FM TECHNOLOGY UPDATE

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This publication is sponsored by the Planon (www.planon-fm.com) and Serco (www.serco-na.com/efaim) corporations.

INTRODUCTION

The **FM Technology Update** white paper is a research product of the IFMA Foundation. The purpose of the Foundation is to expand knowledge of the built environment in a changing world through scholarships, education and research (see **www.ifmafoundation.org**).

Each year, the Foundation conducts a global survey of its constituents asking them to rank research topics of interest. This year's survey indicated that there was an extremely high level of interest in a publication related to FM technology for facility managers who are *not* professionally trained in the field of information technology. This white paper was produced as a result of the survey.

The **FM Technology Update** contains ten chapters, each written by a facility manager who has had extensive experience in the subject matter being discussed. Each chapter is, for the most part, divided into four sections:

1. Basic Technology: history and primer of basic concepts associated with the technology being discussed;
2. Current Use of Technology: how facility managers are currently using the technology for FM applications;
3. Future Use of Technology: how the technology is evolving and how it will impact the practice of facility management in the near-term future.
4. Case Studies: specific examples of how the technology was implemented and the effect of the technology being discussed on the organization.

Additionally, most of the chapters contain two appendices: one containing a glossary of relevant terms associated with the technology being discussed and the second a list of articles and internet references.

The technologies discussed in the white paper tend to be "cutting edge" technologies – that is, they represent technologies that are just beginning to impact facility management. Even for the more traditional technologies (e.g., CAFM), the focus of the chapter is on how the technology is evolving and how this evolution will impact FM in the near-term future.

Topics included in FM Technology Update include the following:

- Building Information Modeling (BIM)
- Building Automation/Control Systems
- CAFM
- Condition Assessment/Life Cycle Analysis
- Workflow
- Geographic Information Systems (GIS)
- Sustainability
- Telecommunications/Networks
- Security, Emergency Preparedness, Mobile Communications
- Radio Frequency Identification (RFID) in Asset Management

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CHAPTER ABSTRACTS

Chapter 1: Building Information Modeling and Facility Management

Louise Sabol

Building Information Modeling (BIM) is a relatively new technology that has mostly been used for architectural, engineering and construction (AEC) applications. BIM technology involves the creation of a complete 3D digital representation of a building system (or building component) that efficiently incorporates, in its database, a wealth of information associated with the building model. What is significant about the technology, beyond being a simple drawing and documentation tool, is its ability to enable interdisciplinary collaboration throughout the life cycle of a building, the capability to easily manage change and the ability to easily transport information about the building from one life-cycle phase to the next.

In BIM models, building elements exist as virtual simulations of that component. For example, a wall object contains attributes of that wall and might contain data about the types and quantities of materials of that wall. The objects are put together to create the total model of the building. Thus, as a building moves through the life cycle from planning to design to construction to facility management, the information attached to the building components provides an integrated database of relevant information that can be used by stakeholders. By the time the BIM model reaches the facility manager, there will probably be significant amounts of data about the spaces, construction materials, assets, and so forth that are of value to FM applications. In such a data-rich environment, BIM has the capacity to significantly reduce costs and promote efficiencies. It does this, in the words of the author, because:

- It accelerates the processes so that decisions and changes can be made early with a reduced impact to time and costs.
- The accuracy of the model, and its ability to communicate effectively to the diverse parties involved in building projects and management, reduces miscommunication and reinforces understanding visually.
- Quantities and data can be automatically generated by the model, producing estimates and workflows much more quickly than conventional processes.
- Data delivered at project turnover is more complete, more structured.

BIM promises to fundamentally change how building data is stored and manipulated in a computer. It represents a single digital repository of all building components that provide a fully integrated 3D model whereby a change in one view is reflected in all views. The integrated data repository of geometry and building attributes enables building documentation that is currently unavailable in current CAFM and IWMS systems. For example, BIM space components can be supplemented to track information such as room numbers, area calculations, and occupant censuses. Equipment objects can record manufacturer, room location, equipment specifications, reference URLs, among many other attributes. Thus far, BIM has been successfully used by the A/E/C professions. It is only a matter of time before facility managers will insist on the use of BIM technology for FM data creation, analysis and management. Finally, the author presents a case study of BIM use for FM applications at the Sydney Opera House.

Chapter 2: Building Automation and Control Systems

Terry Hoffmann

Facility managers rely on automated systems for monitoring and control of buildings they manage. The author, in this chapter, describes the evolution of BAS systems as energy management and control systems, their current use in FM, how they are evolving and presents a case study of a Florida university.

Background

The History of automated BAS systems coincided with the first great energy crisis and the recognition that well-established electrical and electronic control systems could be improved with emerging digital technology. Control systems typically involved a myriad of wires that snaked back to a central console and did not lend themselves to energy management as we know it today. Systems that used computer programming to select loads for starting and stopping (called Energy Management and Control Systems) was a major step toward reducing commercial energy bills. In the 1970s, these systems were installed in large commercial spaces and resulted in reduced electrical consumption and used process control computers and proprietary operating systems. Later in the decade, they migrated toward the use of mini-computers. The 1980s, according to Hoffman, "ushered a major change in the method of controlling a building's mechanical and electrical systems. It marked the beginning of the Direct Digital Control (DDC) revolution." DDC technology required less maintenance and were easier to fine-tune than previous counterparts. Additional benefits of CCD technology include more flexibility to have multiple inputs from lighting systems, electrical switchgear, or monitoring fire and security devices. Energy Management and Control Systems evolved into BAS which became the popular descriptor. In the 1990's, improvements related to increased integration of multiple systems into a central workstation, along with the emergence of user programming languages. The 1990s, according to the author, were also notable for two new BAS concepts: first, the concept of *connectivity* (i.e., having systems and devices from one vendor be accessible from a workstation provided by another vendor) and; secondly, the concept of *open protocols* as a method for systems and devices to be interoperable. By this time, mini-computers were completely abandoned as platforms for building automation systems. Widespread connectivity was made possible but proprietary gateways enable integration still existing. The solution, according to Hoffman, was "for the BAS supplier to open its field protocol and make it available for others to develop communication options." The result of this interoperability effort resulted in the BACnet (developed by ASHRAE) and LonTalk (developed by Echelon) protocols. Finally, the 1990s saw the emergence of web browsers for accessing data. With the 21st century came the use of open protocols and the use of the IP (internet protocol) networks as the common communication standard across business enterprises (called convergence). Open protocols enabled, for example real-time energy usage data available to an enterprise accounting system where it might be integrated with information from the manufacturing and human resource systems in order to calculate the true cost of operating the company on a day-to-day basis.

Current BAS Functionality

Hoffman summarizes BAS today as follows: "Building Automation Systems use current technology to provide safety for both occupants and assets. They contribute to the productivity of the enterprise by conserving energy and optimizing the efficiency of equipment throughout facilities and the people who are responsible for operating and maintaining them. They provide a foundation for sustainable programs and projects by providing the accurate and secure data required for decision making and verification." However, although this represents the current state of BAS, most buildings still maintain older standalone systems from multiple vendors. This in turn results in extreme energy inefficiencies. Hoffman states a statistic that is very disquieting: "we spend over $14 billion per year powering data centers, yet only 30% of that energy ever touches a computer. Lighting, cooling and support for auxiliary devices, including plug loads, comprise the other 70%." Energy efficiency and sustainability are not, unfortunately, the only drivers. Designers of BAS must also deal with complex factors related to: reliability, compatibility, mobility, connectivity, scalability, security, interoperability, flexibility, usability and maintainability. Hoffman then explores what he believes the technologies that have the greatest impact on these factors:

- Harmonized standards
- Wireless technology
- IP based control

Future BAS Technology

Installed BAS systems will receive the greatest benefit from enterprise applications associated with energy optimization, asset allocation, resource planning, sustainability application and dashboards. These applications will require new network infrastructures that can take advantage of state-of-the-art software and hardware technologies including semantic technologies, augmented reality, context aware control. And ubiquitioius access (all explained in the chapter). What is the BAS system of the future going to look like? The author responds that it "is likely to be comprised of very intelligent nodes that are capable of making informed decisions on their own. But they will also know when it is necessary to ask for help from other devices on the local network – or escalate the search to the enterprise or Web level as the situation requires."

Chapter 3: CAFM/IWMS: Balancing Technology, Processes and Objectives

Chris Keller

FM Automation (CAFM/IWMS) is primarily viewed as an FM department tool that supports FM operations. The facility can be a key tool for the leadership of an organization to use to achieve its goals. Proper selection and implementation of these tools is critical in determining the current and future value these tools and the FM department has to the organization as a whole.

Most IT projects fail. They fail primarily through a misalignment of the project objectives and the project solution. FM Automation tools facilitate processes which deliver FM departmental objectives in support of an organization's mission. Integrating organizational objectives and the value provided by achieving the objectives with the selection and implementation process can insure the FM department's successful support of these objectives.

Facility managers need to adjust the technology tools and processes well in advance of a problem's visibility in order to successfully address the new requirements for their customers.

Proactively preparing the facility to address its inhabitants future needs requires analyzing trends in facility management, business and technology.

New and future technology will facilitate the daunting task of achieving organizational objectives and more easily convey to leadership the value of FM to the organization.

Chapter 4: Condition Assessment / Life Cycle Analysis

James B. Clayton, PE

Condition Assessment / Life Cycle Analysis is a process that determines the physical condition and fitness for use of buildings as well as the investments required for major repairs and replacement of building systems and components. The author describes this process as involving three steps:

1. Collect and maintain data about the buildings, their systems, and their components;
2. Use the data to compute metrics and drive mathematical formulas;
3. Apply the metrics and formula results to a variety of organization-specific purposes such as condition reporting, budgeting, fund allocating, project selection, and tracking.

Clayton classifies the many techniques used to deploy this process into three categories: the Traditional Method; Shortcuts to the Traditional Method; and the Engineering Method. The Traditional Method collects "deficiency" and remaining life data, which special software converts to condition indexes, backlogs of deferred maintenance, prioritized project lists, and funding plans. Inspectors create "deficiency" data by touring buildings, observing defects, and recording opinions of required corrective actions, costs and urgencies. They also "guestimate" remaining useful life of building components based on published average useful life data.

Shortcuts to the Traditional Method seek to cut the cost of the Traditional Method. They include the simple reduction of the frequency of building inspections, the inspection of statistical samples of systems rather than entire buildings, varying inspection frequency of buildings systems by age or mission criticality, and the employment of statistical or parametric models.

The Engineered Method, developed by the U.S. Army Engineering Research and Development Center, seeks to both cut the cost and improve credibility of the basic process. It is built around the collection and processing of "distress" data, which inspectors create by surveying pre-targeted systems, observing defects, and selecting attribute descriptors from pre-established lists. Inspectors neither record opinions of required corrective actions, costs or urgencies, nor "guestimate" remaining useful life of building components. Instead, special software uses the "distress" data to perform these functions, as well as to calculate condition indexes, backlogs, prioritized project lists, and funding plans.

Clayton compares costs and features of the three alternative deployment categories and presents a case study associated with the Engineered Method. He also makes suggestions on how to decide which alternative is best for an organization, and offers lessons learned in making that choice.

Chapter 5: Radio Frequency Identification (RFID)

Geoff Williams

Radio frequency identification, or RFID, is a new technology that is just beginning to be adopted by facility managers. RFID uses radio waves to automate the identification of objects (e.g., assets, people). This is accomplished by storing data about the object within a microchip (called an RFID tag) which is attached to an antenna. The tag is able to transmit the data using radio frequencies back to a reader which converts the radio waves back into digital information. These tags are very inexpensive and offer a host of potential applications for the FM.

RFID vs. Barcoding

Barcoding is currently used extensively for the tracking of furniture and equipment. In the past, the asset management of a facility relied heavily on bar-coding systems for tracking a site's furniture and equipment. RFID differ from barcoding in a number of ways:

- Barcode readers require a direct line of sight to the printed barcode while RFID readers do not. In fact, RFID tags can be read at much greater distances of up to 300 feet
- RFID readers can rapidly read up to forty or more tags per second. Reading barcodes is much more time-consuming due to the fact that a direct line of sight is required;
- RFID tags tend to be more rugged than barcodes since barcodes must be exposed. The RFID tag is either protected by a plastic cover or embedded within the product itself.
- Barcodes have no read/write capability whereas RFID tags can communicated with the reader which can in turn alter the tag itself. This is particularly significant if the tag has a sensor that sends data to the reader which, in turn, will alter the tag data based on the sensor reading.

RFID and Facility Management

Given the technology and characteristics of RFID technology, Williams discusses a number of FM applications that lend themselves to this technology. These include:

- Asset tagging for anti-theft. Organizations can embed tags in assets above a certain dollar threshold that can trigger an alarm if the asset changes location;
- Asset tagging for asset management. Tracking assets (FF+E for example) can be done automatically and update asset management software systems such as those found in CAFM and IWMS.
- RFID tags for personal management. This application has privacy implications but RFID tags on people will locate them automatically in terms of emergency.
- RFID tags for security management. Tags can be used as a key to access a building or certain spaces within a building.
- Building Automation System applications. When deployed with a sensor, RFID tags can record, for example, temperature, movement and radiation. Such data can be used to control real time systems or trigger work orders for a Computerized Maintenance Management Systems (CMMS).

Chapter 6: Roles of GIS in FM

William P. Witts, Jr.

Geographic Information Systems (GIS) is software for analyzing geospatial information (i.e., point, line, areas) tied to a global coordinate system. Because of this, GIS can perform certain types of analysis that cannot be done with traditional CAFM systems. Traditionally GIS has not been used for FM applications. Rather, it has been used for applications such as land analysis, utility distributions, asset management and so forth.

Witts uses GIS technology for analyzing spatial components of a building such as floor plans, building information and utility structures. GIS can analyze vector, raster and tabular data and each has a role for FM applications. For example, vector data can perform traditional CAD analysis; raster data can analyze a building in the context of the other buildings using a vast array of existing geospatial databases; tabular data can store attributes associated with vector or raster data or exist outside of a spatial reference.

This chapter describes and illustrates both traditional FM applications as well as applications that traditionally fall outside the scope of CAFM or IWMS software. For example, location maps can depict the closest exit of a fire hydrant to a building; density maps might display population densities on a campus at different times of the day; change detection maps can show how a facility has changed over several years. Finally, Witts presents a case study of how GIS is deployed at MIT for FM applications - both inside and outside of a building.

Chapter 7: Security, Emergency Preparedness and Mobile Communications

Julie Knudson

The fields of mobile communication, security and emergency preparedness have recently evolved and combined because of factors such as new and low cost technology, increasing security threats and an increasingly mobile workforce. Ms. Knudson, in this chapter, talks about these fields and the extreme interdependence that currently exists between them. For example, the increasingly mobile workforce has forced a shift in thinking about how services are provided and how information is shared between disparate elements of the workforce. IT departments are expected to provide secure access to data both for both onsite and offsite workers. Increasing workplace violence likewise has impacted mobile communications and emergency preparedness and continuity of operations (COOP) planning.

Mobile Communications

Facilities managers are increasingly leveraging mobile communication technology to remotely monitor systems, to alert specific staff of danger, to notify appropriate personnel and to capture event information (e.g., video footage and card access logs).

Security Technology

Security technology pervades all aspects of facility management and might include basic caller ID on phones and personal “duress alarms” to more exotic biometric access control systems.

Access control systems with identity management have increasingly replaced conventional door key locks. Newer CCTV systems are capable of evaluating situations and automatically generate reactions based on those situations.

Emergency Preparedness

Events such as the 9/11 terrorist attacks have led to numerous FM procedures associated with emergency preparedness and COOP activities. Directly associated with this is the development of mass notification systems that rely on mobile phone, pagers, computers and a variety of personal communication devices.

Because of the newness of these emerging technologies and applications, the author describes many of the "growing pains" associated with these areas. The lack of interoperability between systems, the difficulty of sharing disparate data between various systems and users, the cost of wide deployment of such systems, the training and preparation involved all contribute to such growing pains. At a 2007 IFMA conference, for example, a study revealed that "13% of respondents indicated they did not have emergency evacuation procedures in place, and only 26.5% of respondents said they conducted communication drills. In addition, 44.4% said they didn't conduct total drills of any kind with notification." Finally, the author discusses how security, emergency preparedness and mobile technology are evolving and how this evolution will impact the practice of facility management.

Chapter 8: Sustainability

Louise A. Sabol

The author contends that "sustainability's focus is to improve the stewardship of our resources for the future - a goal consistent with effective facility management." The current state of such stewardship is somewhat daunting: building operation accounts for approximately 40% of U.S. energy use, and this number increases to an estimated 48% when energy required to make building materials and construct new buildings is included. Moreover, the actual operation of buildings account for an additional 38% of the U.S.'s carbon dioxide emissions and over 12% of its water consumption. Energy management is particularly important to facility managers since it contributes about 30% of a typical office building's expenses. It is also the place where significant improvements can be made. The U.S. Green Building Council, for example, estimates that commercial office buildings use 20% more energy on average than necessary.

Measuring Sustainability in the Built Environment

There exist multiple standards for measuring sustainability today (e.g., LEED EB, Green Globes, Energy Star). The Leadership in Energy and Environmental Design (LEED) green building rating system, developed by the U.S. Green Building Council (USGBC) is rapidly becoming the de facto standard. The LEED-EB rating system evaluates a building in five areas: Sustainable Sites, Water Efficiency, Energy & Atmosphere, Materials & Resources, and Indoor Environmental Quality.

Technologies Supporting Sustainable Facilities

Software technology is just beginning to be applied to sustainability in the built environment. The author identifies Building Information Modeling (BIM) as one of the more promising areas for energy management (see chapter 1). BIM is a three dimensional model that facilitates the analyzing of building designs for sustainability requirements. Many standalone energy and sustainable design applications (e.g., Energy-10, eQuest, ENERGY PLUS (DOE), DOE-2.1E and BLAST) have the ability to evaluate energy usage. BIM vendors are incorporating capabilities for their software to exchange data with these programs, as well as with other more vendor-specific programs for energy analyses.

Technologies that track and manage sustainability for facilities are in the early and evolving state of development. CAFM, CMMS, and most recently, IWMS (Integrated Workplace Management Systems) are currently being enhanced to include tools for managing and tracking sustainability-related operations and assets. For instance, Tririga - a leading IWMS vendor, has enhanced their IWMS offerings with a module - *TREES* (Tririga Real Estate Environmental Sustainability) to manage a range of sustainability data. Finally, the author identifies other promising areas for sustainability technology including building performance and monitoring (Building Automation Systems) and building commissioning.

Chapter 9: Information and Communications Technology (ICT)

Richard Hodges

Hodges chapter describes how the accelerating rate of innovation in Information and Communications Technology (ICT) is shaping life in the 21st Century, and the effect those changes will have on the design and use of commercial buildings. He identifies four major technology trends:

1. Ubiquity,
2. Mobility,
3. Personalization, and
4. Virtualization

For each of these trends, the author analyzes the behavioral effects of those trends, and argues that Facilities Management professionals must understand and plan for operating in a world of technology-driven change. As an example of the kind of adaptation that will be necessary, the chapter includes a review of wired and wireless communications infrastructure technologies and presents ideas for new “future-proofed” designs that reduce both cost and eco-footprint of ICT infrastructure. The chapter concludes with case studies that provide real-work examples of the new design approaches in various types of buildings.

Chapter 10: Workflow Technology

Paul Head

Workflow technology moves business forward by supporting enterprise requirements for transactional and human-centric processes. The facilities management organization can leverage the extended enterprise to propel knowledge into motion. Evolving from imaging and transactional processes, workflow technologies have come a long way to support the more human-centric business requirements to positively affect every employee, manager, supplier and customer. Standards developed by the Workflow Management Coalition (WfMC) have helped establish an effective framework to support a common software development and communication method between diverse technologies that require workflow to drive their requirements. Documentation standards such as Business Process Modeling Notation (BPMN) benefit the organizations leveraging workflow and ensuring a common way for business process consultants to document the business requirements and technology consultants to implement the requirements.

As a facility management professional, it is important to understand the basics of workflow and the significance of how it can influence your daily life. Through a better understanding of the types of workflow and areas that can be effectively controlled by workflow solutions, you can leverage your expertise and current FM technologies into a series of repeatable best practices. In a period of uncertainty and an ever changing workforce, workflow technology can ensure a faster ramp up for new employees, reinforce standard operating procedures for existing employees and support regulatory reporting for compliance. As with any benefit, to maximize your investment requires the necessary time to capture effective processes and correct broken processes to provide the highest yield. Whether you are interacting with multiple organizations to complete a task, monitoring systems to ensure maximum up time, or interacting with internal groups to communicate change, workflow technologies support the facility manager to execute their strategic mission through the leveraged use of the extended enterprise.

AUTHOR BIOS

James B. Clayton, PE

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Jim Clayton is a Registered Professional Engineer, holds an MSEE from the University of Michigan, and has worked 44 years as a facilities engineer, plant operations manager, business executive, government official, and private consultant to public agencies and commercial owners.

In 1984, following a distinguished career in the Navy Civil Engineer Corps, he joined Kaiser Engineers, Inc. as Operations Manager for the firm's Northern Virginia office. Later, he served as Vice President of two other engineering & management consultant firms, and subsequently founded UNITY, Inc. where he was President from 1996 - 2007.

Mr. Clayton is a pioneer in facility asset management and has testified before the U.S. Congress on facility condition assessment, maintenance policies and repair budgets. He set up the not-for-profit Center for Facility Repair Programs to advocate among building owners and facility managers the benefits of science-based planning and budgeting processes; to create related educational programs and unbiased technical information; and to monitor issues affecting the industry.

Paul B. Head II

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Paul Head is the director of the Business Transformation practice under the Professional Services Business Unit for Serco Inc., a unit of one of the world's leading service companies. His Business Transformation (BT) practice focuses on providing clients in depth analysis and tailored solutions to complex business transformation issues. Serco consultants serve governmental agencies and fortune 1000 companies transforming existing operations to meet the current business requirements as well as helping shape new organizations in evolving market spaces. Through careful mapping of organizational functions and roles BT consultants are able to provide real time solutions to the distribution of intellectual and physical capital. By utilizing a holistic operational assessment, Paul and his team bring together all of the aspects of the organizations assets and business processes.

With over eighteen years of experience serving clients in the healthcare, oil & gas, manufacturing, chemical, civilian and defense sectors, Paul is a highly sought after process management professional with Lean Six Sigma expertise.

Paul holds an undergraduate degree in Architecture and Environmental Design from Ball State University.

Richard Hodges

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Richard Hodges is the Founder and CEO of GreenIT. He has 25 years of experience in the technology industry and as a consultant. Since the early 1970's he has had a personal commitment to environmental responsibility, development of appropriate technologies, and the evolution to a sustainable built environment.

Mr. Hodges established GreenIT as the first consultancy to develop a systematic, strategic, and systemic approach to sustainability for Information and Communications Technology Systems. GreenIT was the first in the sub-specialty of consulting with organizations on ways to save money and energy in their IT departments.

As a firm, GreenIT is committed to leadership in collecting and creating clear, unbiased information about sustainability solutions for IT; creating practical programs that organizations can implement to achieve measurable results; and communicating as broadly as possible the liabilities and benefits of IT in building a more sustainable future.

Terry W. Hoffmann

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A native of Milwaukee, Wisconsin, Terry holds a Bachelor of Science degree in Electrical Engineering from Marquette University and a Master of Science degree in Engineering Management from the Milwaukee School of Engineering where he currently serves as an adjunct professor in the evening division at the Raider School of Business.

In his 35 year tenure with Johnson Controls, Terry has spoken extensively at numerous conferences and industry events. He represents the company on both marketing and technical committees. He has written numerous articles for various industry trade publications including *the ASHRAE Journal, Today's Facility Manager, the Refrigeration Systems Engineering and Service (RSES) Journal, Heating Piping and Air Conditioning (HPAC), Engineered Systems, Buildings Magazine and Automated Buildings.* His white papers on building automation, control and IT convergence have been published and distributed on the Web.

Chris Keller

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After earning a Bachelor of Arts degree from Wesleyan University and a Masters of Architecture degree from the Graduate School of Architecture and Urban Planning at UCLA, Chris Keller began his professional career as an architect. Chris' passion for architecture and computers led him into the world of FM Automation.

Chris has been implementing FM Automation systems since 1988 across many industries including education, finance, insurance, pharmaceutical, government, healthcare, utilities, manufacturing, aerospace and defense. In 1993, Chris formed Integrated Data Solutions and merged his company with Facilities Solutions Group in 2006. As Managing Director of FSG, he continues to provide FM process and automation services to commercial, institutional, and government organizations.

Since 1996 Chris has been an active member of IFMA and has served as an officer of the Information Technology Council from the year 2000 to the present. He was President of the Council from the year 2005 to 2007 and currently stays active as a Past President.

Chris' architectural work was published in *Southern Homes* magazine. Chris has written a host of articles relative to FM Automation appearing in *Maintenance Solutions*, *Building Operations Management* and *Total Maintenance Solutions* magazines. He was a contributing author for the RS Means Guide and has been published in the Facilities Management Journal. Additionally, Chris has given more than 100 seminars and webinars on FM Automation and has been invited to speak at AIA, AEC, BPIA, IFMA, Realcomm, FAECOM, FIATECH, and APPA conferences.

Julie Knudson

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Julie Knudson is a consultant and writer based in Seattle, WA. She has over 15 years of experience in facility and technology management, with a strong focus on the biotechnology industry. She founded Olympic Bay Management to provide highly specialized support to small and mid-sized companies undertaking facility and technology projects. In addition, Julie works with support companies serving the facility management industry, using her experience as a facility manager to help them strengthen client relationships, streamline operations and increase profitability.

Ms. Knudson also writes articles, white papers and other material for clients in the facility and technology industries. She has been an IFMA member for more than 5 years, and she is also the editor of the IFMA Seattle newsletter.

Louise Sabol

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With Design + Construction Strategies, Louise Sabol applies her more than 25 years of experience in the building and technology professions for project with this AEC-FM technology consultancy firm. With previous firms, Louise was involved in real property asset management studies and technology analysis projects. Her clients included GSA, the U.S. Department of the Treasury, Gensler, Marriott International, USA Today, TRW/Treasury Department, NASA, IBM, and the U.S. Air Force Academy. Louise developed CAD and space management database applications for the National Gallery of Art's Architecture/CM and Design Installation group.

Earlier in her career, Louise worked as an architect for Skidmore, Owings and Merrill on medium to large commercial projects in both Denver and Washington, DC. She became involved in the firm's computer group, which developed and integrated applications for this architecture/engineering and planning firm.

Louise has a B.S. in Architecture and Master of Architecture degrees and is a registered architect.

Eric Teicholz

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Eric Teicholz is president and founder of Graphic Systems, Inc., a Cambridge-MA firm specializing in facility management and real estate automation consulting. He is a Fellow of the International Facility Management Association, chair of Knowledge Management and member of the IFMA Foundation Board of Trustees, a member of the Facility Maintenance and Operations Committee (FMOC) at the National Institute of Building Sciences, and an executive member of Harvard's Graduate School of Design's Alumni Council.

Teicholz has helped organizations define and implement FM technology for over 30 years and is the author of ten books on Computer-Aided Design and Architecture, Computer-Aided Facilities Management and Geographic Information System technology – including McGraw-Hills "Facility Design and Management Handbook: Theory, Practice and Technology,".

Teicholz was educated as an Architect at Harvard University. Before Graphic Systems, he spent 12 years at Harvard's Graduate School of Design as an Associate Professor of Architecture and Associate Director of Harvard's largest R+D facility, the Laboratory for Computer Graphics and Spatial Analysis.

Geoff D. Williams

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Geoff Williams holds a bachelors degree in Environmental Studies and a professional degree in Architecture from the University of Waterloo (Waterloo, Ontario, Canada). Since 1997 he has worked for Seawood in Toronto and has been responsible for overseeing the development of and the marketing of Seawood's own web-based facility management solution SeawoodFM.

Mr. Williams has been involved with IFMA since 1999 and currently holds the position of President of IFMA's Information Technology Council (ITC) and President-Elect of the Toronto Chapter. He has also presented on facilities and technology topics at IFMA's World Workplace, AEC Systems and the CHES National Conference.

William P. Witts, Jr

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William Witts is the GIS/CAD specialist for the MIT Department of Facilities. He has 9 years experience in the GIS field working in municipal government and as a consultant in the AEC industry. Earlier in Mr. Witts career he worked as the GIS coordinator for the Town of Bedford, Massachusetts. There Mr. Witts oversaw all aspects of GIS management within the Town. Just prior to joining MIT Mr. Witts worked on GIS integration with asset management products for a large AEC firm.

Currently at MIT Mr. Witts is working on several GIS mapping projects, support of GIS/CAD based applications, and administration of enterprise wide databases and servers for the department.

Mr. Witts has a B.S in Regional Planning and a Masters degree in Geographic Information Science.