AUTODESK UNIVERSITY

CS500720

How Model-Based Workflows Counteract Higher Costs and Labor

Mark Harrison
American Progress Group

Werner Maresch
American Progress Group

Jordan Watkins
PTAC Companies

Learning Objectives

- **Learning Objective 1**: Learn how to enable “Freedom in Design” and “Automation in Fabrication.”
- **Learning Objective 2**: Learn how to improve workflows by using a model-based approach and creating digital twins.
- **Learning Objective 3**: Learn how first movers benefited from Model2Fabrication and our solutions.
  Learning Objective 4: Receive input that can help you benefit on your own with easy steps, without radical changes, and in less time than you thought.

Description

Today's workflows based on PDF, Microsoft Excel, and so on, will not counteract the ongoing trends of increases in costs of goods and labor shortage. On the other hand, current trends in design with highly detailed models and technologies-e.g., building information modeling (BIM) and innovative automation in fabrication-could deliver solutions to these issues. But how can we use all those components in a smooth, reliable, and efficient workflow? In this session, we'll demonstrate how advanced technology is using model-based workflows that remove the burden of different software applications using old-fashioned interfaces and ever-growing complexity that untrained personal cannot handle. Based on 30+ years of experience in the precast business, there are many benefits that are already in use by customers worldwide and are ready to be used by those in need.

Speakers:

Mark Harrison is the Senior Sales Manager for American Progress Group with over 17 years of experience in the North American construction industry. Mark has successfully sold and managed numerous end-to-end construction projects and remains committed to providing optimum results to precast producers through accessible automation technology. Mark holds a B.Sc. in Mining Engineering from the University of Alberta and is an active member of the Precast/Prestressed Concrete Institute and the National Precast Concrete Association.

Werner Maresch is the Managing Director of the Progress Software Group division of progress group and has been involved in leading and developing breakthrough technology for the precast software, 3D design and automation industries for over 25 years. Over 30 years of experience in transforming the construction business. In different positions ranging from software development, product management and sales to heading a small team that became the worldwide leading provider for the most efficient solutions within the precast industry. Currently leading a team of motivated talents to enable “Model to Fabrication” at PROGRESS GROUP in wonderful Brixen / South Tyrol.

Jordan Watkins owns and serves as the Chief Executive Officer for the PTAC Companies, a collection of companies focused on engineering, technology development, and real estate development. In addition to his role as CEO of PTAC, Jordan also serves as the managing partner for a technology startup created to develop technologies for construction estimating in the insurance industry. After graduating from Auburn University, Jordan joined PTAC Consulting Engineers. Under his management, the firm has achieved significant growth and expansion. Outside of his role in the various companies, Jordan is proud to serve as a member of the Board of Directors for the Precast Concrete Institute Gulf South Region.

Today's Challenges & Context

With today's workflows mainly based on PDF, Excel, static documents, the ongoing trends of increasing costs of goods and labor shortages will not abate. Construction projects are becoming increasingly complex and collaboration is increasingly important with many different parties involved. Changes in the project are difficult to communicate efficiently and accurately among these parties with these static documents and protocols.

There are currently many modern design solutions in use today providing readily available highly detailed models and technology solutions. For example, BIM and innovative automation in fabrication can address many of these problems. These solutions are being successfully used today but are unfortunately not well known outside certain industries.

BIM Process Diagram

The BIM process diagram above may be well known but there is a challenge in **how to use all those components in a smooth, reliable and therefore efficient workflow.**

In this session we will uncover how:

- To benefit from cutting edge technology using model-based workflows…
- To take out the burden of different software applications…
- You can avoid to use old fashioned interfaces…
- To counteract the ever growing complexity….
- To implement solutions that can be handled by untrained personnel…

Challenges of the Construction Sector:

Based on a recent and extensive study released by the PCI (Precast / Prestressed Concrete Institute), key findings on the challenges this industry faced, are cited below in their publication. Specific quotations are provided below directly from the producers (manufacturers) who provided the data. I encourage all attendees to read the report available through PCI.org.

Building material prices, availability, and finding qualified labor to install the material are the primary influencing trends impacting the industry.

Pricing:

"All materials are experiencing cost increases – concrete, steel, nails, etc. – but steel is one the biggest ones. 300% increase" - Engineer

Availability:

"Lead times have increased for everything“ - Building Owner / Operator
"People are looking for material in 6 months, but it’s such a challenge." - Contractor

Labor:

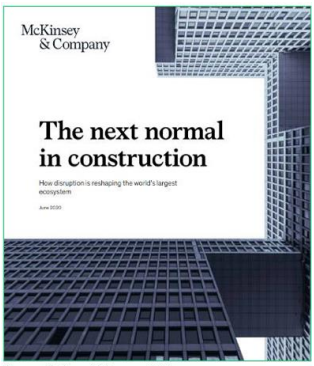
"It is becoming increasingly difficult to find qualified workers. Our challenge isn‘t finding work. It is finding people to do it." - Contractor

"We are looking at every opportunity to address to labor. We are open to any means or methods to do that." - Contractor

Source: Precast Concrete Institute Market Study 2022

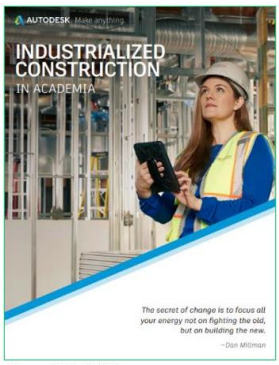
Challenges of the Construction Sector

As mentioned earlier, these challenges and problems have been discussed at length in many publicly available reports. Below are two that are publicly available online and provide helpful details and context.



Source: McKinsey & Company 2020

[McKinsey & Company: The Next Normal in Construction]



Source: Autodesk 2021

[AUTODESK: Industrialized Construction]

Key Highlights and Takeaways

McKinsey: A highly complex, fragmented, and skill and project-based construction process that is difficult to grow and scale. The construction industry of the future is becoming a more **standardized**, **consolidated**, and **integrated** construction process.

Autodesk Industrialized Construction: "The construction industry is among the least digitized sectors around, with almost all its processes being repetitive and labor-intensive"

“Large projects typically extend 20 percent beyond the initial project completion date, and they are usually up to 80 percent over budget"

Source: Autodesk: Industrialized Construction

Who are we?

PROGRESS GROUP is a precast industry leader and manufactures systems, machinery and software for precast concrete plants. Building with precast concrete elements improves living conditions for people all over the world. Our technology creates attractive workplaces and environmentally-friendly, durable building systems for high-quality living and working areas.

COMPLETE
PRECAST TECHNOLOGY
WORLDWIDE

Website LinkedIN YouTube

Learning Objective 1:

Learn how to enable “Freedom in Design” and “Automation in Fabrication.”

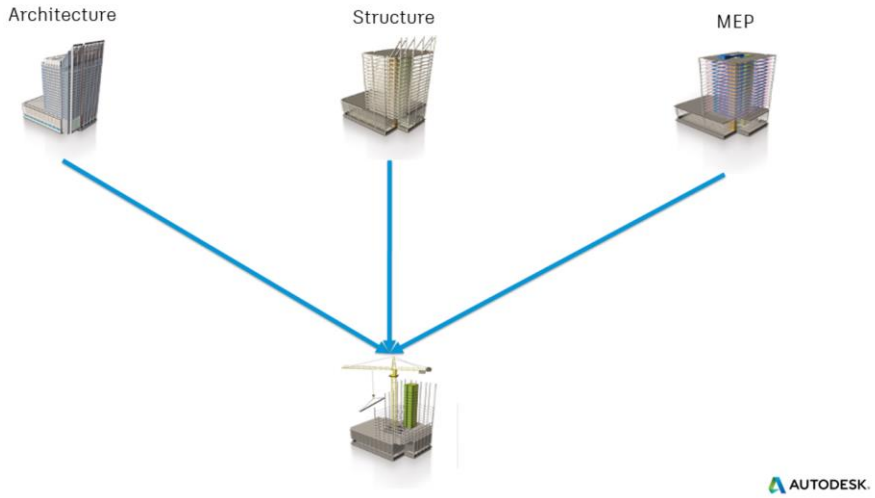
Autodesk Revit / BIM provides fully detailed and realized models that many companies currently use succesfully in the world of design to collaborate and communicate design.

In the manufacturing / fabrication space there exist many technologies that enable the highly automated and modern means of using data models to manufacture complex goods.

In the past there was always **a missing link** connecting both worlds without restricting each others possibilities. In other words, fabrication lacked data and design was complicated if data concerning manufacturing restricutions had to be extracted / generated and communicated back up to the architects.

Missing Link Between Design + Fabrication

As mentioned before, due to the inherent specializations and distinctions that exist in the construction process (I.e., Architects, Engineering, Fabrication, Construction, Erection) there is commonly a problem with these companies communicating effectively with each other via different software solutions and interfaces. Everybody can bring in his own information / model / data to the process, but how to avoid mistakes by different software solutions and their interfaces?

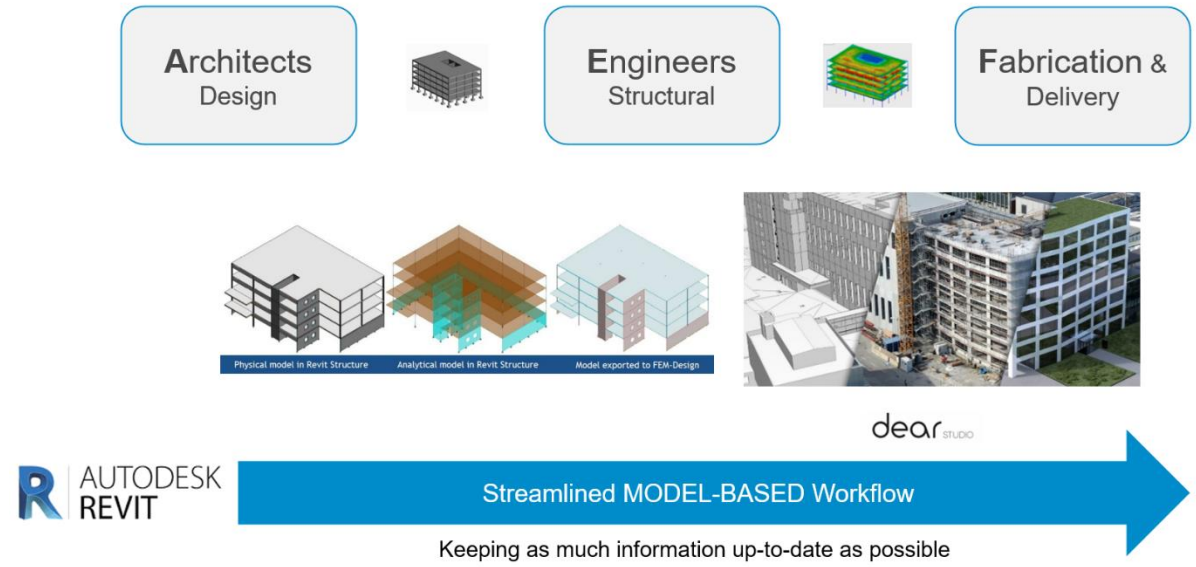


Streamlined Workflow Basics:

In a BIM workflow there are very often different parties involved which has to be taken into account when using a model-based approach:

A = Architects
E = Engineers
F = Fabricator / Precast Plant

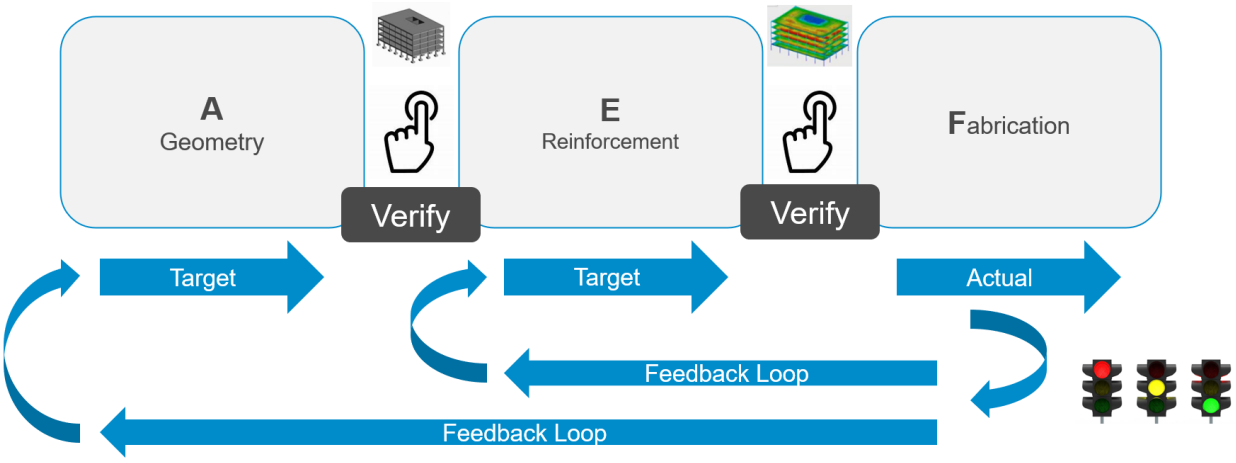
Streamlined Workflow within A-E-F



By keeping as much information in one system (i.e., REVIT) and keeping it actual over the whole workflow we avoid double work and errors by different software solutions and their interfaces as mentioned above. This keeps all communication in the model itself and no time is wasted trying to interface 3rd party interfaces into the model and creating room for errors.

It is important to stress that the **Model2Fabrication** (our tool) workflow keeps as much information FROM the other parties; as much as possible to streamline this process. Our solutions collect as much information as possible, and even take care of the different revisions in the workflow within Revit (NOT different software).

Ownership & Feedback Loop within A-E-F:



Verify Results at any stage of the design process to **make sure Design is safe and sound**

Represented above is the core, and perhaps greatest benefits of model-based workflows: an **automized digitized feedback loop** for any and all changes regarding fabrication occuring in the overall DESIGN process itself.

On a big picture level we can assume the following important verification steps in this loop:

Architect (A) takes care about the geometry of the overall structure, this becomes more complex as the divisions of the building system using prefabricated parts have to be taken into account.

In the almost guaranteed and eventual event of the cases where the elemented (precast) divisions ARE part of the design considerations, this information NEEDS to be transferred / communicated from **Fabrication** (F) to the Architect. For simplicity, let's call it manufacturing feedback. Examples of these restrictions would be plant individual element size restrictions, reveals on exposed concrete, logistics / trucking considerations, etc.

In the past the factory had to cope with this design oversight from the architect, and had to regularly send information requiring confirmation with time consuming documentation. The feedback loop within the model, by *using the model to communicate* allows direct feedback without any human interaction and just in time. This is a key difference between old and new.

Engineers (E) are involved here too, as they take care of the reinforcement design, (i.e., so everything is held in place in the finished structures). They too, have to take into account some manufacturing restrictions, because they are most of the time acually creating real 3D data at this stage in the model itself.

To repeat, in the past most solutions demanded design to input lots of fabrication details needed for production data. We call this a “tech centric approach” where the interface demands the design input up front.

We, at PROGRESS GROUP, follow a little different approach.

We call it “human centric approach” where technology helps humans to do a better and more efficient job without lots of additional burden to enable using it. The changes that need to be made by party and communicated are identical in both instances (tech centric and human), but the means by which the communication occurs **is orders of magnitude more streamlined and simpler using the model.**

Streamlined Workflow “Target vs Actual”:

With this said let's look into the difference between information as **Target** vs. **Actual**.

Target means the owner wants to achieve a specific result - without the need to know and take care of all fabrication details.

Actual means that fabrication gives feedback about the actual outcome from a fabrication point of view and all parties within the workflow have the chance to agree on the outcome or modify design specs accordingly.

By doing so, we are able to collect all data and combine it with the actual Fabrication restrictions, send any improvements needed back to Arch or Eng in the same model and workflow via BCF (BIM collaboration format) and by using the PTS (Production Test Service) to its full potential by testing feasibility of production of elements.

Therefore, while we are communicating fabrication changes back through the workflow to the engineer and architect simultaneously, we are creating and working with the same data that is then being used by fabrication.

In other words, we are not creating documents to communicate changes and then creating new fabrication documents after these are approved; **we are working in the same model with the same data** our equipment will produce the resulting elements simultaneously while it is being checked upstream in the workflow. (A-E)

With this system in place, you are able to minimize the use of PDF and Excel and improve efficiency and quality within your workflows. We know this system because we, PROGRESS GROUP produce in our own precast plant and face the same issues as most of the other producers in our business in these matters.

To recap, this **DIGITIZED FEEDBACK LOOP** for the changes allows the architects / engineers to verify their inputs in design / check through these changes:

- ARCHITECT cares about **geometry**
- ENGINEERING cares about **structural integrity**
- FABRICATION delivers **the element** based on this

PTS server checks any changes made by fabrication and sends these confirmed changes up the workflow to verification. In terms of Freedom of Design and this digital feedback loop, there is no massive paperwork and document burden to communicate via the model-based workflow using these tools.

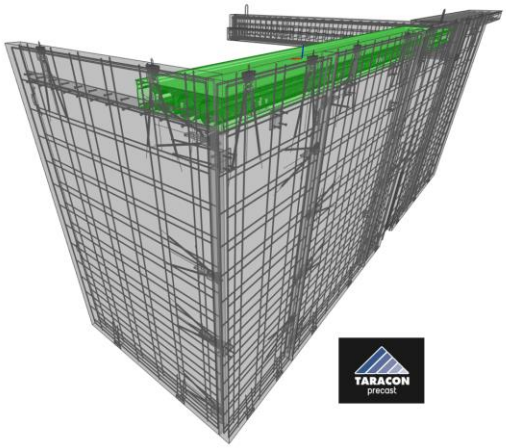
Learning Objective 2:

Learn how to improve workflows by using a model-based approach and creating digital twins.

World of Design
#BIM
#IFC

World of Industrialized Fabrication
#PXML
#IFC4precast

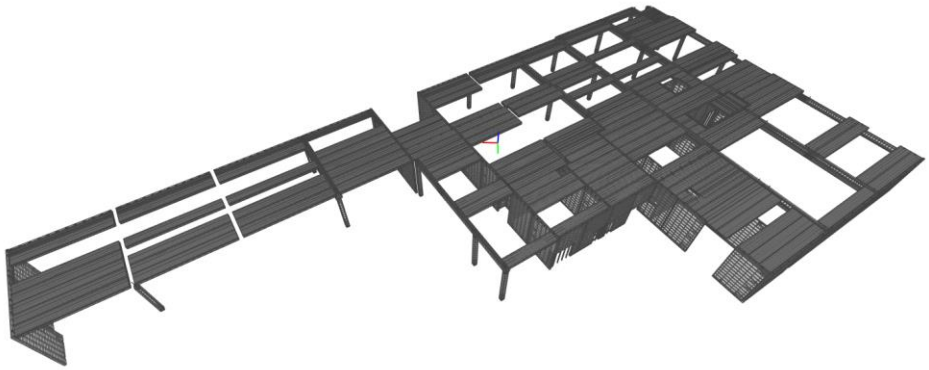
We had previously discussed the “missing link” between the world of design and the challenges of fabrication. Now we want to explain how the **Model2Fabrication** tool provides this link and how it works.



Source: Taracon Precast 2021

Above is sample data from a project using a **detailed Revit model**. These models are typically highly detailed containing specific and detailed fabrication requirements for precasters (i.e., reinforcement, lifters, embeds, connection details, etc.). However there are some limitations to the model that come from the design process.

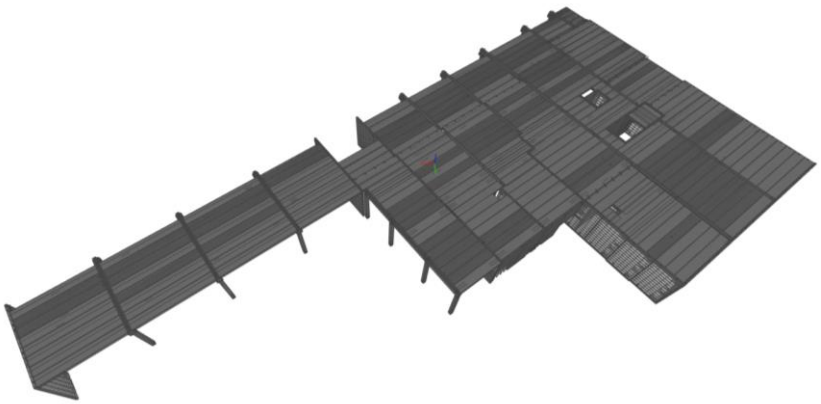
For reasons that come with saving design time, let us explain the difference between the **detailed elements** and **hulls.**
The designer will usually fully design and detail a single unique element, but where multiples of this identical element exist on the same model this detailed information is not copied over and instead hulls are used as placeholders. Below is a visual example of this occurring.



Revit Model with Gaps in the element data

This does save a lot of time and keep the model lean in terms of data, for the fabricator using automated manufacturing technology these hulls are not usable due to this missing data.

One feature of the Model2Fabrication tool is the "**fill in the blanks**" function where the model is then fully detailed for all the banks. This is necessary because we need to produce each instance of these hull elements. As a result, the fully detailed model is provided and resembles below.



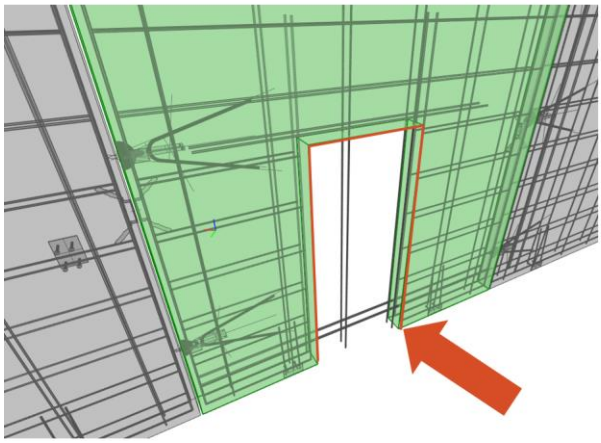
Revit Model with COMPLETE element data after processing

So again, **without any additional work** you get a fully detailed 3D model of all elements for fabrication. We like to call this: **what you see if what you get.** In other words, the completely processed model is exactly what will be produced and delivered to the owner / customer. There is no possibility of transcription errors in the manufacturing process by using this approach.

To recap, in Revit, the designer kept data and design man-hours to a minimum and did not fully detail identical elements. But **YOU** the fabricator need every element detailed for automated fabrication. M2F does that for you, fully automatically without any manual input. It needs only to be defined once within Revit and the tool does all the work for you afterwards.

Maximize Efficiency by Using Every available Detail:

Model2Fabrication goes even further, by not only using geometric data but creating articles (i.e., unique parts) based on attributes and geometric information by combining them.



Source:		Result:
Geometry	converts to	Geometry
Geometry	converts to	Article
Attribute	converts to	Attribute
Attribute	converts to	Article
Attribute	converts to	multiple Articles
Attribute	converts to	multiple Articles based on Geo

Any given information within the **Revit Model** will be used to create the most comprehensive output imaginable.

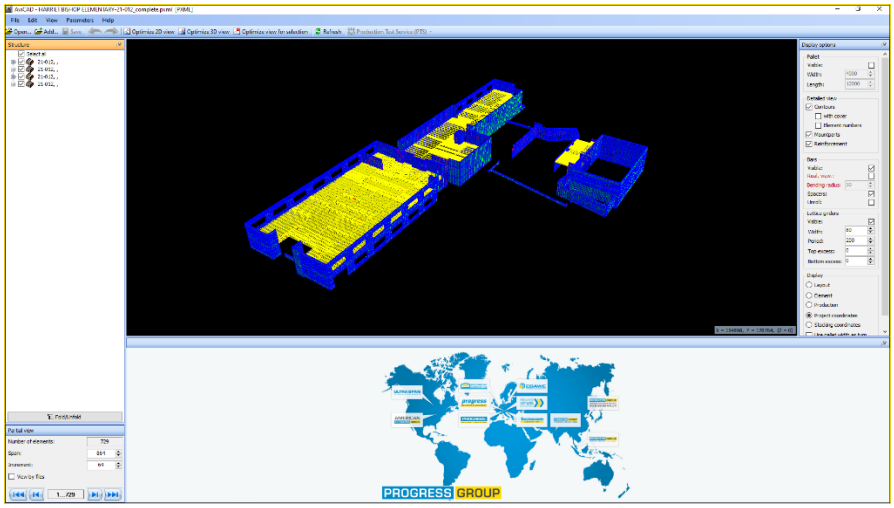
For example, to properly install a window there typically needs to be a lot of detailed articles, parts (Glue, isolation, tape etc.) and laborious steps involved by the fabricator. In our experience with Revit models, designers will not specify or include those details in their model outside of the window size / parameters itself to minimize complexity. In past, the fabricator would have a recipe of parts / man-hours that would need to be calculated as costs / materials needed as part of quoting and supplying a project. Usually done manually and time consuming.

Model2Fabrication can assign to the models attributes this recipe of parts (costs) to the fabricators model itself for any and all windows that meet certain attribute definitions. It does this **without adding unneeded information and complexity** to the architects and engineers working in the model space itself.

In other words, with this tool our **ERP** (Enterprise Resource Planning) system gets MORE out of the ORIGINAL model for accurate cost tracking / inventory management. And we do not change or add complexity to the model for others. Model2Fabrication extracts and adds this missing recipe of labor costs / specific parts necessary to produce this opening (in this example).

Extraction to PXML – Model Based Manufacturing Benefits:

After successfully using the **Model2Fabrication** tool to extract a fully detailed, enhanced and more cost-accurate data model in PXML format, we are now ready for highly automated production of precast elements.

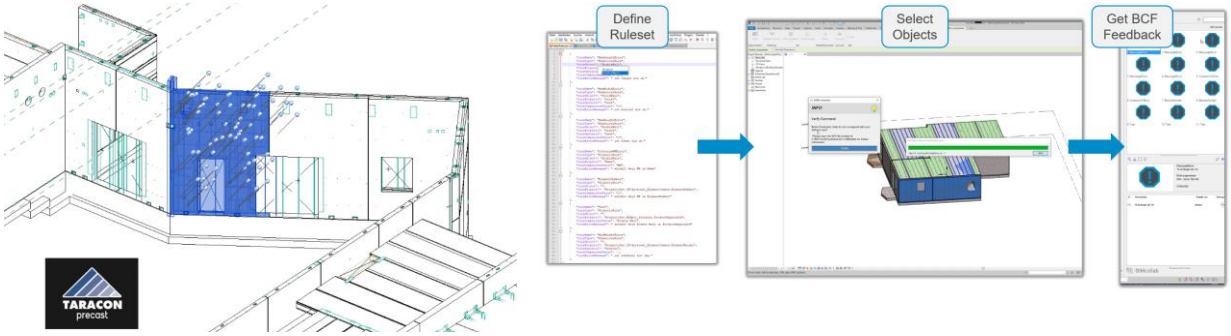


PXML Model in Progress Test Server: Ready to Automation

The Progress Test Server (PTS) can now analyze all the elements in the model and check for limitations on the production itself. Errors in design, size limitations for production / shipping, missing details are all now checked and shown visually on the interface well before production begins. In traditional precast production, **these errors are often not ever realized until fabrication actually begins resulting in inefficiency and lost opportunity costs of the production machinery (i.e., idle equipment while errors are being resolved).**

Ruleset Customization:

Next release will include the user defined Verification button that in effect provides a ruleset customization function. This allows a user-defined list of fabrication restrictions and concerns to be automatically flagged on the model itself for quick reference and resolution. Users can add to the **Verify Check** function what he wants to have safe and in place before the workflow gets disturbed by missing stuff or mistakes in design.



Ruleset Customization and Element Checking

Together with the PTS function we basically create a feedback loop that ensures quality and efficiency without lots of human interaction or man-hours.

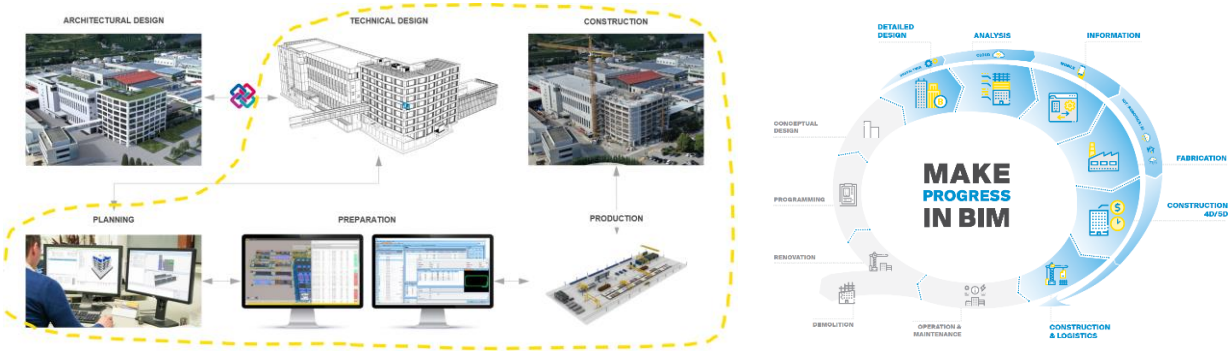
Learning Objective 3:

Learn how first movers benefited from Model2Fabrication and our solutions.

PTAC Engineering and Taracon

Source: Taracon Precast 2022 & InfraStructure, LLC 2022, PTAC Engineering

The concepts and models already shown may seem theoretical and abstract, but these were developed using **real-world** data in collaboration with industry partners and leaders: **PTAC Engineering** and **Taracon Precast.**



Practical Areas of Focus in the BIM / Construction Process

Following up on above graphic, while model based workflows provide real and tangible benefits to the design process, the **practical** benefits of this tool will be highlighted in the yellow areas of the graphic or blue areas of the BIM process diagrams shown.

Additionally there are incremental and standalone modular software products available to the precaster to streamline their existing processes starting with the Model2Fabrication tool we just discussed, leading into plant automation and management of the production for real projects.

- Create **fully detailed 3D model** out of existing Revit models → Model2Fabrication
- Long bed
- Workflow
- Quality check
- Data for checking

→ aheadAPS

Practical Areas of Focus in the BIM / Construction Process

Visualization of a Digtial Factory being realized through modular, standalone software solutions

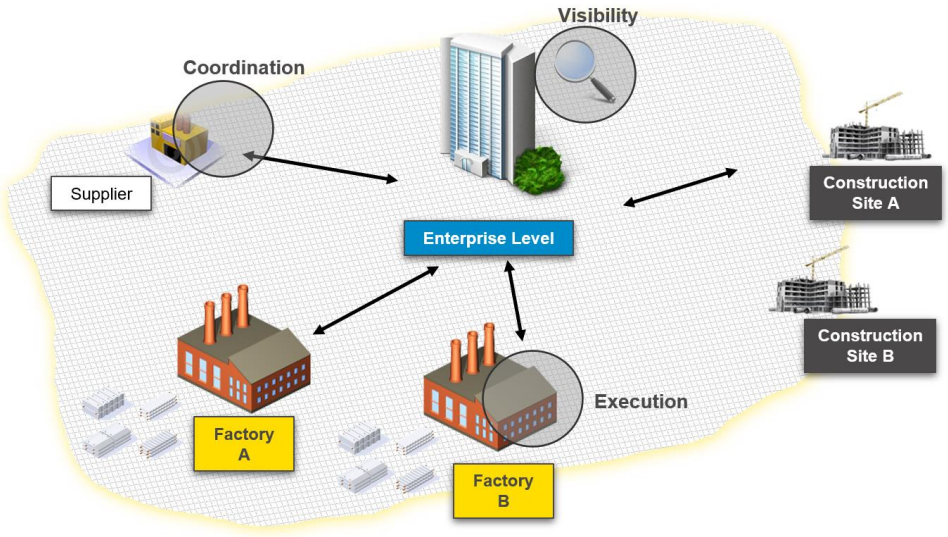
Learning Objective 4:

Receive input that can help you benefit on your own with easy steps, without radical changes, and in less time than you thought

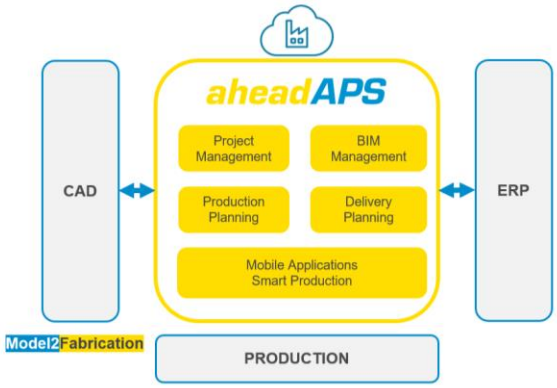
As previously mentioned, in order to get a fully realized and streamlined automated manufacturing process we have outlined the means to **extract and use the existing high-quality Revit models** in the industry today with the Model2Fabrication tool.

This tool can then be used to create high quality PXML data that can be then used in highly automated production machines available in the precast industry today.

This may seem difficult to get to a full automated manufacturing process, but there are incremental and modular software solutions that are possible to apply to your process along the way.



aheadAPS Overview:

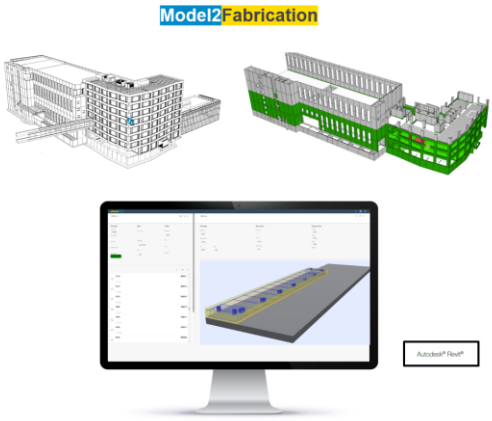


APS – Advanced Planning and Scheduling System:

- Using BIM Data to streamline your processes
- Cloud-based solution that acts as a **HUB platform between the CAD, ERP and MES** systems to cover the specific business processes of the precast concrete industry
- Enables manufactures to deliver on time and produce more efficiently
- Reduces unit costs with more efficient production runs
- Improves decisions with capacity visibility & scenarios and analytics
- Plugs in easily to the existing system and doesn‘t require a lot of maintenance

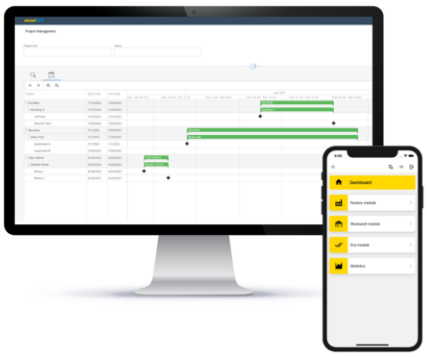
BIM Management:

- Visualization of 3D-BIM Model
- Digital Twin for precast building
- Central status overview
- Import of BIM Data
- Milestone Planning
- Quantity take-off of raw materials



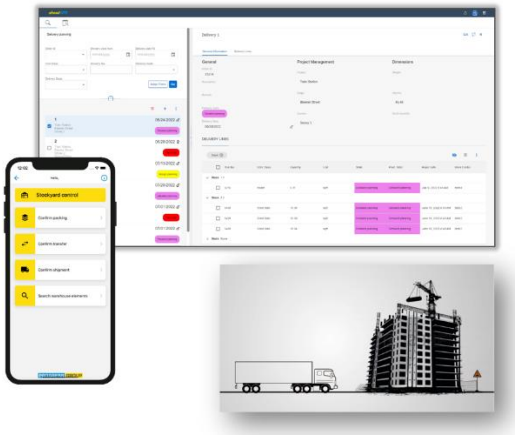
Project Planning:

- Central planning functionality
- Rough planning of deliveries
- Backward planning of production
- Delivery and production status overview
- Identification of critical path



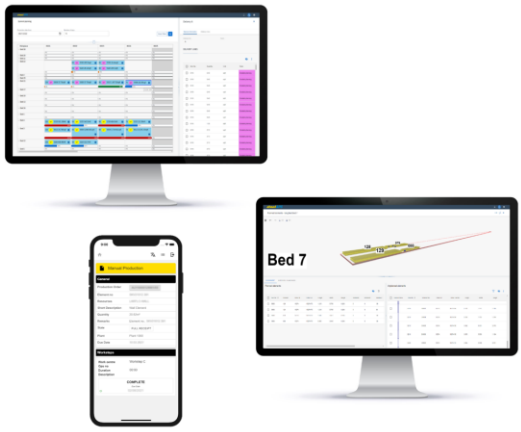
Delivery Planning:

- Cost efficient transportation planning
- Tracking of your shipment
- Mobile access on site
- Graphical state tracking
- Planning of Installation team



Production Planning:

- 3D - Planning of single workplaces
- Capacity overview
- Status tracking
- Work-Preparation
- Nesting optimization

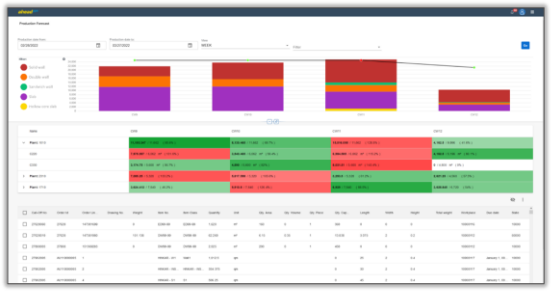


3D Stacking:

- 3D Stacking of elements
- Loading List preparation
- Handling of different transportation units

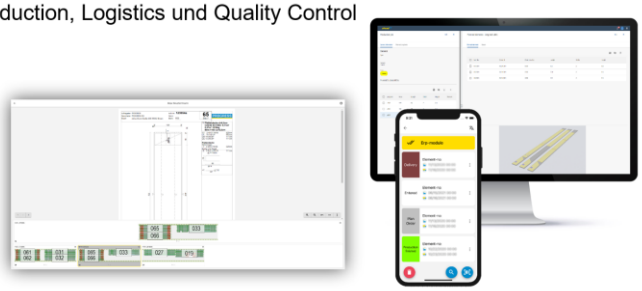
Capacity Planning:

- Graphical Capacity overview
- Workload for each work center
- Central planning function
- Identification of bottlenecks



Smart Production:

- Get rid of paper in production
- Integration to 3th party tools (ex: Plotter etc.)
- Mobile Application for Production, Logistics und Quality Control
- Quality Control
- Time registration
- Status Feedback



Modular Software Solutions for Business Processes:

PROGRESS GROUP provides an **OPEN EcoSystem** that works with other solutions and machinery equipment too. Clients and users are free to choose what fits them most although PROGRESS GROUP can provide most topics as one stop shop to modernize and streamline their processes.