JSG

Project Report

On-Site Management by Site Engineers

Using tablet and electronic transfer of data

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Contents

1. Project Brief

The purpose of this project is to identify a construction related situation where current or future advances in information and communication technology, ICT, can be applied to the construction process in a positive and productive manner.

2. Project Proposal

– Data transfer system for Site Engineers

The project chosen is to look at and propose an information communication technology system that can be used on-site by engineers to submit documents in a more efficient manner. The documents referred to would include inspection and check forms for various activities taking place on site. The documents would be submitted via the information and communication technology system to in-house and external parties to the project, as required. The document submissions may be key points in construction dictating follow-on activities, recording progress or authorising payments for sub-contracts.

For the purpose of this proposal, it is assumed that the site engineer has the use of a device, specifically an iPad, that the engineer can use to access contract drawings and specifications via BIM in the cloud, or similar, and that there is 100% broadband coverage on the construction site, which has the speed and capacity to operate instantaneously and for sizeable documents.

The project proposal can be applied to small, medium or major projects as scalability is a key factor to embracing the technology.

3. Problem Description

– Site Engineers operating with hard copies

3.1 Job Description

The site engineer's job encompasses site supervision of construction, quality control checks, inspections, health and safety inspections, sign off of completed work, snagging, reporting progress, keeping a daily diary, and liaising with designers etc. These are the day to day activities, but there are also key engineering roles such as problem solving, temporary works, construction methods, risk assessments, design variations and buildability, which also have to be taken on board.

If the day to day routine on-site activities were made more efficient by the use of ICT, it would enable more productive working with regards to the other key engineering roles.

3.2 Mobility

The activities and tasks of a site engineer require work in the office and also out on-site. Depending on the specific project, the site area may be compact in area and adjacent to the site office, alternatively it can be a number of separate sites, as in a road or rail project, or one vast site as for a major civil engineering project, or it could also be multiple storeys as for a unique high-rise building project. The site engineer has to be mobile and the job is often complicated with the need to return to the office to refer to drawings and contract documents. Form filling, progress reporting and diary keeping, although recorded on-site, are often completed in the office requiring a written submission or input of data twice to complete the task.

3.3 Planning, Quantity Surveying and Document Control

Sign-off of certain construction elements by the site engineer often dictates follow-on operations or activities and can trigger payments to sub-contractors. The site engineer has to liaise with the planners and quantity surveyors, requiring detailed reports of progress on-site. Accurate daily diaries and progress photographs are also required to verify any claims or details at a later date.

Site records, in the form of hard copies, are collated by document control and are extensive for large projects. Storage of these documents needs to be updated to minimise hard copies and adapt to new data formats which can be more easily stored, copied and transmitted.

3.4 Submission and Transfer of Data

Completed inspection, check and handover forms are filled out in hard copies and passed to internal departments such as document and quality control. Certain forms also have to be submitted to external parties such as the Resident Engineer or the Clients representative. Submission of such documents is dictated by the project quality assurance and quality control plans, and is a stipulated requirement and a task that has to be fulfilled by the site engineer.

3.5 ICT Provision

Site engineer's access to ICT has been limited and construction sites have been notoriously low on technology. Engineering technical support on-site is often limited to hard copies of forms and drawings.

The provision of ICT for designers, whether architects or structural engineers, based on site is likely to be more current and up to date, as they will be linked into the design office ICT facilities. Depending on individual projects, the Resident Engineer may have ICT capability which can be used to receive and share documents.

3.6 Fragmentation

Technology provision between in-house departments on-site has caused fragmentation, with the engineering department lacking with regards to ICT hardware and software. Certainly a personal computer or laptop is available to the engineer in the site office but technology out on-site has been very limited.

Quantity surveyors and planners have had access to task based computer programmes for the last 30 years approximately. Site engineers have had individual office based computers for the last 20 years, which have mainly been used to produce Word documents, such as method statements, letters etc. Links to document control and viewing of documents on the office computer has only really occurred in the last 10 years. There have been no tailored programmes that have been able to assist the site engineer in their tasks and activities on-site, in the way that the programme software has been instrumental in assisting the planners and quantity surveyors.

3.7 Investment

Little or no investment has been put into developing site based systems that the site engineer can use and which link the designers, contractor and the client. Current practice certainly facilitates emailing and the transfer of documents via the computer in the office environment.

In general major projects which have a larger budget and more stringent project stipulations, with regards to paperwork, may allow the contractor to implement or enhance their ICT facilities. This may also be true of a number of similar small or medium sized profitable projects which can follow the same template and that have the margin in their budget. The contractor would have to gain from the efficiency, productivity or cost savings in order to be encouraged to fund ICT development, unless it was a stipulation of the project and could be included in the tender.

Civil engineering projects are by nature one-offs and tend to need innovative and individual approaches. Time is often not given to developing suitable ICT at the beginning of a project before site works commence. If the ICT system is not set in place at the beginning of a project then it will not be adopted at a later stage, unless as a trial run.

4. Objectives and Solutions

– Provide the Site Engineer with a software platform to share documentation/data from remote on-site locations resulting in increased productivity and efficiency

4.1 Device and Platform

The site engineer needs a suitable software platform loaded onto an iPad, which can be used instantaneously to share completed electronic forms with specified individuals, thus streamlining the on-site management process. The iPad will use the iOS mobile operating system developed by Apple. The user interface of iOS, being based on the concept of direct manipulation using multi-touch gestures on a sizeable screen, assists the input of information by the site engineer. The simple, intuitive and engaging nature of the iPad have made them particularly user friendly.

A major benefit of iOS is the huge coverage and use of the Apple devices worldwide. In June 2012, iOS accounted for 65% of the mobile web data consumption and 410 million devices were activated. Such coverage and usage would make the adoption of the proposed system more straightforward and acceptable by the workforce.

As of October 2013, Apple's App Store contained more than 1 million iOS applications, 475,000 of which were optimised for iPad. These apps have collectively been downloaded more than 60 billion times. This gives an indication of the user-friendly nature of the iPad and associated apps.

4.2 Software

The Platform software needed for the site engineer to send data to other parties would require various features as follows:-

1. Remote access for on-site locations
2. Reliable technology for instantaneous updating of data
3. Document sharing with specified individuals, including sharing and activity audit log to view the status of forms submitted, senders and recipients
4. One-click sharing giving link to a file for other individuals to view or download the latest version in seconds, avoiding attaching large files to emails.
5. Security of devices, data and apps, including encryption, remote wipe, 2 step verification, privacy safeguards and certification and compliance
6. Data stored to be saved as site records
7. Scalability to roll out any number of devices over a whole project
8. Permissions for individuals to access data
9. File recovery and versioning giving full history, track changes and recover work.
10. Unlimited document storage space to expand with project
11. Support system for technical issues

There are numerous providers of a variety of software which may be adapted to the task, such as Dropbox, Google Docs, RSS Feed.

4.3 Forms

The system would operate by using predefined iForms which are already pre-loaded for the specific activities by the software platform. The forms, that are to be submitted by the site engineer using the system, will be specified and this could be incorporated on the quality control plan, which would ordinarily include quality control checks and sign offs. For full utilisation of the software on-site, a system would have to be developed and set in place before construction starts. Adherence to the system would need to be stipulated in the contract documents, ensuring the specified forms are submitted using the software platform.

For example, iForms could be used for the following activities:-

- Setting out/tolerance checks
- Risk assessments
- Pre pour concreting checks
- Post pour concreting checks
- Utilities/service checks
- Steelwork checks
- Temporary Works checks
- Health and Safety inspections
- Sub-Contractor sign off

5. On-Site Case Study

- Pre Pour Concrete check

To understand a specific site engineering task in detail, the activity of a pre-pour concrete check will be examined. The site engineer will conduct the inspection prior to approval for the concrete pour. The inspection process may need input from the Resident Engineer and the Temporary Works Co-Ordinator, depending on the section of concrete to be poured and any particular temporary works requirements.

The process to be replicated by the software and input on the iForm is as follows:-

Data input by Site Engineer

Part 1 **A. General Details**

- Date
- Time
- Weather Conditions
- Ambient Temperature
- Concrete Pour Description: Area/Size/Section

(Automatic iForm filling of this information could be preset with links in the software and relevant apps)

B. Inspection Details

- Formwork
- Reinforcement
- Cast-in Items
- Special Details
- Preparation of Surfaces

C. Concrete Details

- Concrete Design/Mix
- Batch Number
- Concrete Plant Details
- References for Test Cubes
- Shutter Temperature Monitors
- Concrete Vibration Monitors

(Again, automatic iForm filling of this information could be preset once the concrete mix details have been entered)

D. Send iForm in-house to:

- Temporary Works Co-Ordinator
- Quality Control Engineer

Data input/approval by Quality Control Engineer/ Temporary Works Co-Ordinator

Part 2 **A. Inspection and completion of iForm**

- Additional action may be required before approval is given

B. Send iForm to external party:

- Resident Engineer

Data input/approval by Resident Engineer

Part 3 **A. Inspection and Endorsement of iForm**

Again, additional action may be required before approval is given.

Part 4 **Approved iForm**

The iForm will be sent back to the site engineer and copied to Document Control for record purposes.

All stages of the approval process would be recorded and logged before the authorisation to pour concrete. The site engineer would have notification of the progress of the iForm at all stages.

The concrete pour will then proceed.

The iForm will also include a link for the concrete testing results to be automatically added after 3, 4 and 7 day tests, for example. Receipt of this information will be automatically sent to the site engineer for visual verification.

The iForm will also confirm when formwork can be struck, depending upon concrete strengths reached.

6. Research – Hard Hat Apps and iForms

- What is currently available to site engineers?

6.1 Hard Hat Apps

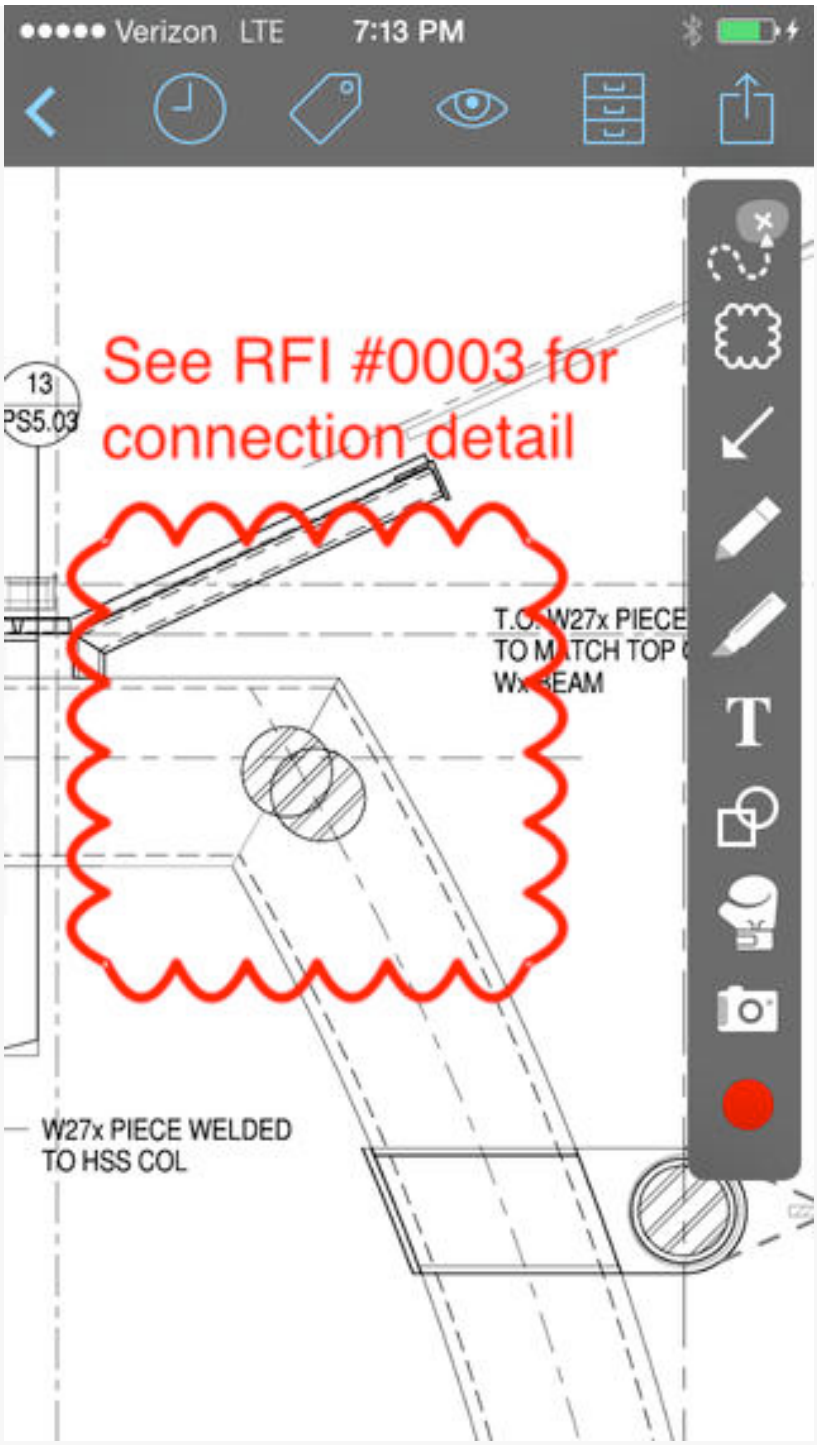
App 1 – PlanGrid

PlanGrid is a construction collaboration and annotation tool for the contractor and architect. The PlanGrid app lets contractors and architects collaborate with their project plans, specifications and photos on the iPad. PDF drawings are uploaded to plangrid.com and they are automatically synchronised to all project iPads in real time. Any markups made can easily be shared with everyone on the project.

Features of PlanGrid are as follows:-

* Always have the current set with you, no matter where you are
* Automatic leaf-in and versioning of new plan revisions
* Automatic hyperlinking of all detail callouts
* Cloud based annotations, markups sync to the team
* Automatic punchlists that sync and become searchable
* Quick field takeoff and estimating tools
* Markup your drawings with our full annotation suite
* Filter your drawings by system, revision, or however you prefer
* Take progress photos and pin them to your blueprints
* Automatic uploading and tracking of progress photos
* Construction management tools like RFI posting and submittal distribution

Screenshot


Verizon LTE 7:13 PM
See RFI #0003 for connection detail
13
PS5.03
W27x PIECE WELDED TO HSS COL

App 2 - OnSite PlanRoom

Description

Review and share plans and construction documents, all from the convenience of your iPad. OnSite PlanRoom is an innovative app designed to synchronize with ConstructionOnline, where you can easily upload and store your plans and construction documents!

View important project plans and documents when you're away from the office
• Preview specifications, correspondence, and other construction documents in these formats: PDF, Word, Excel, RTFs, images, videos, and .mp3s
• Store files locally so that you can still view them when you are unable to connect to the internet

Keep your team connected with shared viewing and workspaces
• Send share links to your team members, clients, or anyone else, all from the app
• Control who can see and edit files by setting permissions in your ConstructionOnline account

Track progress with real-time updating and notifications
• View, Add, and Reply to Comments on your plans, documents, and images
• See a current thread of recent uploads, downloads, updates, and comments

OnSite PlanRoom is a powerful cost saving tool that will increase productivity for contractors, architects, engineers, and others who need to access drawings and plans in the field. No more carrying expensive, heavy, or faded drawings. Start seeing them instantly on your iPad with OnSite PlanRoom.

App 3 - weatherAPP

weatherAPP

Weather Prediction for weatherAPP
To determine concrete pouring conditions, the **weatherAPP** averages the daytime, predictions for air temperature, wind speed, relative humidity for the searched location.

Weather Service
The forecasts are provided by World Weather Online, which has developed their own weather forecasting model which can deliver reliable and accurate weather information

for any geo-point in the world. This weather model is run along with other metrological models to compare and deliver accurate weather forecasts. Data is also derived from from renowned establishments like European Centre for Medium-Range Weather Forecasts, World Meteorological Organization, NASA weather satellite imagery, NOAA GFS2 model and JMA model.

App 4 – Doka-Tools

Doka-Tools

The Doka Tools app is a digital calculation tool for your site. Time-consuming, labour-intensive methods of calculating the optimum equipment quantities are now a thing of the past. With Doka Tools, it takes just a couple of seconds to optimise the components for Dokaflex floor-slab formworks, and to work out the permitted rate of placing and the maximum fresh-concrete pressure during pouring.

FURTHER INFORMATION

Gives a boost to efficiency

No matter which Dokaflex floor-slab system you are using, the Dokaflex calculations let you optimise the type and the spacing of the necessary beams and props, in just a few mouse-clicks.

Digitally calculating the pouring rate

The rate at which concrete can be placed has a very great influence on the speed, and thus on the economic efficiency, of CIP concreting work. The Doka Fresh-Concrete Pressure Calculator is a quick and easy way to calculate the permitted rate of placing and max. fresh-concrete pressure.

We're already working on the next developments. Our aim is to continually enlarge and improve Doka Tools, so that it becomes an ever more useful digital helpmate for you at the site!

Features:- Dokaflex 15 and Dokaflex 30 tec design calculation, Dokaflex optimization, Fresh-Concrete Pressure Calculator, 'Share' functions for all calculations, Additional information about Doka, direct contact to Doka Services

6.2 iForms

iFormBuilder mobile platform

Powerful and Flexible Form Builder

HOME / POWERFUL AND FLEXIBLE FORM BUILDER

Combining powerful and easy commands with Javascript and the support and form building expertise of iFormBuilder's legendary support staff, iFormBuilder's form building is the most capable mobile data collection platform.

ZmB

Zerion Mobile Behavors (ZMB) - *"Makes skip logic seem like child's play"*

iFormBuilder's industry leading Zerion Mobile Behaviors (ZMB) creates a one of a kind comprehensive form building framework. Using simple Javascript commands, you can add skip logic, conditional elements and even interconnected forms and subforms.

Let us build your forms

Form building has never been easier with iFormBuilder's expert support and form building team. Simply buy hours to work with our team and iFormBuilder's experts will get to work on creating exactly what you need.

Robust Form Structures, all of the inputs you need

With more than 27+ input widgets including photo capture, barcode and magnetic strip reader, signature, gps, date and time recognition, iFormBuilder allows you to create forms that can master any data collection task. From Point of Sale to Survey, to inspection and customer check-in forms, iFormBuilder has the power and flexibility to be the solution to any mobile data collection need.

iForm
By Zerion Software

No Paper. No Connection. No Problem.

iForm brings business grade, offline data collection to iPhones, iPads and iPod Touches. iForm helps you increase productivity, reduce costs, and reduce paper use.

Conduct surveys, inspections, walk-throughs, work-orders, audits, tasks, research studies and clinical trials easily and cost effectively on your iPad, iPhone, or iPod Touch.

Using the iFormBuilder web interface, users can create business grade forms that will work seamlessly across all supported devices. Data views give you the flexibility to see your data in a variety of outputs including Map View, HTML View, PDF View and Excel View. Data feeds (XML, JSON, XLS, RSS, ATOM) offer seamless integration with your back-end systems.

The iFormBuilder platform gives you the power to turn your mobile device into an enterprise grade data collection tool.

Key Benefits:
-Quick turn-around with over-the-air form distribution
-Real time data upload
-Offline data collection (out of service, no wifi)
-Ensures accurate data capture and eliminates redundancy
-Immediately communicate changes and updates to your mobile workforce with server assignment and client-to-client assignment
-Massively scalable
-Maximum security (being used by HIPAA and FISMA regulated projects)

6.3 Bechtel

Better building with iPad.

"iPad allows innovation to get out of the office and into the field where it belongs."

Eli Walter, Engineering Manager, Bechtel

Bechtel is one of the world's most respected engineering and construction companies, with projects that span energy, transportation, communications, mining, oil and gas, and government services.

"Bechtel projects by definition require innovation, because they are things that have not been done before," says Walker Kimball, Bechtel Senior Vice President. Bechtel's complex international operations demand powerful, flexible project management tools and support systems. iPad and an array of custom-built and third-party apps connect workers with essential information that helps them meet the company's exacting efficiency, quality, and safety standards worldwide.

"iPad absolutely helps people be more efficient. Better quality, better productivity, a reduction in costs, and a happier customer. You're able to transform more lives."

Constructive Custom Apps

Bechtel has created several powerful in-house apps that make the iPad platform even more valuable in the field. “For any construction project, we do a great deal of monitoring and reporting,” Engineering Manager Eli Walter says. “Traditionally, we’d have a form, and a field engineer with a clipboard out on a site writing a report with a pen. Now, with iPad, the minute something gets changed or updated, engineers can see it on their device.”

Using a custom app called iForms, field engineers fill out safety inspections, quality reports, and hundreds of other forms onsite. And an in-house app called Documents lets engineers create, update, and share important technical information anywhere. “It’s not unusual for projects to have over a quarter-million documents, drawings, specifications, quality records, and certifications,” notes Kimball. “With Documents on iPad, employees get speedy access to current information that would have taken hours or days to retrieve before.”

Another iPad app, Concrete Monitor, wirelessly communicates with embedded sensors to help improve concrete quality on the thousands of cubic feet of concrete poured every day on Bechtel job sites. And Bechtel field engineers use a third-party app, junaio - Augmented Reality Browser, in tandem with the Autodesk 360 Mobile app, to superimpose schematics of mechanical, electrical, and plumbing systems over current images of a construction site. “We take advantage of the GPS technology built into iPad to map exactly where we are in the facility, then overlay this virtual information onto the physical assets,” Christian Reilly, Manager of EPC Systems, says.

In addition to these engineering apps, Bechtel has developed an app specifically to help keep workers safe on hazardous sites. “At Bechtel, safety is one of our core values,” says Walter. “xSDS is our Executive Safety Data System app—it’s an incredibly effective tool for making safety performance visible.” xSDS uses predictive analysis to allow Bechtel to be more proactive about safety incidents. “At the end of the day, we want to send all of our people home safe,” adds Reilly.

Ahead of the curve with iOS

Bechtel’s IT team relies on the many resources available in the iOS platform for development, deployment, and security. “The iOS ecosystem has been fantastic for us,” Reilly says. And it’s also easy to manage the apps and keep devices secure remotely via MDM. “We have a very robust mobile device management platform,”

says Reilly. “It allows us to monitor iPad use around the world and remove applications or wipe devices if there are security infringements or devices are lost.”

“We’ve taken advantage of everything iPad offers, from the actual devices themselves to the SDK and the encryption capabilities within iOS.”

The Ultimate Project Manager

As Bechtel builds highways, dams, power plants, airports, and other vital structures, iPad brings greater safety, quality, speed, and efficiency to each new project. “iPad removes what in the past has been a huge barrier for construction projects,” Walter says. “It allows innovation to get out of the office and into the field where it belongs.”

Reilly agrees: “iPad really helps us to make sure that we get things right, first time, every time. We’re doing things that would never have been possible without iPad.”

App Recap

- iForms enables field engineers to fill out and submit electronic forms, streamlining project management.
- Documents lets workers share time-critical project site data, so site engineers always access up-to-date information.
- Concrete Monitor improves efficiency and quality by measuring temperature of concrete throughout pouring and curing.
- xSDS pinpoints safety incidents and helps predict safety concerns worldwide, significantly improving worker safety.

Apps on iPad help Bechtel engineering teams stay up-to-date with the latest site plans and drawings, and reduce paper consumption on projects around the world. Project drawings, specifications, and checklists are available almost anywhere on Bechtel job sites, with iPad and custom, in-house apps.

7. Summary

In summary, from research there appears to be major advancements towards ICT systems for site engineers. Systems have been developed and adopted by a few major construction companies. Some apps for certain on-site tasks have been developed and tailor-made for specific operations. Certainly the iPad, iOS platform, custom made apps and iForms seem to be working well as a system. Linking these into more on-site tasks will be dependent on development of further apps and iForms. Combined with cloud technology, site engineering is slowly being revolutionised.

8. References

Research was carried out through Google search engine, the most informative sites were as follows:-

Apple	www.apple.com/ipad/business
Wiki	en.wikipedia.org/wiki/IOS
PlanGrid	www.plangrid.com
OnSite PlanRoom	www.itunes.apple.com/ie/app/onsite-planroom-for-ipad
WeatherAPP	www.weatherapp.us
Doka-Tools	www.doka.com/web/tools/apps/doka-apps
iFormsBuilder	www.iformbuilder.com
Bechtel	www.apple.com/ipad/business/profiles/bechtel www.bechtel.com
Windows	windows.microsoft.com/en.ie/windows-vista
Google Docs	docs.google.com
Dropbox	www.dropbox.com
RSS Feed	www.rssinclude.com

New Civil Engineer Magazine published by The Institution of Civil Engineers
Laing Civil Engineering Site Engineers Handbook