Empowering a paradigm shift: MicroStation to Civil 3D

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Learning Objectives

- Identify strategies to help civil engineering firms shift from MicroStation to Civil 3D
- Describe types of data required for a Civil 3D project while adhering to BIM principles
- Explain best practices to manage, share and create data
- Formulate a pedagogical framework to share new technical knowledge

Description

Moving from a MicroStation to a Civil 3D platform is a paradigm shift. We will review the data presented to senior leadership, arming them with information to make the switch. Not all projects are equal; hence, we will discuss types of projects suitable for the change. Equally, teaching data management, BIM principles, and Civil 3D is key to a successful platform migration. We will cover the pedagogical theory and techniques used to empower users with new skills. We will consider key strategies to facilitate this shift across different offices in the U.S. Data is central to a Civil 3D project. We will examine the data management tools and techniques used to make the learning curve less steep. This will include types of data that are typically necessary for a design project with Civil 3D. In this talk, we consider how data was created, managed, and shared in Civil 3D 2019/20. Finally, we will review a few technical and non-technical challenges encountered while making the shift.

Speaker(s)

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Introduction

This Industry Talk is a story about our digital transformation at Gannett Fleming. It charts our journey empowering our peers while shifting paradigms from a 2D Drawing Centric approach using MicroStation to a 3D Model Centric approach using Civil 3D. We undertook this change on a wide range of projects, from roadway design and site design involving collaboration with multiple disciplines, including architects and bridge designers. These projects spanned across different states. They were in varied regulatory contexts with stakeholders and employees from across the United States.

Our journey is a story of a paradigm shift — moving from a 2D Drawing Centric (2DDC) to a 3D Model Centric (3DMC) approach using Autodesk Civil 3D. Thomas Kuhn, an American Physicist and Philosopher, introduced the concept of a paradigm shift in his seminal work: "The Structure of Scientific Revolutions." A paradigm shift entails changing theoretical perspectives and adjusting practices accordingly.

We can look back a few hundred years at a classic example of a paradigm shift. Today, it is inconceivable, but in that era, even the scientific community viewed the earth as the center of the universe. A paradigm shift involved changing a perspective that the sun and not the earth was the center of the universe.

The shift from 2DDC to a 3DMC approach is not a paradigm shift of the same magnitude as moving from a geocentric to a heliocentric view. It will not shake the philosophical and moral perspectives of societies. It is nevertheless a paradigm shift. The transformation involves changing the understanding of how data is created and managed. Correspondingly it requires changing practices around data management.

From Kuhn's work, we know societies resist paradigm shifts. Any change is angst producing for people even if it is a necessary and beneficial transformation. Further, Kuhn informs us that a new paradigm overcomes friction and becomes the dominant paradigm with time.

Outlined here are a set of strategies that helped us overcome friction due to the paradigm shift. Notably, before implementing these strategies, we ensured an empathetic environment where we considered and addressed change adopters' perspectives.

Transformation Strategies: MicroStation to Civil 3D

We took a three-pronged approach to navigate the paradigm shift successfully. A surveying instrument is a useful metaphor to consider. For a surveying instrument to work with precision, we must pay attention to the tripod’s three legs. Similarly, we paid attention to three facets necessary to enable the change from a 2D-Drawing Centric (2DDC) to 3D-Model Centric (3DMC) approach.
Facilitate Leadership Commitment

Develop a Pedagogical Framework

Pragmatic Technical Implementation

**EMPOWERING PARADIGM SHIFT WITHIN AN EMPATHETIC MILIEU**

**Facilitate Leadership Commitment**

From Business Leaders’ vantage point, a firm is always balancing competing needs. They need to balance current business needs and future goals. Making a conscious paradigm shift requires an exact blueprint. Like any well-crafted map, the roadmap should identify potential routes and obstacles along the way to the destination. It should include a comparison of current and future paradigms. It is critical to provide business leaders a blueprint to make decisions balancing current and future needs.

Transitioning to a 3DMC approach involves two tasks that require significant resource inputs. It entails the upskilling of personnel to use new tools and changing their viewpoints. Additionally, it consists of creating supporting content such as templates. Before embarking on a paradigm shift, comparing the future approach with the current approach adds clarity to the roadmap.
We can map projects in terms of human and financial resources and project milestones. All projects, regardless of the approach, expend resources to produce milestone deliverables. Figures 1 and 2 denote resources spent on the X-Axis, and the Y-Axis shows project milestones. Each unit of input resource constitutes human labor and capital. Figures 1 and 2 below show a comparison of progress between the 2DDC and 3DMC approaches in resources expended and project milestones.

For initial projects, a 3DMC approach will undoubtedly expend more resources in comparison with a 2DDC method. Project stakeholders and leadership need to know the delta in resources to make an informed decision. There are two potential pinch-points during the initial implementation of projects using the 3DMC approach. Firstly, the project requires additional resources units in totality.

Figure 1 shows that the region to the Resource Inflection line’s right denotes the total additional resources needed. A firm could supplement the extra resource units required using a training budget or research and development budget. Project managers could educate clients by showing them the long-term benefits of using the 3DMC approach. Finally, the value-added from using the 3DMC method could help a firm win additional work.

The second pinch-point is equally essential to consider. Due to the reasons mentioned above, projects may have a potential gap in expectation at the earlier project milestones. It is unlike the first pinch-point discussed above. A firm does not expend financial resources directly. Clients become accustomed to seeing a certain level of completion at the earlier stages of the project with an established 2DDC approach. By articulating the milestone expectation gaps early, we can help address potential issues with stakeholders. Further, project liaisons could communicate the value of additional content added to the project and its value-added to the client.

Scientifically, it is impossible to compare two phenomena (Design Project in our case) that have not been completed following both paradigms. An accurate scientific comparison would mean a project is executed by two teams of similar disposition and skillsets by following the two alternate paradigms. That is the only way we could truly compare the two approaches. However, we could use past data and prior experiences of personnel within the firm who have empowered such a shift. Gather data based on their experiences. Comparing two approaches is not a futile exercise. As it allows us to examine our current resources, identify potential gaps, and strategize interventions.
Figure 1: First C3D Implementation

After the first project implementation, the law of Increasing Returns takes effect. In terms of resources expended or cost, increasing returns mean lower costs per unit of output. As firms produce more units of a commodity, they incur lesser costs per unit. The law of Increasing Returns applies to a 3DMC approach as well.

Efficiencies of an upskilled labor force and existing supporting content will reduce resources expended. Figure 2 shows a comparison between the 2DDC and 3DMC methods after the law of Increasing returns has taken effect. The region to the Resource Gains line’s right denotes the resources saved by taking the 3DMC approach.
Figure 1 is our current position in our roadmap, whereas Figure 2 is our intended future position. We need to know what potential roadblocks in our journey. What are the alternate routes available to achieve our future goal? Balancing current business needs and future goals requires prioritizing tasks involved with a paradigm shift.

Prioritization adds clarity to the roadmap. It provides a choice of routes and corresponding effort needed to reach our goals. A Decision Matrix is useful for prioritizing tasks and identifying how to accomplish those tasks within an organizational context. We identified the essential functions necessary for a 3DMC approach using Civil 3D. Subsequently, we assigned numerical values for effort, priority, and relative importance for each task.

Using numerical values for priority, effort, and reward, we developed a Decision Matrix (Refer Figure 3) with four quadrants. The X-Axis denotes units of effort, increasing from left to right. In contrast, the Y-Axis represents reward rising from bottom to top. The size of the bubble illustrates the relative importance of the task.
The Decision Matrix may vary for different organizations. However, it provides useful guidance to evaluate and prioritize necessary actions. Actions with a bubble shown with a larger relative size are essential for executing a project using the 3DMC approach. Tasks within each quadrant require a different upskilling and implementation process. Tasks in the first quadrant require the least effort and gain the least reward. These tasks are low-hanging fruit, and project teams could accomplish relatively quickly at the project onset.
While the incentives may not be tangible immediately, efficiencies will accumulate. Providing a mechanism for commonly used resources, such as blocks, is an example of a first quadrant task.

The functions in the second quadrant require the most effort, accompanied by the least reward. Managing pipe catalogs is an example. Neither collaborative platform provides an effective option to manage customized pipe catalogs. Moreover, customizing pipe requires additional skillsets, and we did not anticipate any unconventional pipes for the projects. Hence, we chose to use the default pipe catalogs.

Tasks in the third quadrant require the highest effort, but these tasks result in high rewards. They are essential for the successful implementation of a project using Civil 3D. We cannot use the same strategy for all the tasks in this quadrant, however. For example, creating and managing custom assemblies was assigned to personnel with the most experience creating sub-assemblies. It avoided expending additional resources towards upskilling. Further, since neither collaborative system, ProjectWise, or BIM 360, provides a seamless method to distribute custom sub-assemblies, for the initial projects, we avoided developing a plan to distribute custom subassemblies without impacting functionality.

We located the management of Data Shortcuts (DREFS) in the third quadrant. It is the backbone for managing and sharing 3D model data across and within teams. At the project onset, we identified key personnel who will create DREFS. Additionally, we ensured the upskilling of all personnel to consume DREFS.

Finally, the fourth quadrant tasks decide for themselves; these require low efforts but provide high rewards. For example, creating project templates with correct datum and units is a simple task. Tasks within this quadrant are straightforward that project teams could accomplish at the onset, avoiding significant errors downstream.

Comparing the 2DDC and 3DMC approaches help business leaders see how different processes impact current business needs and future goals. The Decision Matrix provides additional detail to the roadmap on how a firm could choose to accomplish various tasks in terms of effort, reward, and priority. These are crucial data points that give business leaders a roadmap, which empowers them to make the best decision. While data points within the roadmap depend on the project and organizational context, creating these roadmaps are useful.

**Establish a Pedagogical Framework within an Empathetic Environment**

A paradigm shift involves two facets: changing practice and changing the theoretical approaches of practitioners. Embracing a new paradigm requires moving away or significantly altering prior theories and practices of tackling problems.

During prior industrial revolutions, organizations could embrace new paradigms using top-down directives to alter practices without changing practitioners’ theoretical perspectives. However, in the current industrial revolution, we are besieged with data continuously processed by Artificial Intelligence. It becomes imperative for practitioners to change their theoretical perspectives.
After all, we are not automatons driven by Artificial Intelligence. We must convince practitioners of the new paradigm's efficacy and how the new view is mutually beneficial.

Theoretical change requires changing the way people conceptualize a problem. Imagine the effort involved in convincing astronomers to change their view from a geocentric to a heliocentric planetary model. For centuries, the scientific community granted that the earth was the center of the planetary system.

It is not impossible to change perspectives within an organization using a top-down directive. However, this approach is time-consuming and not very efficient. An alternative method is to approach changing attitudes with emotional intelligence to create an empathetic environment. In our journey, emotional intelligence meant acknowledging, identifying, and managing prospective change adopters' emotions within our organizational context.

Technological change is inherently an angst producing activity. Hence, acknowledging human emotions is essential to adopt change effectively while maintaining productivity. Creating an empathetic milieu was necessary for the journey since many of the change adopters were in different offices. Further, in some cases, we did not have the opportunity to meet in-person. Finally, importantly, it aligns well with our work culture at Gannett Fleming.

It brought to light not only how people thought about the shift but also how they felt. Numerous studies have documented that project teams attentive to human emotions and fostering positive work cultures improved productivity\(^3,4\).

We paid attention to how our team member's emotions impacted each other and the project. Relying on research and facts, we addressed concerns. We remained attentive to feelings and acknowledged them; however, ultimately, decisions were guided by facts. We provided change adopters with resources to upskill and cross-train. Besides technical and non-technical issues experienced by change adopters, we addressed any perceived issues. Rather than dismissing perceived problems as "not-real," acknowledging them help thwart the spread of inaccurate information.

In many ways, technical change is more of an emotional journey than a technological adventure. Regardless of the amenable environment created, not all change adopters will experience the ebbs and flows similarly. It is essential to acknowledge the peaks and troughs along the journey. Identifying the lows and look to remedy them so that it minimally impacts the project. Similarly, recognize the crests and look to leverage situations that created those peaks. The differences in the experiences of change adopters are illustrated in Figures 4 through 6. Each figure shows the emotional journey of change adopters.

At the core, any shift involves dealing with information about the change. Kübler-Ross, in her seminal text *On Death*\(^5\), illustrated the five stages of grief when people encounter news about terminal illness. People start by experiencing denial, then moving through frustration, negotiation, depression, and acceptance. Psychologists refer to these stages as the Kübler-Ross grief cycle.
Change management texts and seminars use the archetypical Kübler-Ross grief stages to discuss employees' emotional states as they encounter change. While some experts adapt to these states, they follow the same path as the Kübler-Ross grief cycle.

In our journey, we noticed not all change adopters follow the same archetypical stages. News regarding technological change is not the same as a terminal illness. Figures 4 and 6 show profiles of change adopters. The profiles of change adopters shown here (Figures 4 – 9) are a composite of different people. Their names are fictitious, so they are unidentifiable. The composite profiles of adopters shown in Figures 4 and 6 do not follow the classical Kübler-Ross emotional cycle.

Within your organization, you are likely to encounter visionaries at different levels of the organizational hierarchy. It is important to remember that there may be visionaries on every level of a corporation. For a plethora of reasons, they may not want to lead the technological change. However, they have the vision of transformation and accept the switch immediately. Similarly, some of your peers may not share your vision but admit to the move instantly.

Figures 4, 5, and 6 illustrate the ebbs and flows of change adopters' emotional journey over time. Examining personal journeys, it is not surprising that when personnel experience denial, frustration, and depression, it negatively impacts projects. Listening to concerns of change adopters when they experience the troughs of denial, frustration, and depression, we started to notice common patterns. Below (Figures 7 – 9) are critical quotes highlighting the change adopters’ concerns.

Why is creating an empathetic environment important? Suppose you went in with a preconceived notion that everybody will experience denial and follow the same stages of emotion through your digital transformation. In that case, you might not be able to provide appropriate tools and resources for that particular person who is not experiencing denial at the first stage.

Additionally, it hurts the digital transformation. Suppose an individual is excited upfront and has skills to share; She or he could potentially be a peer leader to distribute knowledge. If you started with a preconceived notion that this person will be in denial, you have lost an invaluable resource. And potentially negatively impacting the morale of a person who was looking forward to the digital transformation. Hence it is imperative to provide an empathetic environment so we could understand the different perspectives.

The critical point is that it is unwarranted to accept every opinion. However, it is essential to respond to various perspectives. We responded to concerns by relying on data, research, and best management practices recommended by Autodesk.
Figures 4 and 5 illustrate emotional profiles over time. The diagrams show the stages of denial, frustration, negotiation, depression, and acceptance.
I am really excited about the new approach. It has been a long time coming. Hmmm…. It requires a lot of communication between team members. And I don’t mean sending emails or messages. We need communication that helps with learning. So that we can learn and grow from each other. I hope we can just pick up the phone and learn from each other. Also… I am concerned not all team members have the same skills. I feel that we need to teach some of our colleagues as well.
All this 3D stuff is great. It sounds and looks good on YouTube. Once you start applying to a real project, it all falls apart. Don’t get me wrong; I will do the work as required; I don’t have a problem with it. I will learn as needed and as fast as possible. But what resources do we have to learn about problems and how to solve them on real projects. I hope we don’t get stranded because we don’t have a quick way of learning beyond what is shown on sample tutorials.

No problem you know me. I have always said I will do whatever it takes to get the project completed. I am committed to completing the project in whatever format clients require. I am concerned about learning a new approach so quickly. It is a lot of new stuff. You should know I won’t able to do everything. Others should be trained too.
By analyzing the concerns of change adopters, we identified a common thread. They were anxious regarding training and upskilling. Further, they were sensitive to learning new skills using real project data. Moreover, they were concerned about upskilling colleagues and collaborative learning.

We fostered a collaborative atmosphere by approaching adopters’ concerns with emotional intelligence and addressed their concerns and perspectives without judgment. We based our responses on established industry standards and data. However, it was apparent that we needed a cohesive pedagogical framework to reduce a significant source of angst around upskilling.

**Mapping a Pedagogical Framework**

Pedagogy is a theory and practice of education. Establishing an educational approach appropriate to a task at hand and your organizational context is essential. A cohesive pedagogical approach is the hidden neural network through which team members develop, share, and exchange knowledge.

Early in our journey, we realized that a single pedagogical approach would not work for our diverse group. Our team members brought varied skill levels and had different ways to process and learn new knowledge. Importantly, we learned from our change adopters’ perspectives that they needed additional ways to learn new skills. Moreover, listening to our peers confirmed that we needed to formulate a pedagogical approach that maps educational methods and tasks.

To craft a pedagogical framework, we examined the three classical educational approaches. We evaluated the benefits of Behaviorist, Cognitive Constructivist, and Social Constructivist approaches. We tailored it to our organizational context and project needs.

In a behaviorist approach, knowledge is a set of behaviors acquired as a response to external stimuli. Learners react to instructions from teachers, tutorials, or manuals. In our context, this means team members gain skills in response to video tutorials or manuals. A behaviorist approach is useful for acquiring skills that require minimal or no cognitive analysis. It is not a helpful approach to learn concepts.

Learning via a cognitive constructivist approach entails assisting learners in assimilating new knowledge by building on their prior experience. Learners are encouraged to make changes to their existing intellectual background by adapting to new knowledge. As the name implies, this method is useful to learn concepts, learners adjust or enhance their thinking.

A social constructivist method is akin to the cognitive approach. However, with a Social Constructivist approach, cognitive development occurs but with teachers’ guidance or collaboration with others. Collaboration is the key to a Social Constructivist approach.

The Decision Matrix developed, as shown above, is used to prioritize tasks as we shift paradigms. We leveraged the Decision Matrix to customize a pedagogical framework. Project
teams could use it to develop a pedagogical approach that meets their needs within the organizational context.

All the tasks shown within the Decision Matrix require the upskilling of project personnel at different rates. Not all members have the same skills at the onset of a project. Moreover, from an efficiency perspective, not all personnel need to become proficient in all the tasks.

The tasks in the first and third quadrants require low effort. Typically, team members learn these skills using a behaviorist approach. They could learn these tasks from video tutorials or manuals. Acquiring new skills do not require changing their thought processes. Over time, through repetition, team members modify their behaviors to develop new skills.

The skills to perform tasks in the second and third quadrants require more effort than to perform tasks in the other quadrants. We noticed tasks requiring more significant effort correspond to a more substantial mental effort from the learners in our journey. Learners typically acquire these skills with a constructivist approach, either cognitive or social. They build on existing knowledge or adapt existing thought processes.

<table>
<thead>
<tr>
<th>Task</th>
<th>Pedagogical Approach</th>
<th>D.M., Quadrant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Custom Scripts (use)</td>
<td>Behaviorist</td>
<td>Quadrant -4</td>
</tr>
<tr>
<td>XREFS</td>
<td>Behaviorist</td>
<td>Quadrant -4</td>
</tr>
<tr>
<td>Custom Blocks</td>
<td>Behaviorist</td>
<td>Quadrant -1</td>
</tr>
<tr>
<td>2D-Resources</td>
<td>Behaviorist</td>
<td>Quadrant -1</td>
</tr>
<tr>
<td>Project Templates</td>
<td>Behaviorist</td>
<td>Quadrant -4</td>
</tr>
<tr>
<td>DREFS</td>
<td>Cognitive Constructivist</td>
<td>Quadrant -3</td>
</tr>
<tr>
<td>Sheet Set Manager</td>
<td>Cognitive Constructivist</td>
<td>Quadrant -3</td>
</tr>
<tr>
<td>3D-Resources</td>
<td>Social Constructivist</td>
<td>Quadrant -3</td>
</tr>
<tr>
<td>Custom Pipe Catalogs</td>
<td>Cognitive Constructivist</td>
<td>Quadrant -2</td>
</tr>
<tr>
<td>Custom Scripts (create)</td>
<td>Social Constructivist</td>
<td>Quadrant -3</td>
</tr>
<tr>
<td>Custom Sub-assemblies</td>
<td>Social Constructivist</td>
<td>Quadrant -3</td>
</tr>
</tbody>
</table>

**Table 1: Task-Pedagogical Approach Mapping**

Creating a cohesive educational framework within an empathetic environment has significant advantages. From a functional perspective, a coherent educational framework reduces friction due to the shifting of paradigms. It makes upskilling a smoother process. Any change, let alone acquiring skills to adapt to that change, is a fraught process for people. Hence, for an efficient paradigm shift, we should create a coherent educational framework within an empathetic environment. It enables the teams to hear and react to various users’ perspectives.

**Establish a pragmatic technical approach**

A pragmatic technical approach is crucial in moving from a 2DDC to a 3DMC system. It is one of the three legs of the tripod essential for empowering the paradigm shift. The operative word is
"pragmatic." We do not live in a world with unlimited resources. To prioritize and establish a practical technical approach, we refer to Figure 3: C3D Implementation Decision Matrix.

We establish a practical technical approach by adhering to foundational data management concepts from Information Systems Design. As Well As following a practical approach towards content creation. The two are not mutually exclusive.

**Figure 10: Key Technical Concepts**

In Information Systems design and theory, a Single Source of Truth (SSoT) refers to organizing data and metadata to avoid data redundancy. Every data element is stored exactly once. By avoiding data duplication, SSoT ensures data consistency. In a 2DDC approach, often, there are multiple sources of truth. For example, designed grades are noted in a design file and subsequently copied over to the sheet files. The potential for data duplication creeps into the project. The problems associated with data duplication increase exponentially with project size.

Data Encapsulation is the concept that extends the SSoT concept. The internal structure and representation of the data are hidden from sources consuming the data. Following data encapsulation, you can organize data by user roles.

The internal structure of data is hidden from sources consuming the data. A simple example of data encapsulation in the CAD world is reference files. The Limits of Disturbance, for instance, could be in one file shared across the entire project. Sub-consultants and other collaborators have access to consume that data. However, you can set limits on their access to edit that data. Figure 11 below highlights a few key advantages of data encapsulation.
Referring to Figure 3: C3D Implementation Decision Matrix, we identified four key data types (See Figure 12: Key Data Types). Depending on the project, you may have additional data types. Still, typically for most 3D model-centric projects using Civil 3D, these four data types would suffice. We must manage different data types through appropriate data channels.

**Figure 11: Data Encapsulation Advantages**

- Protects data from unwanted access
- Allows access to data without revealing details
- Minimizes human errors
- Simplifies maintenance

The first data type consists of data that are typically two-dimensional — right-of-way drawings. Proposed striping plans, text files, and spreadsheets are examples of these types. Supporting data, such as line types and plotter configuration that controls the visual display, constitutes the second data type.

**Figure 12: Key Data Types**

- Two-Dimensional Project Data — Right-of-Way drawings, Proposed Striping Plans
- Resources — Line types, Plotter Configuration
- Horizontal BIM Data — Alignments, Profiles, Pipes, Surfaces, etc.,
- Horizontal BIM Support Data — Templates with styles controlling the display of H-BIM data
The third data type consists of Horizontal BIM data, such as Surfaces, Alignments, Profiles, and Pipes. These are model data that must be encapsulated and follow the SSoT principle.

Civil 3D styles controlling the 3D model display are the fourth type of data that we often share across the project. From the Civil 3D 2017 version, teams could share Civil 3D styles shared via the manage shared reference mechanism. It allows teams to encapsulate Civil 3D style data and adhere to the SSoT principle.

Different styles represent the same data in different ways. For example, we could display a Proposed Surface on Construction Plans with 1-foot contour intervals. In comparison, we could show the same Proposed Surface on a Drainage Sketch with 2-foot contour intervals. Imagine a project with hundreds of drawings consuming the Proposed Surface model. If you had to edit the Proposed Surface’s display during the project’s course, you would have to edit all the drawings. However, if project teams use the Style Reference Manager, then edits to the Proposed Surface style are propagated across the entire project.

Like any process managed by adhering to the SSoT principle, if users unwittingly edit the data, we run the risk of propagating unnecessary changes across the project. Using your collaborative platform, teams could roll back the unintended edits. However, as part of the training, team members are trained to edit styles only if they need that modification across the entire project. The changes must conform to the project standards. If they require it only for a subset of drawings, then they create a new object style.

Identifying and using appropriate data channels helps project teams to adhere to SSoT and Encapsulate data. Using file management mechanisms through collaborative platforms such as Bentley’s ProjectWise and Autodesk’s BIM 360, we shared Two-Dimensional project data. The data included: drawing files, spreadsheet files, image files, and GIS files. The support resources for 2D resources such as line types and plotter configuration also used file management systems; however, we had made minor revisions to the workflow.

Table 2 Mapping Resources Overview lists the required steps to map resources within the ProjectWise and BIM 360 environments. Conceptually, the mapping steps are similar within the ProjectWise and BIM 360 environment, with minor differences. Figure 13 shows a typical project folder structure that teams could use in either the ProjectWise or BIM 360 environments. You could tailor the folder structure per client or organizational needs.
The example project structure shown herein is adapted from the Massachusetts Department of Transportation to our specific project needs. A project folder structure may vary from a regulatory agency to another, maybe even differ from client to client. However, a similar folder structure separating different data types will help teams adhere to the Single Source of Truth principle and also Encapsulate data. Various data types are in their respective channels and home locations so that project teams could manage data effectively.

**Table 2 Mapping Resources Overview**

<table>
<thead>
<tr>
<th>ProjectWise Resource Mapping</th>
<th>BIM 360 Resource Mapping</th>
</tr>
</thead>
<tbody>
<tr>
<td>Create CAD &quot;Resources&quot; folder on local machines</td>
<td>Map options to resources folder</td>
</tr>
<tr>
<td>Export &quot;Resources&quot; folder to local machines</td>
<td>Export user profile</td>
</tr>
<tr>
<td>Map resources to above folder</td>
<td>Create a batch file to start using above profile</td>
</tr>
<tr>
<td>Export user profile</td>
<td>Distribute above profile and batch file to the team</td>
</tr>
<tr>
<td>Create a batch file to start using above profile</td>
<td>Use the batch file to start C3D</td>
</tr>
<tr>
<td>Distribute above profile and batch file to the team</td>
<td></td>
</tr>
<tr>
<td>Use the batch file to start C3D</td>
<td></td>
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</tbody>
</table>
Figure 13: Typical Project Folder Structure

Project Root Folder

Common Resources

H-BIM Data:
1. GEOM (Geometry) – Alignments, Profiles
2. PIPE_G – Gravity Pipe Networks
3. PIPE_P – Pressure Pipe Networks
4. SURF (Surfaces) – Surface Models

2D Data:
1. Drawings
2. Spread sheets, Text files
3. Images

Discipline Folder
Autodesk Civil 3D provides Data Shortcuts as a mechanism to manage 3D Model data. Using Data Shortcuts, teams can adhere to the SSotT principle. Hence, any collaborative platform/process must support Data Shortcuts. We have software licenses to Bentley’s ProjectWise and Autodesk’s BIM 360, which currently support Data Shortcuts.

BIM 360 began supporting Data Shortcuts only towards the end of 2019. Thus, for projects before 2020, we chose ProjectWise as our collaborative platform. Further, choosing ProjectWise for the earlier projects was pragmatic as most of our staff was well-versed in the software. Project teams would require upskilling only to manage Data Shortcuts via ProjectWise. They would not require training in other facets of the program.

ProjectWise manages Data Shortcuts differently than BIM 360 or a networked environment within Civil 3D. You could think of ProjectWise’s management of Data Shortcuts as a black box. Figure 14 illustrates the steps required to manage Data Shortcuts within ProjectWise.

**FIGURE 14: PROJECTWISE DATA SHORTCUTS**

Unlike the BIM 360 or networked environments, within ProjectWise individual XML files for each object’s Data Shortcut are not directly visible. The Data Shortcut file (*.CivilDSProj extension) is a "self-healing" file. Whenever a user edits Data Shortcuts via Civil 3D’s tool space, the ProjectWise Data Shortcut (*.CivilDSPro) file gets updated in ProjectWise. To update data shortcuts within the Civil 3D tool space, users double-click on the ProjectWise Data Shortcut (*.CivilDSPro) file.
For projects starting in 2020, we began using BIM 360 as a collaborative platform. Data Shortcuts management via BIM 360 is similar to managing Data Shortcuts on a local or networked computer. It uses Autodesk Desktop Connector to synchronize files to the cloud. There are a few crucial points to consider before migrating or setting up a project on BIM 360. Figure 15: BIM 350 Migration illustrates the necessary steps taken to migrate to the BIM 360 environment.

![Figure 15: BIM 350 Migration](image)

Taking a pragmatic approach was the third step in empowering the paradigm shift from a 2DDC approach using MicroStation to a 3DMC methodology using Civil 3D.

It involved adhering to fundamental Data Management concepts from Information Systems Design. Teams must consume data via appropriate data channels for efficient data management. Finally, we produced content only as needed to conserve resources.

**Lessons Learned**

First and foremost, we should have introduced programming and automation while embarking on this paradigm shift. We could have built-in a lot more efficiencies downstream of the implementation. For example, we could have an automated creation of user profiles.
Secondly, we would have significantly benefited from a formalized librarian concept for knowledge distribution. For instance, a peer or a group of peers could function as a librarian. If an end-user has a question, they could ask the librarian. Subsequently, the librarian directs them to an appropriate resource or people who could help the end-users effectively. In the era of web searchers and automated bot responses, having a person who is intimately aware of knowledge resources within the organizational context would greatly help.

Conclusion

In this talk, I recounted our journey of moving from one paradigm to another using Civil 3D; it is a story of changing our peers’ theory and practice. The three strategies that our story rests on are: (1) facilitating leadership commitment, (2) formulate an educational framework, and (3) implementing a pragmatic technical approach. Importantly, before embarking on the paradigm shift, we ensured to foster an empathetic environment — where we considered and addressed change adopters’ perspectives. Understanding the views of our peers helps reduce friction that paradigm shifts typically encounter.
References


2 Merriam-Webster. Definition of PARADIGM.


Credits