Progressive mobile BIM tools usage for productivity improvements on construction sites

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Abstract

The growing trend of using mobile BIM (Building Information Modeling) technologies is an industry effort that continues to benefit various technologically savvy construction organizations. However, in today's industry, project stakeholders are not fully exploiting some advantages these mediums have to offer. This paper will review popular software packages available on the market as well as their relevant mobile products and illustrate potential improvements, mainly in the field, to productivity on a construction project. Furthermore, authors analyze and designate how specific devices may improve jobsite productivity by outlining the capabilities of the mobile technologies and platforms. Additionally, the authors discuss the changes to traditional construction management procedures and the challenges progressive mobile BIM tools will present as this new skill-set is integrated into the curriculum.

Keywords

Mobile BIM, productivity, software, management, curriculum.

Introduction

The use of Building Information Modelling (BIM) has improved information sharing on construction projects although there are still many areas where information fails to flow. The growth of mobile technologies has benefited construction businesses in many ways; however, in the construction industry, the project participants still do not exploit all of the advantages these technologies can offer. As technology advances it has become evident that the ability to generate more and more electronic data increases yearly at a staggering rate.

The challenges of dealing with a disproportionate amount of data are very apparent in current construction projects. What started with the ability to generate large numbers of drawings easily using 2D CAD systems has now accelerated with the introduction of Building Information Modelling (BIM). This, together with the internet, cloud-based technologies, email and the proliferation of smart mobile devices has added challenges and opportunities to this industry.

The ability for professionals to have access to relevant and appropriate information in a timely manner, and to be able to act on it based on their experience, is key to successful project delivery. In this sense, organizing the scope of this paper was done in order to review the most popular software packages available in the market, as well as their relevant mobile platform and features. This review of more progressive tools had the purpose to find out and expose how

effectively these software packages can improve the productivity of a construction project, mainly in the field. Considerations for off-site improvements and increased productivity were also given and the main benefits to owners and other stakeholder users were provided.

Software Developers in the Current Market

Autodesk Revit: specialized software created for Building Information Modeling (BIM) available in Architecture, Structure, and Mechanical-Electrical-Plumbing (MEP) – by applying cloud service to their software packages, Autodesk has changed the way of communication and working in a positive direction. The followings are the on-site and off-site improvement considerations each software package provides and their advantages offered by developers for additional services.
- On-site: has mobile applications to access online databases
- Off-site: uses cloud services to minimize the cost of upgrading hardware, improving workflows, and sharing files
- Owners and Users: anyone can create an Autodesk 360 account, which includes 3GB of free storage space – if user has an Autodesk Subscription, he/she receives 25GB of storage space per seat on Subscription, as well as access to powerful cloud computing services, such as Autodesk 360 Rendering, Optimization, Energy Analysis, and Structural Analysis

ArchiCAD: a BIM software designed mainly for architects which is available for both Windows and Mac OS
- On-site: create BIM models on mobile devices
- Off-site: cloud-integrated model sharing service for BIMx
- Owners and Users: offers free trial and is free for students

Vico:
- On-site: uses location based scheduling to manage on-site works
- Off-site: compatible with a wide range of popular BIM tools and scheduling software
- Owners and Users: has numerous tutorial and training videos available on software provider's website

Bentley:
- On-site: has mobile applications to access online database
- Off-site: provides powerful work-sharing capabilities including a spatial view for map-based navigation, and a web view for online browser access – distributed team members can use their own applications and file formats in their own locations
- Owners and Users: can publish precise, data-rich, native engineering content in mediums that are appropriate for different audiences, such as electronic files, drawings, renderings, 3D PDFs, and 3D prints – can also publish digital files to devices such as plotters, tablets, iPads, and the Web

Tekla:
- On-site: has application that allows users to communicate with the offsite office
- Off-site: specialized configurations for Construction Management, Steel, Precast, Concrete, Cast in Place, and Engineering
- Owners and Users: develops software solutions to multiply our customers' potential in Building

and Construction, Infrastructure and energy industry – Tekla BIMsight can be shared by Contractors, Structural Engineers, Steel detailer and fabricators, Precast concrete producers and detailers, and Cast in place concrete producer and detailers – also has support tools for infrastructure-related business operations in energy distribution, public administration, and civil engineering

Bluebeam:

- On-Site: Using Bluebeam Revu for iPad, users can access and navigate PDF files, Redline PDFs with industry-standard symbols, verify measurements in the field, save custom markups for reuse across sessions, and collaborate with colleagues using Revu's cloud-based solution, Bluebeam Studio – users can also Sync files and entire project folders using Dropbox, Box, Studio Projects or WebDAV, or transfer files via iTunes using the Document Manager[1]

- Off-Site: capable of PDF creation, markup, editing and collaboration for an all-digital workflow, includes direct plug-ins for AutoCAD, Revit, Navisworks Manage, Navisworks Simulate, SolidWorks, and Microsoft Office[2]

Owners and Users: the ability to create PDF files, as well as collaborate using AutoCAD, Revit, Navisworks Manage, Navisworks Simulate, SolidWorks, and Microsoft Office will undoubtedly aid in the contractor's ability to communicate with the owner

Trimble Buildings

- On-Site: Trimble Field Link for MEP is a solution that consists of the Trimble Field Link software powering the Trimble Field Tablet connected to a Trimble total robotic total station – this is intended to reduce errors and extend BIM workflow by exporting 2D and 3D MEP model's hanger points or cable tray attachment locations to the field software for easy field location and staking[3]

- Off-Site: Trimble Accubid Enterprise is a server-based, spec-driven estimating platform for electrical, industrial mechanical, and ITS contractors – it is a multi-user platform that harnesses the power of the rich assembly and material databases that help eliminate redundancy and reduce errors for faster, more accurate estimates[4]

- Owners and Users: Trimble's Field Link software will ultimately allow contractors to lay out their jobsites more efficiently and accurately, allowing for a cost savings for the owner – in addition, Accubid enterprise will allow for real-time communication, as it is a multi-user server based platform

Assemble Systems

- On-Site: the entire project teams can access Assemble from any location and from a variety of devices – disparate systems, networks and geographies no longer pose an obstacle to project collaboration, whether internal team members or external stakeholders[5]

- Off-Site: Assemble provides a web-based solution for extracting comprehensive model inventories from industry leading BIM authoring tools – publishing Autodesk Revit Architecture,

Revit MEP, Revit Structure, AutoCAD Architecture and AutoCAD MEP models to Assemble will produce comprehensive project inventories[6]

- Owners and Users: Assemble recognizes geometric properties, including customer parameters that have been defined within Revit[7] – this allows the General Contractor to give each product an individual consideration

GTeam (Gehry Technologies)

- On-Site: GTeam is a web-based software that increases team productivity by making project files available from anywhere - allowing everyone on the team to participate, including architects, consultants, engineers, subcontractors, fabricators, engineers, designers and others – regardless of location[8]

- Off-Site: GTeam gives a historical view of file changes, making auditing easier and faster – this allows for greater transparency, insight, and accountability by centralizing all project team communication, reducing scattered information in email, FTP, various computers and multiple offices; GTeam also automatically converts 3D files (Revit, AutoCAD, Digital Project, Rhino, SketchUp, etc.) to a common format so it reduces the time spent changing 3D files to other formats[9]

- Owners and Users: GTeam (is becoming Trimble Connect) allows owners to centralize the BIM data of all digital assets, reduce costly change orders that impact project delivery, help all members of the building process use the most relevant data, audit and report on all past and present project data and activity, and manage legacy BIM data without CAD tools[10]

Graphisoft

- On-Site: Graphisoft's BIMx provides a 3D environment to use full BIM models on mobile devices – BIMx hyper-models are models published in the new BIMx model format containing the full scope of project; the 2D layouts are hyperlinked to the 3D model based on the ArchiCAD markers[11]

- Off-Site: ArchiCAD 18 provides a BIM based documentation workflow – aiming to simplify the modeling and documentation of buildings even, regardless of the level of detail; ArchiCAD's also has an Energy Evaluation engine to support multiple thermal blocks, allowing users to evaluate designs with standard compliant technology[12]

- Owners and Users: ArchiCAD 18 runs on both Microsoft Windows and Mac OS X 64-bit operating systems[13], which allows for greater versatility for both owners and users and helps ensure that all parties will be able to effectively communicate using this tool – Graphisoft has also made an effort towards commitment to expanding the possibilities available to the architect, through background processing support, optimized scaling of multiple-core CPUs, and improved central graphics unit performance

Sparkframe

- On-Site: Sparkframe employs a Revit Add-In for Autodesk Revit 2013 and 2014versions:

Architecture, Structure, MEP and comprehensive versions, which enables users to converse, manage tasks, record screenshots, and make markups on Revit elements – since Sparkframe is a cloud service, conversations will be held in real-time, and BIM element-specific tasks can be managed from any web-connected device, such as mobile phones and tablet computers[14]

- Off-Site: Sparkframe sells it product as the best of BIM and email – whereas email may reference a model in words, Sparkframe references the model and elements themselves[15]; this allows for your BIM related communication to live together in one cloud application

- Owners and Users: since there is no Revit installation needed to read and take part in conversations[16], this application minimizes risk for the owners, who may be timid about making a large investment in Revit

Synchro

- On-Site: Synchro Cloud allows project teams to work through any computer or mobile tablet worldwide with high speed efficiency, allowing for access to a highly distributed, full-featured platform at a fraction of the cost of traditional in-house corporate IT infrastructure – in addition; Synchro utilizes US military-grade security, support and service[17]

- Off-Site: Synchro Professional is a 4D visual project management software that provides competitive advantage through 4D/5D BIM software built on the Critical Path Method (CPM) engine – this provides the ability to evaluate approaches and to optimize the project plan using real time 4D visual animation and video production on their computer, before they ever go to the site[18]

- Owners and Users: Synchro Software's 4D technology facilitates the linking of 3D CAD design models to the associated tasks of a CPM schedule allowing users to create project simulations that identify and resolve dynamic time-space clashes and that optimize project performance – this allows owners to ensure they receive their finished product on time and in an efficient manner

Oracle Enterprises

- On-Site: Primavera P6 Enterprise Project Portfolio Management (Primavera P6 EPPM) gives the project team anytime, anywhere access to their project information through web-based user interfaces – team members can update statuses by using any of the three P6 Team Member interfaces that accommodate their line of work, including the P6 Team Member for iPhone application, P6 Team Member Web (tablet), and an email statusing option[19]

- Off-Site: Primavera P6 EPPM enables users to plan, schedule, and control large-scale projects by balancing resources, allocate resources, monitor and visualize project performance, create an environment for team collaboration, and integrate with financial and human capital management systems[20]

- Owners and Users: the ability of Primavera P6 EPPM to help the user choose the right projects for his or her organization is made possible through its integration with financial and human capital management systems – this is a key advantage of Oracle's Primavera software

Sage

- On-Site: Sage's Time Mobile application allows users to submit employee time worked quickly, log the number and type of hours worked, and link the time to a job cost code via iPhone or Android Smartphone[21]

- Off-Site: Sage Estimating solutions give multiple takeoff options, industry-specific pricing databases, and integration with Job Cost, so you can create and set up jobs from estimates; once the job is won, all the estimators need to do is approve the estimate, and the job is automatically created for cost to budget comparisons[22]

- Owners and Users: Sage 300 Trade Specialty (formerly Sage Timberline Enterprise) is designed to address the complexities of the service and specialty industry, and allows users to utilize a single data entry point and track important details, such as accounting, work orders, and inventory[23] - this enables users and owners to more effectively monitor and maintain the health of their organization

The Advantages of Using Progressive Digital Tools

Once at the jobsite, the superintendent does not have to return to the office to update the process or report an issue; everything can be done immediately with an internet capable device. The superintendent can use a checklist for work tasks and a punch list for tracking issues, or receive/create a note on the plan, regardless of whether the superintendent is in the office or at the site. With these software packages in use, the sub-contractors, general contractor, engineers, architects, or owner can save time on meetings and updating processes. With the interactive feature of a mobile device, any party in a project is allowed to get immediate updates from the other party, and can quickly reply back to solve the problem. The owner can easily stay updated with either general or detailed project statuses by simply accessing the project database with the account that is provided. The accessibility will help the company stay ahead of the issues that may arise, and easily manage multiple projects. Furthermore, owners will have more control in what they are investing in.

Mobile BIM and Productivity

There are many factors that affect productivity; for example: the labor quality, the labor's working behavior, location, technologies, management of labor and resources, are some common key factors that directly impact the productivity rate on the jobsite. With these factors in mind, technology is one of the most important keys to unlocking the door to a unique solution in the construction industry, enabling users to take an idea and transform it to a completed project. We have already seen changes of a similar capacity by eliminating the use of old fashion, hand drawn plans, to using PDF files or Computer-aided design (CAD) models, completely changing the way people interact and communicate during a construction project.

Over the years, software companies have developed more and more specialized software that greatly improves the productivity and profitability of the construction industry. Building Information Modeling (BIM), a digital representation of physical and functional characteristics of a facility[24] was first implemented under the Virtual Building concept by Graphisoft's ArchiCAD in its debut in 1987[25], and has gradually been accepted by construction companies,

leading to a diverse selection BIM tools on the market.

At the breakthrough of mobile technologies, business managers successfully turned their phones into a powerful device that enables them to maintain their work despite their location, and due to these technologies, they are able to improve their productivity.

According to CNN, 88% of all U.S. adults now own a cell phone and 46% of all American adults now use smartphones[26]. This means that the majority of the workforce owns a smartphone. This has created a huge market, especially in the construction industry. In fact, there are some companies who have started to develop software that can run on smartphones or other mobile device such as tablets. This software utilizes the advantage of mobility, as it is clear that having a mobile device capable of performing tasks such as accessing email and modifying plans and schedules will greatly improve the productivity.

In recent years, BIM software has widely been used in average to large construction firms, but with the limitation that these software are most likely used in the office. Today, a smartphone with Internet capability can easily send and receive email from anywhere, so real time communication with the office is no longer difficult. Major players in the software development industry have already jumped in this section of the construction industry, as they have developed a variety of applications that can be used on mobile devices such as the iPhone, iPad, and Android tablets. These applications give people at the jobsite the ability to stay up to date with any changes from the office.

Some flagship companies of this segment such as Trimble, www.trimble.com, and Autodesk BIM360, www.autodeskbim360.com, have already brought BIM to the jobsite through the development of mobile BIM applications. The purpose of these applications is to bind everything into one unique project, where anyone who is working on the project can easily communicate with each other. With an effective way to communicate, the workflow will be smoother and people can make more effective decisions based on accurate information, minimizing errors, reducing the time and cost from inaccurate information, greatly improving productivity, and bringing greater success to the project.

Prevalent Applications

The following are some of the applications that have been developed by major software names in the construction industry:

Autodesk:

- AutoCAD 360 (formerly AutoCAD WS, for iOS and Android):
  - Allows users to view, edit, and share DWG files with anyone, anywhere
  - AutoCAD WS mobile app enables users to work with AutoCAD drawings directly on their iPad, iPhone, or iPod touch.
  - Users can accurately annotate and revise drawings while they are in the field, in meetings, or out of the office
  - Allows users to work with local versions of their designs when they don't have an Internet connection, and easily open DWG, DWF, and DXF files received as email attachments directly on their device
- Autodesk 360 (iOS):

  - Allows users to expedite the design review process by viewing and redlining design files while in the field or out of the office
  - Autodesk 360 mobile app enables users to review Autodesk 2D, 3D, Revit, and Naviswork design files directly on an iPad, iPhone, or iPod touch
  - View and mark up drawings on location
  - Users can open and view 2D and 3D DWF files from their Autodesk Cloud documents account
  - View metadata and other details about elements within the technical drawings
  - Users can use simple redlining and intuitive markup tools to communicate changes, or add text and comments using familiar callouts
- Autodesk Buzzsaw mobile (iOS + Android):
  - Securely access Architecture, Engineering, and Construction (AEC) project designs and documents from anywhere
  - View Autodesk Revit and Navisworks models and metadata about elements in the designs,
  - View 2D and 3D DWF files, and view standard office documents and images
  - Upload project photos directly to the Buzzsaw cloud
- Autodesk Bluestreak mobile:
  - Let users of Project Bluestreak from Autodesk Labs easily collaborate with their Architecture, Engineering and Construction (AEC) project teams from anywhere
  - On the job site or at a client meeting, Bluestreak delivers the latest team communications and automated notifications from Autodesk design applications and web services
  - Communicate with your project team in real-time, view and send messages that are automatically shared with your project team, access contact information for all team members

Autodesk BIM 360 Field:

- (Vela Systems):
  - Provided the construction industry's first "all in one" iPad construction application, including a document library, photos, reports, equipment lists and status, checklists for QA/QC, Safety and Commissioning and issue creation/sign off for tracking any issues (including work-to-complete or punch list issues), while walking in the field
- *BIM 360 Glue:*
  - Cloud-based BIM coordination service that provides virtually anytime, anywhere access to connected project information. BIM 360 Glue is used for construction visualization to perform multidisciplinary collaboration and coordination review cycles faster, while making construction layout tasks more efficient.
  - Provides BIM accessible to all involved on the project and streamline project review workflows
  - Create confidence in planning results by using powerful clash detection tools that take advantage of Navisworks software for construction project management
  - Supports immersive mobile experience and offers the possibility to navigate through saved views, measure distances, and access intelligent object properties

Bentley:

- ProjectWise:

    - A system of servers and services for engineering team collaboration and work sharing that helps teams manage project information to improve quality, reduce rework, and meet project deadlines
    - Create secure work packages from documents stored in ProjectWise, then send the packages to the iPad for use at a construction site or other remote location
    - Share files with other applications that offer advanced editing features, such as Apple's iAnnotate for PDFs and Apple's Keynote for PowerPoints to annotate documents
    - Export return package to ProjectWise Explorer on your desktop to synchronize for review
    - Directly access your ProjectWise database and documents from the iPad with ProjectWise Explorer Mobile
- Navigator (V8i):
    - Bentley Navigator for the iPad lets you navigate, view, and mark up 3D models for design review and coordination as well as safety inspections
    - Uniquely provides panoramic navigation in an immersive environment for true "hands-on" reviews – with this innovative capability, you can navigate models by simply moving your iPad as though it were a "window into the model"
    - The iPad's motion sensors and touch screens also give you fast and easy access to object properties such as the thickness of a pipe, its color, or its pressure rating
    - Any annotations made on your iPad can then be merged with the models on desktop software

Tekla:

- Tekla BIMsight (on Windows tablets)
    - One platform for all project members for live collaboration, combining models from different disciplines into a single project model
    - Avoid conflicts on-site by running automated clash detection and is capable of sharing and communication issues and other valuable information instantly
    - Similar to a discussion board where the project team member can leave note to a posted problem (have to download from email) and share it through email or dropbox (integrated feature)
- Tekla Field3D (iPads and iPhones)
    - It allows any user to load 3D models via email or open files from the web or from your favorite file-share program on iOS
    - It is considered the high-performance IFC & BIM 3D tool for iOS. It does open very large models (over 2 GB) and has many useful and easy functions to view and extract 3D model information. Works fluently on both iPad and iPhone.
    - With Tekla Field3D even stakeholders without desktop BIM software can combine and view 3D models. It is the only IFC-viewer for iOS that allows you to view and share 3D models anywhere

Conclusions and Recommendation for Curriculum Integration

On a jobsite, if the workers have access to the information relevant to their role and the task they are performing at the point of activity, they have the opportunity to dramatically improve their efficiency and productivity. Moreover, location-based technologies and services can be used to identify the worker, their location on site and work packages. This information, which is

available both online and offline, can ensure workflows continue seamlessly, through mobile BIM technologies. Using a consolidated information resource like mobile technology, BIM can be extended from the original design through on-site construction to on-site maintenance and facility management. The technology can improve all information including drawings, specifications and methods of construction, activity sequence flow, commissioning requirements, environmental assessments, and supply chain logistical information. Therefore, companies in the construction industry are embracing more mobile BIM technologies and applications to improve their operational productivity.

Despite the string of different experts from design through architecture, engineering, construction and facilities management, the building projects must be approached from the start as one project with one plan — successively enriched and refined by each participant. This is getting back to the most valuable resource in a company setting - people: training everyone to understand the project lifecycle and the information transmission required to make the process more efficient and productive.

Project integration must be supportive, combinatory and non-competitive, a major cultural shift that will require new skills from every project manager and every other manager or superintendent who is involved in projects. In other words, training must spread beyond the traditional project management expert groups. BIM-enhanced project management training should start in undergraduate education and should be now a core learning and assessment need; not only must it cover BIM theory and the use of BIM software tools and applications, but it must come from industry experts with deep knowledge and recognition of BIM dynamics and mobile technology applications. Optimizing the planning and control of construction projects is the key to promote success. Mobile applications nowadays are increasingly addressing the planning and control of projects. Construction companies cannot afford to continue without a clear project management software platform strategy. The role of standardized, shareable information about project plan milestones, dependencies, resourcing and scheduling is as essential as the exchange of visualization and 3D models. This information should be transferred more to the level of the superintendents and crew leaders on site. Project scheduling and estimating software and its mobile applications may be a BIM fundamental. In order to keep pace with the coming revolution in information exchange, it is essential to choose a solution that has a tried and tested industry, likewise the construction industry.

Even if BIM-ready, relying on a software solution alone will not be sufficient. To embrace mobile BIM practices the implementation of software solutions must be accompanied by process transformation, backed up by a BIM education curriculum in all universities, ideally connected to the specific tools and integrated in the construction management and civil engineering existing curricula. This way, focusing on practical BIM training can be done early for the future workforce and the new generation of project managers will have the opportunity to acquire a valuable skill-set to confront the project challenges of tomorrow.

References

Revu, "Revu iPad Bluebeam", <http://www.bluebeam.com/us/products/revu/ipad.asp> (Dec. 1, 2014)

[2] Revu, "Edit, Markup & Collaborate on PDFs on Blubeam", < http://www.bluebeam.com/us/products/revu/> (Dec. 1, 2014)

[3] Trimble, "Trimble Field Link for MEP", <http://mep.trimble.com/products/trimble-field-solutions/trimble-field-link> (Dec. 2, 2014)

[4] Trimble, "Trimble Accubid Enterprise Estimating", < http://mep.trimble.com/products/estimating/trimble-accubid-enterprise-estimating> (Dec.2, 2014)

[5] Assemble Systems, "Share BIM Data", < http://assemblesystems.com/product/share/> (Dec. 1, 2014)

[6] Assemble Systems, "BIM Solution" <http://assemblesystems.com/product/> (Dec. 1, 2014)

[7] Assemble Systems, "Manage BIM data" <http://assemblesystems.com/product/manage> (Dec. 1, 2014)

[8] GTeam "Features" <http://www.gteam.com/#features> (Dec. 2, 2014)

[9] GTeam "Industry" <http://www.gteam.com/#industry> (Dec. 2, 2014)

[10] Trimble Connect, "Welcome to Trimble Connect" <http://connect.trimble.com/> (Dec. 2, 2014)

[11] Graphisoft, "Download BIMx and BIMx Docs: The mobile app for exploring BIM on handheld Devices" <http://www.graphisoft.com/bimx/> (Dec. 1, 2014)

[12] Graphisoft - ArchiCAD "ArchiCAD 18 Brochure" <http://download.graphisoft.com/ftp/marketing/ac18/pdf/ArchiCAD18_Brochure.pdf> (Dec. 3, 2014)

[13] Graphisoft – ArchiCAD, "ArchCAD 18 Flyer"<http://download.graphisoft.com/ftp/marketing/ac18/pdf/ArchiCAD18_Flyer.pdf> (Dec. 3, 2014)

[14] Sparkframe, "Spark your BIM talk" <https://sparkframe.com/> (Dec. 3, 2014)

[15] Sparkframe, "Frequently Asked Questions" <https://sparkframe.com/faq> (Dec. 3, 2014)

[16] Sparkframe, "About Sparkframe – Getting started through Registering" <https://sparkframe.com/about> (Dec. 3, 2014)

[17] SynchroPro, "SychroPro Products and features" <http://synchroltd.com/products/> (Dec. 2, 2014)

[18] SynchroPro, "SynchroPro" <https://synchroltd.com/synchro-pro/> (Dec. 2, 2014)

[19] Oracle, "Primavera P6 Enterprise Project Portfolio Management – Data Sheet" <http://www.oracle.com/us/products/applications/primavera/primavera-p6-r8-data-sheet-193061.pdf> (Dec. 3, 2014)

[20] Oracle, "Primavera P6 Enterprise Project Portfolio Management – Overview" <http://www.oracle.com/us/products/applications/primavera/p6-enterprise-project-portfolio-management/overview/index.html> (Dec. 3, 2014)

[21] SAGE, "SAGE – Construction Anywhere – US" <http://na.sage.com/us/sage-construction-and-real-estate/sage-construction-anywhere> (Dec. 4, 2014)

[22] SAGE, "SAGE – 300 Trade Specialty Contractor – Brochure" <http://na.sage.com/~//~/media/site/Sage%20300%20Trade%20Specialty/documents/pdf-product-info/Sage-300-Trade-Specialty-Product-Brochure_web.pdf> (Dec. 4, 2014)

[23] SAGE, "Sage Construction & Real-Estate" <http://na.sage.com/us/sage-construction-and-real-estate/sage-300-trade-specialty> (Dec. 4, 2014)

[24] National Institute of Building Sciences, "National Building Information Model Standard Project Committee - About the Building SMART alliance" <http://www.nibs.org/?page=bsa_about> (Dec. 1, 2014)

[25] Wiki, "Origins of BIM", <http://en.wikipedia.org/wiki/Building_information_modeling> (Dec. 1, 2014)

[26] Amy Gahran (CNN), "Survey says most U.S. Cell phone owners have smart phones; so what?" <http://articles.cnn.com/2012-03-02/tech/tech_mobile_smartphones-majority-pew-gahran_1_smartphone-cell-phone-android-phone?_s=PM:TECH> (Dec. 1, 2014)

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David Witt, BSCM

David conducted research under Dr. Marcel Maghiar while achieving his undergraduate degree in Construction Management at Georgia Southern University during 2013 and 2014. He studied the most current software of BIM and mobile technologies and their applications. He is originally from Kennesaw, GA and he currently has the honor to serve as a Second Lieutenant Army Engineer Officer at Joint Base Lewis-McChord. He also received a minor in Business and Military Science. He commissioned into the Army as a Distinguished Military Graduate (top 20% of Cadets in the nation). In the future he plans to work for the Corps of Engineers.

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Mobile technologies in the Sri Lankan construction industry.