Mobile Drawings: The Art of Turning CAD Plans into Interactive Indoor Maps

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As the trend to mobilize the workplace picks up steam, organizations are looking to further enhance the mobile experience. This document outlines some best business practices for drawing publishing, and identifies common misconceptions and potential pitfalls when converting CAD floor plans to a mobile-ready interactive map format. Among the mobile technology innovators, few have overcome the technical hurdles of converting CAD plans into interactive indoor maps. One such company is FieldLFEX. Learn how the FieldFLEX Mobile Floor Maps Publisher can mitigate publishing issues and provide immediate value.

Executive Summary

Many organizations have already embraced mobility and have, or are in the process of, deploying mobile solutions for more than just corporate email. However, the value of many mobile solutions can be greatly improved by the addition of interactive mobile floor maps. Mobile solutions for work management, asset and occupancy survey, asset and facility condition assessment, inspections, move management, meeting room booking, and capital project commissioning all benefit by adding mobile floor maps and mobile indoor wayfinding solutions are only possible with indoor floor maps.

Today, virtually all organizations with more than 500 employees have CAD floor plans and the overwhelming majority has linked their CAD floor plans to enterprise CAFM\IWMS software. This valuable CAD drawing data can be leveraged for mobility, but proper due diligence and prudent planning is warranted to avoid pitfalls and maximize success.

Introduction

Computing and communications tools in the workplace have undergone an incredible transformation in just over 15 years moving us from deskbound phones and computers to laptops, smartphones, and tablets. The proliferation of mobile technology for use in everyday tasks continues to permanently reshape how we communicate. Today, mobile access to corporate email is nearly ubiquitous and mobile solutions for asset and work management as well as inspections and assessments are commonplace.

However, leading organizations committed to employing all mobility has to offer have moved beyond the status quo. They are implementing solutions that are only made possible through the recent advanced in mobile technology, such as leveraging contextualized and interactive indoor floor maps to improve visualization, strategic decision making, and wayfinding. More specifically, they want to add intelligent and interactive floor plans to mobile solutions for work management, asset and occupancy survey, asset and facility condition assessment, inspections, move management, meeting room booking, and capital project commissioning. Looking beyond facilities and infrastructure management, these early adopters are actively engaged in putting mobile indoor wayfinding solutions into the hands of all employees and visitors.

Meanwhile, organizations that aren't as far along in their adoption of mobile technology are well poised to reap the benefits from the actions of the mobile technology innovators. Organizations wanting to deploy asset and work management or inspection and assessment mobile applications can now easily improve these solutions by adding the ability to visualize work with mobile floor plans. Furthermore, they can raise the profile of the facilities group by deploying mobile indoor wayfinding solutions that leverage their linked space management CAD plans.

Emerging trends in the mobile workplace clearly show steady movement toward embedding intelligent and interactive floor plan drawings in mobile applications for users outside the facilities group. The majority of employees in an organization benefit from self-service-style mobile applications enhanced with mobile indoor floor plans. Rich user interfaces include features such as: locating a printer, meeting room, hoteling station, or team member; submitting a location-specific service request; locating and making room bookings; and locating the closest emergency exit or automated external defibrillator unit. New mobile solutions are now available for security personnel to report location specific security incidents and to track rounds. First responders can now immediately get visual access to emergency equipment locations and countermeasure procedures. Where organizations have deployed indoor wireless locating grids, mobile users can find their position in a facility, locate other employees, such as nurses or service technicians, and find mobile equipment, such as infusion pumps or audio-visual equipment.

The Case for Mobile Floor Maps

Large organizations, inclusive of government, higher education, and healthcare, are broadening their technology landscape and adding mobile applications to further enhance productivity. However, many of the mobile applications in use by large organizations do not allow for full mobility as mobile users are only provided with partial digital information to perform their tasks. Paper drawings or wall mounted maps are often referenced by field service technicians as well as any individual needing to locate an area or space. In the end, mobile users always find where they need go, but it can be better. Paper or wall mounted floor plans often lack specificity, are not up-to-date, or can't be located. Regardless of these factors, it is commonplace to find mobile workers relying on paper floor plans or emergency evacuation plan placards for navigation.

The case for enhancing mobile applications to include floor plans and floor maps is relevant for both organizations with deployed mobile solutions and organizations without. The progression into full mobility includes enhancements to existing mobile technology. Publishing CAD drawings to a mobile-ready format and embedding interactive floor plans and maps in mobile applications can eliminate time consuming and costly manual activities and reduce indoor travel time. A study by Christoph Hölscher and Martin Brösamle from the Centre for Cognitive Science at the University of Freiburg found that people travel an average of 36.8% farther than necessary when trying to find indoor locations in unfamiliar facilities[1]. Furthermore, accounting for time lost while stopped and trying to reorient themselves, people took 96% more time than optimal to complete these trips. In another study by Jiang Hao and Yen Ching Chiuan from the Department of Architecture at the University of Singapore it was found that people unfamiliar with complex multi-storey buildings take 62.8% more time to travel to their desired indoor destination than those that are familiar with the facility[2]. This study also found that those familiar with a facility were much less likely to consult a floor plan when attempting to find unknown locations resulting in more travel time than that of unfamiliar visitors, confirming that both familiar and unfamiliar visitors to a facility can benefit from mobile indoor floor plans.

All employees and visitors of an organization must routinely find various indoor locations. Even if only a fraction of the time lost due to being lost, as cited in the studies above can be eliminated, a positive return on investment from providing mobile floor plans to an organization's employees and visitors can readily be demonstrated.

Squeezing Value from Existing CAD Drawings

In the US alone, there are over 20.5 billion square feet of office, healthcare, and education space[3]. Nearly all of these 20.5 billion ft^2 exist as in CAD drawing format. The thousands of organizations that occupy this space invest considerable time and money to produce and maintain CAD drawings to represent their portfolio in digital format. Extending digital floor plans to a mobile device is the next step for organizations in pursuit of optimizing and streamlining operations. However, existing CAD drawings are not suitable for mobile use.

The Best Cake Recipe in the World

Creating AutoCAD floor plan drawings is akin to baking a cake using a tried & true recipe. Where the cake baker uses ingredients, such as flour, eggs, and milk, baking time and temperature, presentation, and frosting to create the cake, the CAD/CAFM operator uses drawing ingredients, such as polylines, text, and blocks, drawing units and precision, layers, and colors to create the drawing. However, the way a cake looks on the outside does not reflect how it will taste, nor indicate how it was made. The most delicious looking vanilla frosted cake could turn out to have mayonnaise for frosting and hamburger for filling. Likewise, the way a drawing appears sometimes does not reflect how the drawing was created. Nor does it reflect its suitability for use as a mobile floor plan.

Following the Recipe: Base Building Drawing Analysis

Beginning in 2008, the authors undertook extensive research and development in the area of mobile floor plans. During this period, the AutoCAD floor plan drawings of dozens of large organizations including drawing sets from government, higher education, healthcare, and Fortune 1000 corporations were analyzed. AutoCAD drawings were thoroughly reviewed and analyzed for adherence to an organization's drawing standards, attention to detail in drawing composition, how many 3rd party CAD objects were used, and the quantity, type, complexity, and composition of block objects. The results are surprising. While most organizations believe they have well-defined and tightly implemented drawing standards, less than 40% actually do. Similarly, most companies do not realize that inconsistent drawing composition and general poor AutoCAD drawing health can be upwards of 25% more costly to maintain and publish than clean and well-maintained drawings.

AutoCAD floor plan drawings are living documents that can easily be decades old. Over a drawing's lifetime many different CAD operators and vendors will update and add to the drawing content. And, a single set of base building drawings will often serve many purposes for the organization. In this case, when a situation arises that requires non-standard updates to the drawings; the tendency is for CAD operators to adapt their drawing "standards" on-the-fly as these new requirements are encountered. These rogue changes often involve adding

detail to the standard to suit a specific drawing, building project, or simply apply the designer's unique style. However, even the smallest change to a drawing standard must be propagated throughout the drawing portfolio. For example, adding a layer called "A-WALL-EXT-JAMB" for door and window jamb objects in the exterior wall in one drawing necessitates that all other drawings in the portfolio have door and window jambs objects moved from the "A-WALL-EXT" layer to this new layer. This time consuming exercise provides little immediate value and is often not performed. However, over time and with each similarly minor change to drawing standards, an organization's master set of drawings becomes increasingly heterogeneous. Since the visual style of any drawing object can be easily overridden, drawings that *appear* to adhere to a standard may not. Without rigid enforcement of drawing standards problems can arise when publishing AutoCAD drawings to a other formats, including mobile. For example, if layers are added to an organization's standards to capture information related to wall fire ratings but only a portion of the drawing inventory was updated, then publishing the interior wall layer and not the fire rated wall layers to a mobile format will result in some mobile floor plans missing interior walls.

At some organizations different sets of base building drawings are maintained by different groups to better meet specific business needs. This strategy allows space managers to more easily maintain proper standards compliance across a drawing portfolio. However, in this situation drawing standards can sometimes lack the necessary granularity to filter out extraneous detail while retaining contextually valuable information. For example, if all exterior wall, structural column, insulation, glazing, window jamb, and window sill objects are on a single exterior wall layer then the resulting mobile floor plan drawing will be unnecessarily bloated.

While drawing standards may meet the requirements of the organization, they may not be appropriate for conversion into a mobile format. Frequent discrepancies are found with respect to how drawing standards are enforced from site to site, building to building, and even floor to floor. Having tightly implemented drawing standards necessitates that all CAD operators who edit a drawing during its life share a common understanding of AutoCAD, the organization's drawing standards, and how to implement these standards. Ensuring an organization's AutoCAD drawing standards support publishing to a mobile-ready format and that these standards are consistently applied across the organization's drawing portfolio is only the first step in being prepared for a mobile future.

Avoid These Ingredients: A Few Examples of Mobile Unfriendly Drawings Practices

During our research and analysis we uncovered many mobile-unfriendly AutoCAD drawing practices independent of drawing standards-related issues specific to how drawing content is created.

The Dynamic Block Double Edged Sword

Since 2006, Autodesk has provided a 'Dynamic Block' in AutoCAD. A dynamic block can be defined with variable visual properties. For example, a typical floor plan can easily contain more than 200 interior doors. These door openings can be of varying width and penetrate through varying wall thicknesses. To make things simple for the CAD/CAFM operator, a single dynamic door block with variable door opening and jamb dimensions can be created. This single dynamic door block can then be inserted 200 times into the floor plan drawing with the appropriate dynamic properties assigned. Each time the single door block is inserted into the drawing it is defined with an arbitrary (and unique) name, as an 'anonymous' block. There may only exist eight (8) different opening and jamb dimension combinations in the floor plan, however, rather than creating eight (8) different door blocks, just one is used. When such a floor plan drawing is published to a mobile format, the reusability nature of the AutoCAD block object is lost and the mobile floor plan data required to define these 200 doors is bloated by 2500%. Anonymous blocks can be created in a number of ways, but regardless of how created, they result in unnecessarily large mobile floor plan drawings.

Polylines Created with BPoly

The AutoCAD® BPoly command is another time saving tool for CAD operators that will automatically create a polyline boundary around the inside of a shape based on a single selected point inside that shape. However, the resulting polyline has a vertex point at every point where another object meets the boundary regardless of whether or not the vertex point is needed to define the polyline. The example below illustrates two equally sized square polylines. The object on the left was created using BPoly and is comprised of 28 line segments. The object on the right was created using the Pline command and has just four line segments. In this example, the use of BPoly increases the data size of this polyline by 700%.

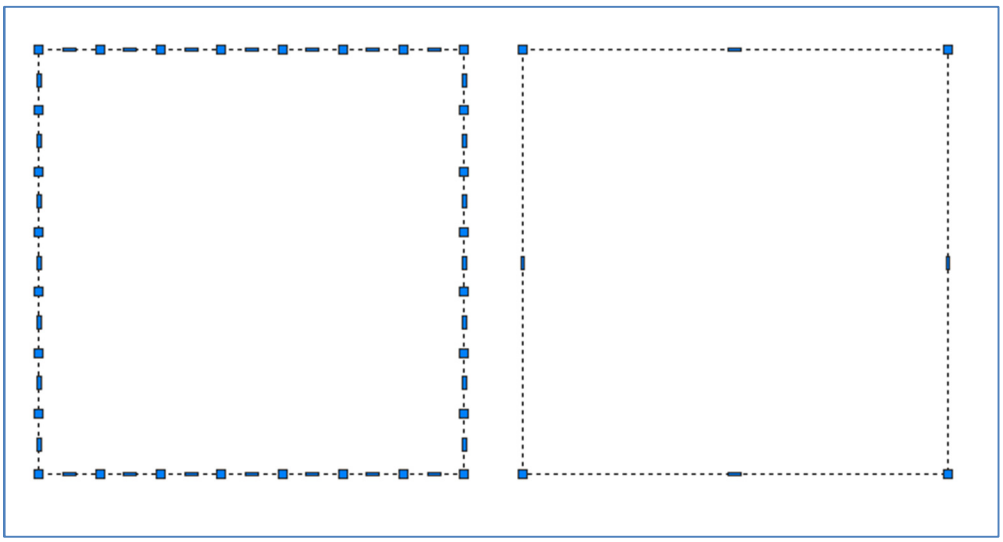

Figure 1: Two equally sized and shaped polylines. The left polyline was created with the BPoly command and comprises 28 segment AutoCAD Objects. The right polyline was created with the Pline command and comprises an optimal 4 segment AutoCAD Objects.

Mobile Unfriendly Blocks

Companies such as building materials suppliers and furniture manufacturers often provide extensive AutoCAD block libraries to Engineers, designers, and architects. Use of these 3rd party block libraries makes the CAD operator's life easy since they reliably represent the size and detail of the product or component being used. However, often these 3rd party blocks contain minute detail that does not provide any value to mobile users. The example below illustrates a vendor's double door block on the left and a minified version on the right. The two blocks provide equal value for mobile users, however, the vendor's block comprises 1149 AutoCAD® objects versus just 18 objects in the minified version on the right. Use of 3rd party block libraries can result in extensive bloating of a mobile drawing; by more than 6000% in this example.

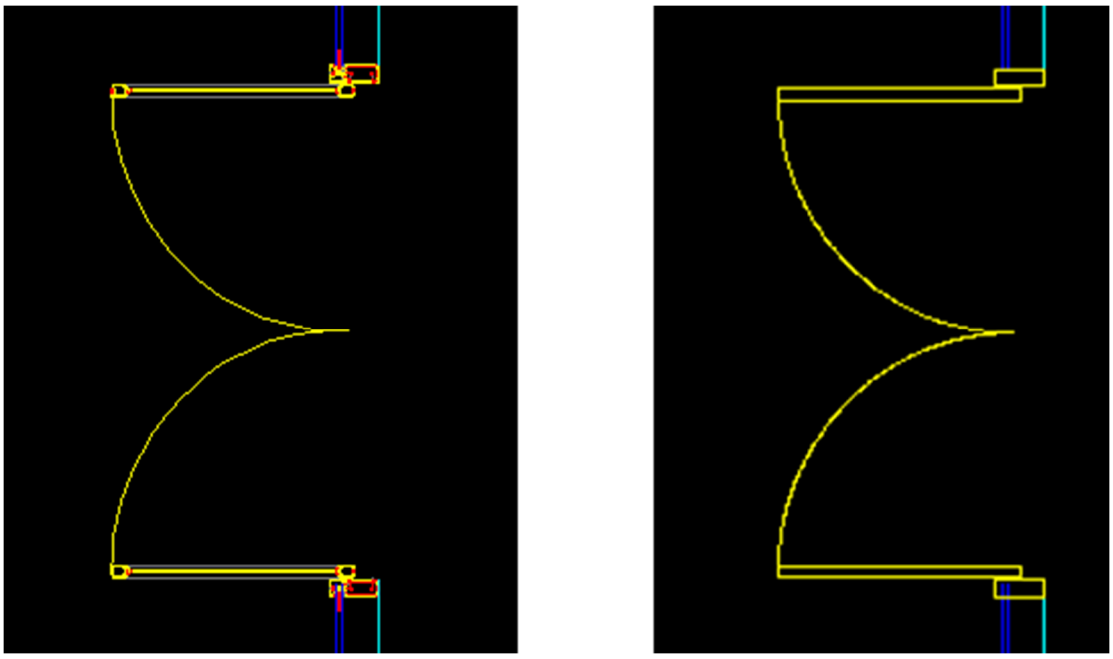

Figure 2: Two double door blocks of equal value to mobile users. The left block is from a 3rd party vendor and comprises 1149 AutoCAD objects. The right block is a minified version of the same block that has been optimized for mobile use.

The Frosting on the Cake: Conclusions from Drawing Analysis

Our analysis revealed the existence of many potential problems for organizations wanting to publish base building AutoCAD drawings for mobile use, including:

- Overly granular standards or variably granular drawings
- Inappropriate or no drawing standards
- Partially enforced drawing standards
- Mobile unfriendly drawing practices
- Drawing best practices not followed

Further analysis revealed a gulf in stakeholder understanding of what constitute mobile-appropriate drawing standards and mobile-friendly drawing practices. Many believe that these issues are minor or inconsequential and choose to proceed with mobile drawing publishing without performing the necessary drawing review and clean-up. However, 57% of organizations assessed had base building drawings in their drawing inventories that when published to a mobile-ready format resulted in mobile drawings that were more than 1000% larger than necessary. The implications of this are higher network bandwidth usage; long data synchronization times; slow, chunky, or non-performance on mobile device; low user satisfaction; higher total cost of mobile solution ownership; and, ultimately, low adoption by casual users.

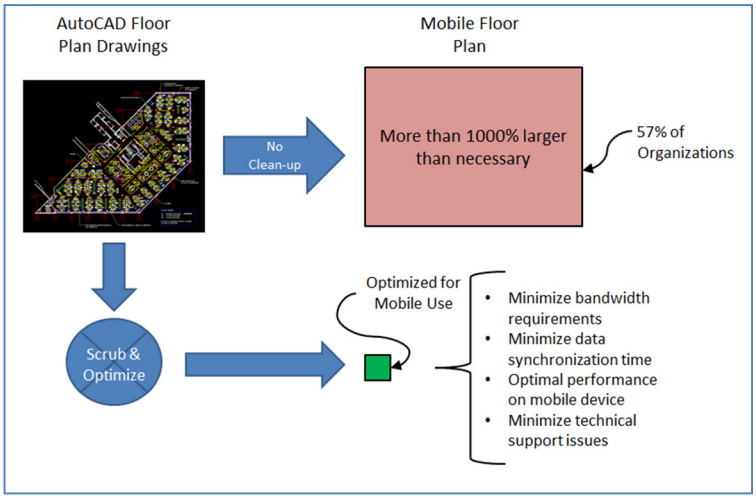

Figure 3: Industry Base Building Drawing Analysis Findings Summary and Benefits of Drawing Optimization

The Drawing Review & Mobile Publishing Solution

As the move toward mobile floor maps progresses, so too will the investment in producing the floor maps. As discussed, there is tremendous value in existing CAD drawings when it comes to producing mobile floor maps. However, there remains a significant effort to review and fix CAD floor plan drawings prior to publishing. This effort can sometimes be a time-intensive and costly task, especially if the CAD drawing has gone through multiple iterations and through many hands during its life.

FieldFLEX Drawing Review

To reduce this effort and build in some checks and balances to the drawing review and preparation process some structured approach and automation should be employed. Certainly the CAD operator can pre-screen a drawing, but a structured method for drawing review and repair, such the process designed by FieldFLEX, will lead to a cleaner and more structured drawing that is suitable for mobile publishing. Additionally, the FieldFLEX drawing review method is supplemented with CAD automation that performs floor plan drawing checks to pinpoint problem areas which need to be addressed prior to publishing.

FieldFLEX Mobile Floor Map Publisher - Overview

FieldFLEX Mobile Floor Map Publisher contains powerful drawing publishing tools to produce light weight, intelligent, mobile-ready floor maps from existing CAD floor plan drawings. Mobile floor plans comprise all necessary data hooks to support data-driven thematic space highlighting, data-driven annotation, and contextual highlighting and annotation for optimized wayfinding. The Publisher is an AutoCAD® based utility for converting AutoCAD® floor plan drawings into a format that can be used on mobile devices by **FieldFLEX Mobile** applications.

The publishing tool can be operated in a batch or on-demand mode allowing the CAD floor plan drawings to be published how and when needed.

Summary

Companies who have already established mobile workplaces and are innovating beyond the standard mobile applications, such as email, can now enrich their mobile workplaces with intelligent, interactive mobile floor maps. Mobile Floor Maps are embedded into the FieldFLEX mobile applications for navigation and location-based activities. Organizations need not look beyond their existing CAD floor plan inventory to create these maps – the value in the CAD floor plans can be increased using the FieldFLEX Mobile Floor Map Publisher.

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