able to achieve this vision for ourselves if we galvanize into action immediately. If not, in 2021 we will still be doing business pretty much as we always have, with the rest of the world passing us by. The 20 concepts outlined in the story with some editorial comment are:

1. **Owner Led BIM** – Owner currently only occasionally aware of BIM
2. **Architect's Role** – Embracing BIM primarily as a marketing tool
3. **Procurement Process** – Design-Bid-Build does not support transformation
4. **Insurance** – Not taking advantage of metadata currently
5. **Value of Information** – Information currently only seen as having minimal value
6. **Open Standards** – Not fully appreciated or embraced
7. **Interoperability of Data** – Data re-collected at each stage, lack of trust mechanisms
8. **Additional Design Services** – Currently focused on delivery of facility
9. **Monitoring the Model** – Model not seen as a true representation of the facility
10. **Handovers** – Information re-collected at each phase, no metadata
11. **Intellectual Property** – Used as a reason for not sharing due to lack of metadata
12. **Code Checking** – Not currently possible due to lack of rule sets
13. **Integrating Lean Strategies** – Few organizations using properly
14. **High Performance Workforce** – Trained workforce is severely unprepared
15. **Product Information** – Not yet available

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[13] http://www.nationalbimstandard.org/vision2021 accessed July 1, 2015

16. **Off-Site Fabrication** – Only occasionally used
17. **Tablets and Mobile Computing** – Beginning to be implemented
18. **Use of Drones During Construction** – Rarely used, but gaining potential
19. **Asset Tagging** – Not integrated into building process
20. **Sensors** – Not integrated into business processes

As you can see, there are many more issues to take on beyond the 10 identified earlier, but those 10 will position us to take on these remaining issues. We also need to identify a baseline for each, identify the desired future position, and track metrics as to the progress made on each. These metrics need to roll up to those high-level metrics mentioned earlier.

Action Plan

The approach to attacking this problem will first be to organize a series of industry wide workshops to define the issues to be attacked related to profoundly reducing waste, significantly improving productivity, reducing total cost of ownership, and creating a sustainable environment for continuous future improvement. These self-funded workshops will identify a baseline from which we start and set realistic goals for the industry to achieve. These goals must be in accord with global goals, as it would be ineffective for us to set goals that were below future goals of other countries as the negative impact on the United States would remain. We must lead not follow. Hence, our goals need to be slightly higher in order to elevate the desired global outcome. Once the goals have been set, we must develop plans to achieve those goals. These plans need to be segmented so that improvement can be demonstrated on an annual or shorter basis to encourage continuous investment. Metrics therefore need to be in place to measure true progress; it will not be to our advantage to game the results, as it will only be to our country's detriment.

If adequate progress is not being made, then collectively the organization must impose a correction to the plan so that it will produce the desired result in a timely manner. The plans need to be set up for investors to support issues that are important to their needs. Any items not receiving initial investment funding will need to be redefined with the help of investors so they will be attractive investments as it is likely that all facets need to be accomplished in order for the complete solution to be realized. In all likelihood, some sectors will complete their goals ahead of schedule, if so they should not stop, but move into a sustainable continuous improvement mode and develop plans to encourage long term investment. This is expected to be a private-public effort in which local, state, and federal investments are made. In all cases, the return on those investments will encourage long-term sustainment and a continually improving industrial success.

Conclusion

The intent of this white paper is to outline the issues related to the fragmentation of the facilities and infrastructure industries and identify the full scope of opportunity that exists to improve profoundly one of the major aspects of the world's economy by encouraging immediate investment in many of the

efforts already planned. The investment needed is in the billions of dollars, but the return on that investment is far more rewarding. When the Chinese can demonstrate to the world that a high-performance 57-story building can be completed in 19 days (completing 3 stories a day), one would say that is an indication there is a lot of room for improvement over the 500 days it typically takes other facilities to be built. I am certainly not saying our goal should be three stories a day for every building, but there is a lot of room for opportunity to improve between 19 and 500 days.

What the United States must to do is to organize a group to take on this challenge. There is a lot of good work being done in many current associations and we simply need the leadership to work together to stand up a focused effort to take on this task. This organizational structure does not currently exist, although one organization could certainly take on the role of bringing the others together to accomplish the goals outlines. Failure to do this is simply not an option if we expect to have a facilities and infrastructure industry in the future. At a minimum, other countries that are currently transforming, largely through government mandate, will be positioned legitimately to win the bids to design and construct our facilities and infrastructure in the future. The other end of the spectrum is that we deplete sources of raw materials and water and the planet goes into far deeper chaos with little chance for recovery, as the issues then will truly be out of control.

The future is in your hands; please make the correct decision to take on this challenge as a coordinated facilities and infrastructure industry.

About the Author:

Dana Kennish "Deke" Smith, FAIA is co-author of **Building Information Modeling: A Strategic Implementation Guide for Architects, Engineers, Constructors, and Real Estate Asset Managers (**Hardcover – April 13, 2009), and has been a thought leader in the facilities and infrastructure industry for over 30 years. After retiring from the Department of Defense in 2006, he served as Executive Director of the buildingSMART alliance and on the buildingSMART International Executive Committee until January of 2015, when he took leave to explore solutions to the larger issues affecting the facilities and infrastructure industry.