AC 2012-4019: ENGINEERING DESIGN SOFTWARE IMPLEMENTATION: HOW ONE ENGINEERING FIRM SUCCESSFULLY IMPLEMENTED AUTOCAD CIVIL 3D

Mrs. Sonya Bond Overstreet, EMH&T

Sonya Overstreet is the Production Support Manager at EMH&T, one of Ohio's premier engineering firms. Overstreet's many years of experience in the engineering field have provided her with a broad technical background in civil engineering and commercial development. With her technical and organizational skills, Overstreet manages the integration, use, support, and advancement of AutoCAD and other similar design software products throughout EMH&T. Overstreet earned a bachelor's of arts degree in organizational communication and is currently pursuing her master's of science in instructional design and performance improvement.

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Engineering Design Software Implementation: How One Engineering Firm Successfully Implemented AutoCAD® Civil 3D®

Abstract

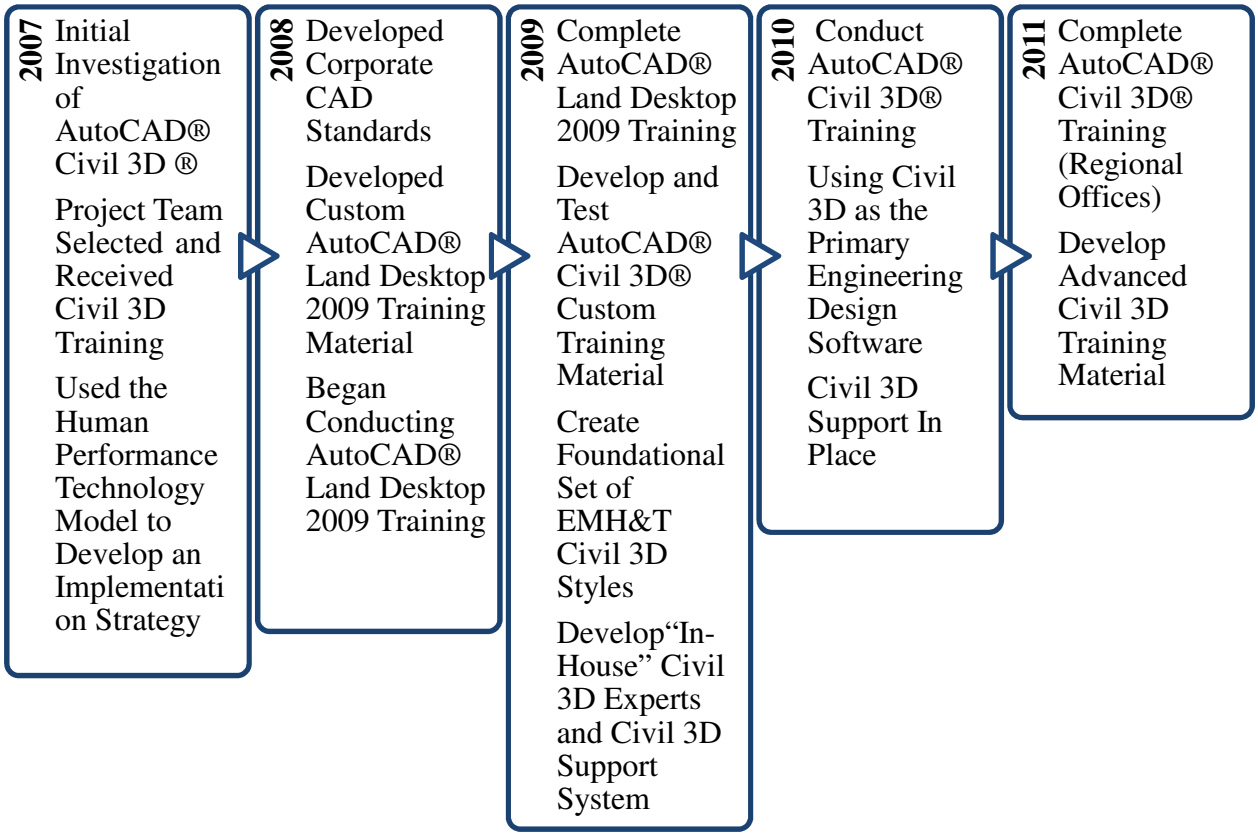
This paper examines the efforts of one engineering firm to position itself for future success and gain a competitive edge by upgrading its engineering design software. With a backdrop of the longest U.S. economic recession since World War II[1], EMH&T embarked on an implementation and training strategy to upgrade their engineering design software. Recognizing that they were at least five AutoCAD® Land Desktop versions behind, the decision was made to undertake a corporate wide technology upgrade. After careful consideration, it was determined that the best course of action was to take a two-phase approach. EMH&T would upgrade from AutoCAD® Land Desktop 2004 to AutoCAD® Land Desktop 2009 and then make the leap to AutoCAD® Civil 3D®. This paper will also provide tips for sustaining and advancing engineering design software upgrades.

Introduction

According to the National Bureau of Economic Research (NBER) the worst economic recession in U.S. history since the Great Depression began in December 2007 ending in June 2009. [1] During this 18 month economic slowdown, the leadership at EMH&T decided to position the company for future success. Responding to industry and technology pressures, EMH&T would use the recession as an opportunity to improve their engineering design process and upgrade their engineering design software from AutoCAD® Land Desktop 2004 to AutoCAD® Civil 3D®. President Sandra C. Doyle-Ahern, MEn said that it was important to advance with Civil 3D to give EMH&T a competitive edge.[2]

EMH&T founded in 1926, has 85 years of experience offering, "…an extensive array of services including civil engineering, land surveying, environmental management, landscape architecture and land planning."[3] EMH&T's ability to remain profitable is contingent on their ability to master the available technology to produce reliable engineering solutions for clients. In 2007, EMH&T began working on a strategy to implement the latest engineering design software, AutoCAD® Civil 3D®. The primary goal of the implementation was to use AutoCAD® Civil 3D® to increase efficiency by producing a more accurate and consistent set of engineering plans throughout the organization. A secondary goal was to have a more flexible workforce that allows project managers to share personnel due to project needs. With these goals, EMH&T developed a comprehensive set of corporate CAD standards, developed custom AutoCAD® Civil 3D® training material to train members of their technical staff and developed a Civil 3D technical support system. Figure 1 shows a general timeline of the overall implementation plan.

Figure 1 AutoCAD® Civil 3D® Implementation Timeline



AutoCAD® Civil 3D® is an engineering design software package developed and sold by Autodesk®. Autodesk® is a world leader in the development of engineering design software. One of Autodesk's most well-known software packages, AutoCAD, was first introduced in 1982[4]. The introduction of AutoCAD created a paradigm shift in the engineering and architectural industries. For engineering firms advancing with AutoCAD, it meant moving their technical staff from hand drafting to computer aided drafting (CAD). Douglas E. Romer, P.E., executive vice president, EMH&T, remembers the early days of AutoCAD. Mr. Romer recalls the serious discussions among the drafting staff asking the question, "Why do we have to go to AutoCAD?" [2]

This paper will focus first on EMH&T's engineering design software prior to the implementation of AutoCAD® Civil 3D®. Second, this paper will discuss how EMH&T used a team approach and human performance technology principles to develop a strategy for implementing AutoCAD® Civil 3D® throughout the organization. Next, this paper describes why EMH&T created custom training material. Last, this paper provides tips and best practices for sustaining and advancing engineering design software upgrades.

Current Technology

In 2007 EMH&T was using AutoCAD® Land Desktop version 2004 as their primary engineering design platform. At this point EMH&T was five AutoCAD® Land Desktop versions behind. Recognizing their technology gap, the board of directors agreed that an upgrade was necessary.

While still releasing updated versions to Land Desktop, Autodesk® was developing a new engineering design platform, AutoCAD® Civil 3D®. AutoCAD® Civil 3D® was generally thought to soon replace Land Desktop. So, for EMH&T the question was to upgrade to the most recent version of Land Desktop or make the move to AutoCAD® Civil 3D®. EMH&T's decision became more urgent when Autodesk® announced that AutoCAD® Land Desktop 2009 would be the last release of Land Desktop[5]. It was determined that moving directly from Land Desktop 2004 to AutoCAD® Civil 3D® would be too large of a technology jump to implement successfully. So, in the end, EMH&T decided on a two-phase upgrade and implementation plan: upgrading to AutoCAD® Land Desktop 2009 with immediate plans to start developing a strategy to implement AutoCAD® Civil 3D®.

Phase One: AutoCAD® Land Desktop Upgrade Strategy

The translation from AutoCAD® Land Desktop 2004 to AutoCAD® Land Desktop 2009 was a fairly simple transition. After reviewing the upgraded features in Land Desktop 2009, it was determined this transition would not dramatically affect EMH&T's current workflow process. Since the entire technical staff was familiar and very knowledgeable of Land Desktop 2004, the move was less time consuming and required less training hours. The project team developed custom training material for a one day training course.

With the first phase of the upgrade and implementation plan complete the project team gathered feedback from end users (engineers, designers and technicians) on the quality of the custom training material, the training session and the availability of expert support after training. All data collected was used to develop best practices and improve the implementation plan for moving to AutoCAD® Civil 3D®.

Phase Two: AutoCAD® Civil 3D® Implementation Strategy

With the first phase of the overall technology upgrade a success the project team began to develop the Civil 3D implementation strategy. The project team, dubbed the Civil 3D support team, was made up of seven core team members. These team members, project managers and technical staff, represented the information and technology department and production departments. Other team members that temporarily joined the project represented the human resource department and the regional offices. With such a diverse project team assembled, many potential issues were brought to the table: hardware issues, engineering design issues, and performance and training issues. From a performance improvement perspective the team walked through, for the first time, the Human Performance Technology (HPT) Model. Human Performance Technology is defined by the International Society for Performance Improvement (ISPI) as "a systematic approach to improving productivity and competence, uses a set of

methods and procedures -- and a strategy for solving problems -- for realizing opportunities related to the performance of people."[6]

Working through the HPT model the Civil 3D support team completed a gap analysis to identify the performance improvement opportunities. To complete the gap analysis the Civil 3D support team requested documentation from all project managers on their team's CAD standards, workflow and an example set of the various plans they produce. Additional information was collected through a series of individual and group meetings with project managers and the technical staff. The Civil 3D support team sorted through the information received and began to map the differences. The findings of the gap analysis are found in Table 1.

Table 1 - Gap Analysis Table

Desired Workforce Performance: All AutoCAD users are to be proficient in utilizing Civil 3D and following established company standards to produce a consistent and accurate work product (plans) to allow more flexibility among the workforce.		
Actual Workforce Performance: AutoCAD 2004 is being used for production of work product and the use of standards varies greatly between departments and regional offices.		
Gap	**Impact**	**Cause**
AutoCAD® Civil 3D® is not being used as the primary engineering design software.	The goal of the organization to use AutoCAD® Civil 3D® as their primary engineering design software cannot be realized.	AutoCAD® Civil 3D® has not been implemented as the primary engineering design software throughout the organization.
Nearly every group throughout the organization produces plans using their own individualized CAD standards.	There is no consistency in the look of the plans throughout the organization. It is difficult to share personnel. Technical staff needs to learn new CAD standards depending on what group they are working with, causing a decrease in productivity.	A uniform set of CAD standards has not been developed or implemented. Senior management evaluation of work product differs.
All groups are not using the 3D modeling capability in the available engineering design software.	It is difficult to share personnel. Technical staff may need to learn 3D modeling depending on what group they are working with, causing a decrease in productivity.	A plan production workflow standard or best practice has not been developed and implemented. Technical staff is not trained to use the 3D modeling capability in the available

		engineering design software. Senior management evaluation of work product differs.

During the cause analysis phase, the project team found the lack of environmental support included: the lack of comprehensive data for current departmental and regional office CAD standards, workflow and procedures (1), no training established for Civil 3D (2), and the development and implementation of corporate CAD standards had not been made a priority (3). The project team also found the use of the current engineering design software, AutoCAD® Land Desktop 2004 and 2009 was not being used as a design tool by all production departments. There was also a general attitude of skepticism toward the need, availability and quality of Civil 3D training.

The interventions developed by the Civil 3D support team to achieve the desired performance included: establishment of corporate CAD standards (1), development of custom AutoCAD® Civil 3D® training and material (2), conduct in-house Civil 3D training sessions for all CAD users (3) establishment of an in-house Civil 3D support system to address user questions (4). A fifth intervention was later added, upgrade computer hardware and software, after it was found that the current computer systems did not run AutoCAD® Civil 3D® efficiently. By upgrading all systems to 64-bit Windows 7 machines, the technical staff experienced fewer fatal errors and crashes while using AutoCAD® Civil 3D®. Table 2 shows the direct link of proposed interventions to identified performance gaps.

Table 2 – Performance Gap and Intervention Links

Performance Gap	Intervention
AutoCAD® Civil 3D® is not being used as the primary engineering design software.	- Establish corporate CAD standards - Develop custom AutoCAD® Civil 3D® training and material - Conduct in-house Civil 3D training sessions for all CAD users - Establish an in-house Civil 3D support system to address user questions
Nearly every group throughout the organization produces plans using their own individualized CAD standards.	- Establish corporate CAD standards
All groups are not using the 3D modeling capability in the available engineering design software.	- Establish corporate CAD standards - Develop custom AutoCAD® Civil 3D® training and material - Conduct in-house Civil 3D training sessions for all CAD users - Establish an in-house Civil 3D support system to address user questions

Corporate CAD Standards

Looking at the results from the gap and cause analysis it was clear that a comprehensive set of corporate CAD standards needed to be created. The efficiency gained with AutoCAD® Civil 3D® is found in the dynamic linking of labels to the 3D model. AutoCAD® Civil 3D® styles control the appearance and sometimes the behavior of the Civil 3D objects in a drawing. For instance, labels calling out the size and length of a pipe are dynamically linked to the pipe network so when the pipe size changes, the label automatically updates throughout the plan set. Developing Civil 3D styles, "…that meet your company standards is one of the most important steps you can take to ensure that you have a successful transition to AutoCAD Civil 3D".[7] EMH&T current practice was that each work group had their own take on CAD standards resulting in plans from one group looking vastly different from plans another group produced. It was communicated by the board of directors that they wanted to see consistency among the plans produced throughout the company.

After several meetings with project managers and the technical staff examining various plan types produced by different departments a consensus was formed on what the minimum expectation was for a set of plans. Next the Civil 3D support team identified the CAD standards, see Table 3, that needed to be established to move forward with building Civil 3D styles and implementation of the software.

Table 3 Corporate CAD Standards/Best Practices

Corporate CAD Standards/Best Practices Needed for Plan Production	
Layer Names	Linetypes
Lineweights	Symbols
Font Styles	Drawing Template
Abbreviations	

In addition to the CAD standards and best practices the Civil 3D support team developed other digital information standards to ensure a successful implementation. These standards and best practices included an overall project directory structure and project workflow best practice.

Custom AutoCAD® Civil 3D® Training

With a set of corporate CAD standards in place the Civil 3D support team turned their attention to training. The team had a choice to: train the technical staff with off-the-shelf training material or create custom training material specific to EMH&T and the work they produce. Several of the Civil 3D support team members had received basic and advanced training in AutoCAD® Civil 3D® with off-the-shelf material and found that the material lacked the depth needed to train

EMH&T CAD users, and the training exercises and examples were not relevant to the plans EMH&T produced.

The Civil 3D support team felt that creating custom training material was important to the Civil 3D implementation because they could:

- Tailor the material to the specific needs of EMH&T.
- Reinforce corporate CAD standards and other digital information standards.
- Provide greater relevance to users by using examples of EMH&T work products.
- The data set for the training exercises would use EMH&T Civil 3D styles.

The goal of the custom training material was to replicate the work environment the CAD users would operate in after training. The hope was the training would be immediately relevant because every product produced in training would be similar to the product the CAD user would produce for any "real" project.

By designing custom training material, the Civil 3D support team was able to limit training to 3-days instead of the 5-days that most outside consultants conduct. The reduction in training days was the result of eliminating unnecessary training material and targeting the training to focus on the production needs of EMH&T. Another advantage of custom in-house training material is that EMH&T would hold the copyright. This would give EMH&T the flexibility of editing and reproducing the material with as-needed options not available with off-the-shelf material.

Summary

EMH&T's transition from AutoCAD® Land Desktop 2004 to AutoCAD® Civil 3D® was no easy task. This was a huge corporate initiative that affected nearly every aspect of their engineering design and plan production process. Work began in 2007, when a project team was assembled to investigate the functionality of Civil 3D and ended December 2011 with all technical staff receiving AutoCAD® Civil 3D®. The total number of technical staffed trained was 184, including employees in the Columbus, Indianapolis and Charlotte offices.

In order for the implementation of AutoCAD® Civil 3D® to be successful, it is vital to have the approval and commitment of the organization's board of directors. Without their commitment, it is unlikely that the necessary resources (time, personnel and money) would have been allocated. It is also important to have their commitment to set the tone for the entire organization that the implementation was a top priority. Other tips for a successful AutoCAD® Civil 3D® implementation:

- Investigate Civil 3D thoroughly to gain a good understanding of the functionality of the software, and how moving to Civil 3D will affect the current plan production process. Do not underestimate the time and resources required.
- Develop a set of corporate CAD standards.
- Build a diverse project team that represents different areas of the organization to lead the implementation.

- Engage as much of the technical staff in the implementation as possible.
- Develop a support system with in-house experts to assist users after training.
- Keep the time between training and on-the-job application to a minimum.

EMH&T's AutoCAD® Civil 3D® implementation was successful because they identified the need and causes, developed a strategy to meet the need, had the commitment of the board of directors and a strong and diverse project team. Mrs. Doyle-Ahern and Mr. Romer, both agree that managing risk in business is challenging, but in difficult economic times it is important to take those risks to position the organization for success in the future.[2] Moving from AutoCAD® Land Desktop to AutoCAD® Civil 3D® was a risk with a successful outcome giving EMH&T the ability to be more efficient and produce a more consistent set of engineering plans and increased flexibility with shared personnel among groups.

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