AUTODESK UNIVERSITY

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3-D Integrated Structural Analysis and Design Workflow

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Learning Objectives

- Gain a better understanding of the 3-D analysis and design workflow
- Learn how to enhance the current standard of analysis and design
- Learn how to develop automated workflow processes
- Learn how to combine the software and design tools required for projects into a single, integrated analysis workflow

Description

This class presents a new approach to the structural analysis and design workflow. Utilizing Autodesk Revit and Dynamo in collaboration with third-party analysis and design software, users can achieve an automated workflow between a conceptual model, analysis model, and design tools. This class shows how to connect innovative 3-D modeling data with traditional calculation methods. The use of Autodesk Revit as a modeling platform and Dynamo as a data extraction and export tool streamlines the workflow and revolutionizes the current approach to analysis and design. This proposed workflow can be adapted to each user's preference and used repeatedly across multiple projects. Specific project needs can be included seamlessly in the workflow. This class explores this proposed workflow as it was used for a structural seismic retrofit project at the NASA Ames Research Center in Moffett Field, California.

Your AU Experts

Ali Afrasiabi, S.E., P.E. ali.afrasiabi@aecom.com
Ali has over 15 years of diverse structural engineering and leadership experience in new building and structure design as well as evaluation and rehabilitation of existing structures. He is the Structural Group lead for both building and water structures for AECOM–San Francisco Bay Area. He is spearheading several multidisciplinary projects with a focus on integrated project delivery utilizing Autodesk, Inc., products as a platform. Ali has a special interest in advancing the traditional design and calculation method to an automated approach using the vast amount of information available within 3-D modeling.

Peter Jacobs, P.E. peter.jacobs@aecom.com
Peter is a structural designer with AECOM in Oakland, CA. He currently focuses on seismic evaluations and retrofits of existing structures. With knowledge in both Autodesk Revit modeling and analysis modeling, he is working toward an integrated analysis and design workflow utilizing Revit, Dynamo, and other analysis and design software.

Understanding the Analysis and Design Workflow

A project's life cycle has many ingredients. However, engineers and designers generally focus on three key components: analysis models, calculations, and drawings. To successfully complete a project, information must be transferred between these different components. The efficient transfer and circulation of data and the production of drawing sheets are essential in completing a project on time, within budget, and with limited errors.

3-D modeling and analysis programs create a way for us to store building information and member properties that allows for the possibility of automating the transfer of data between the design elements. Automating the transfer of data reduces the probability of error in calculations and drawings and improves the overall productivity of the project. Such automation also allows engineers to focus their time on developing creative solutions to challenging problems without spending unnecessary time on routine tasks.

Traditional Analysis and Design Workflow

In the traditional workflow, the various design elements within a project are completely separate entities with limited to zero interoperability. An engineer creates an analysis model, performs calculations, and provides sketches to a drafter. Information is manually transferred between each of these design steps, potentially introducing errors and inconsistencies throughout the design cycle. When a calculation requires a change in the design, the analysis model and drawing package must be updated manually. As the design iterates and evolves throughout the design cycle, the information is repeatedly transferred and updated manually.

Collaboration between these different processes requires manual transfer of data and continual quality checks to ensure that all changes are accounted for throughout the design cycle. The traditional workflow demands manual work, which burdens the project budget and schedule, and exposes the project to the possibility of inaccuracies in the calculation and drawing packages. Figure 1 lays out the traditional analysis and design workflow, specifically the manual iterative process required within the design cycle.

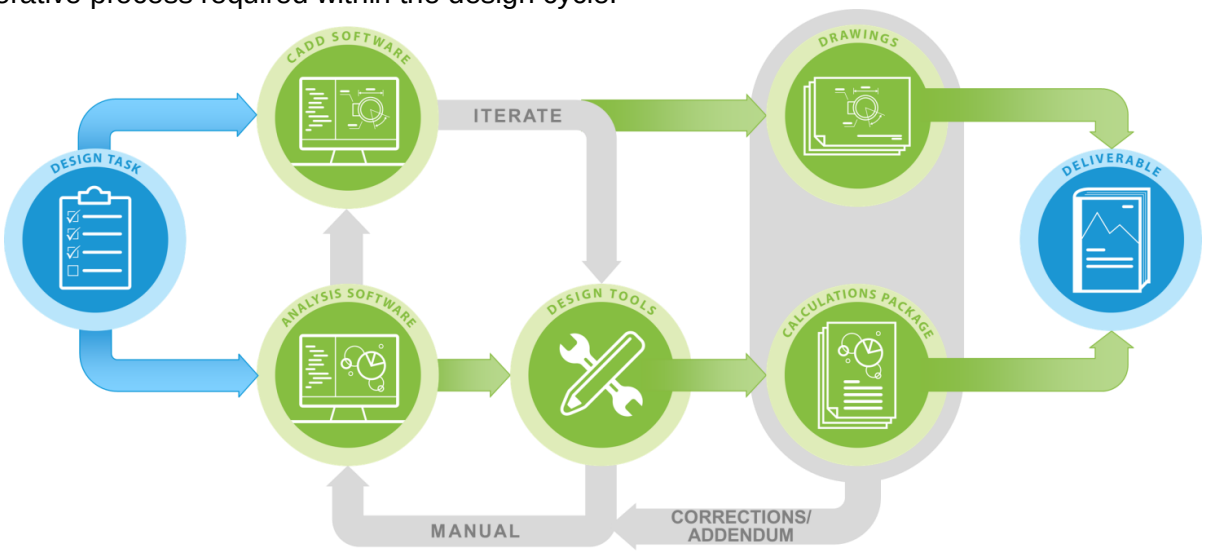

FIGURE 1: TRADITIONAL ANALYSIS AND DESIGN WORKFLOW

Enhancing the Traditional Workflow

With ongoing advancement of the interoperability of engineering software, traditional engineering methods and workflows will likely evolve to take advantage of these innovations. How can analysis or design updates be integrated automatically into the workflow and circulation of design tasks? Can engineers seamlessly incorporate design changes into the analysis and drafting model without loss of information? Using the latest software tools, these possibilities become realities.

Although there are numerous types and sizes of projects and various types of third-party software, the enhanced workflow can be adapted to the preferences of the design team. Template workflows can be created and used across a variety of project types and needs. Workflows can also be modified based on software preferences and available tools.

Our use of an analysis workflow for our work at the NASA Ames Research Center reflects improvements developed over several projects that require efficient transfer of large amounts of data. We initiated the enhancement of our traditional workflow when a group of enthusiastic and entrepreneurial engineers realized that they were spending an unnecessary amount of time on routine tasks. From project to project, certain aspects of the design cycle were automated to increase productivity and limit errors. Working with industry experts, we continued to evolve the analysis and design workflow.

The introduction of Dynamo into the industry created the opportunity to close the loop on our analysis and design workflow (see Figure 2). Dynamo enabled us to link our design drawings (through Revit) with our analysis models and calculations. This direct connection ensured that the construction drawings would match the calculation results and limited the likelihood of data transfer errors.

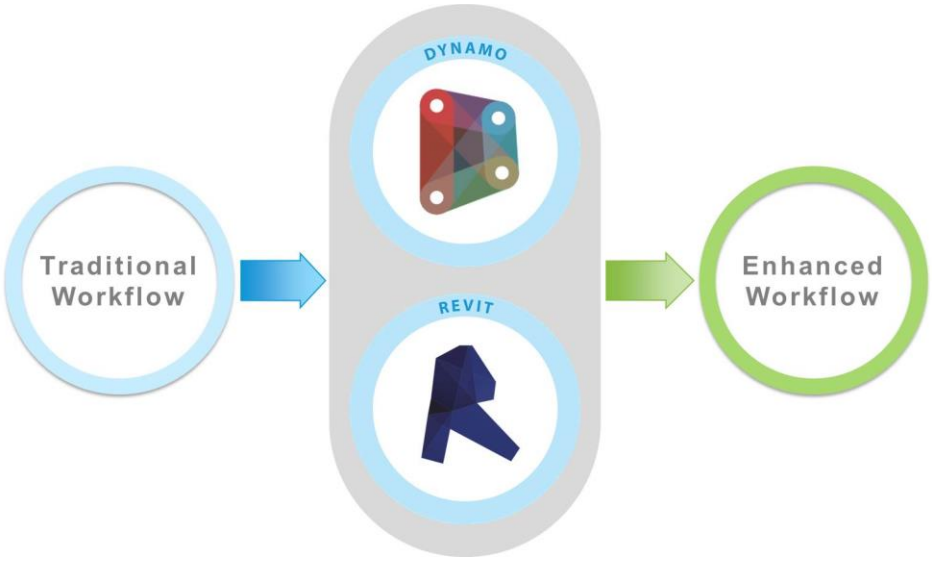

FIGURE 2: ENHANCING THE TRADITIONAL WORKFLOW

Developing the Automated Workflow Process

Revit and Dynamo are the keys to an automated workflow process. Dynamo acts as a translator between Revit and all of our engineering tools. It can seamlessly transfer large amounts of data between various third-party programs and directly connect our building model with our analysis model and design tools (see Figure 3).

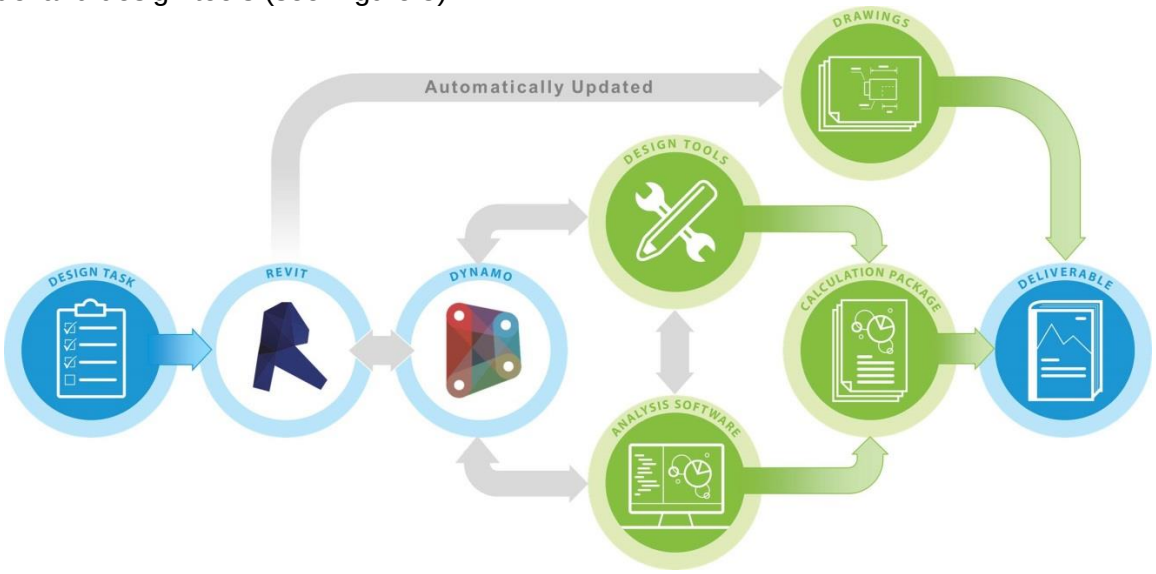

FIGURE 3: AUTOMATED WORKFLOW PROCESS

Revit and Dynamo complete the automated 3-D analysis and design workflow that was previously theoretical. They have become the central components of the interoperability of the modeling, analysis, and design (see Figure 4). Once the workflow is achieved, iterative design does not require manual repetitive tasks; the information is passed along seamlessly from one program to the next, continually updating the necessary information. As the design changes based on the calculations, the Revit model and analysis model are automatically updated. When the Revit model and the analysis model are updated, the drawing sheets and analysis output (demands) are updated—which completes the design cycle, and the calculations can be rechecked and the iterative process can begin again.

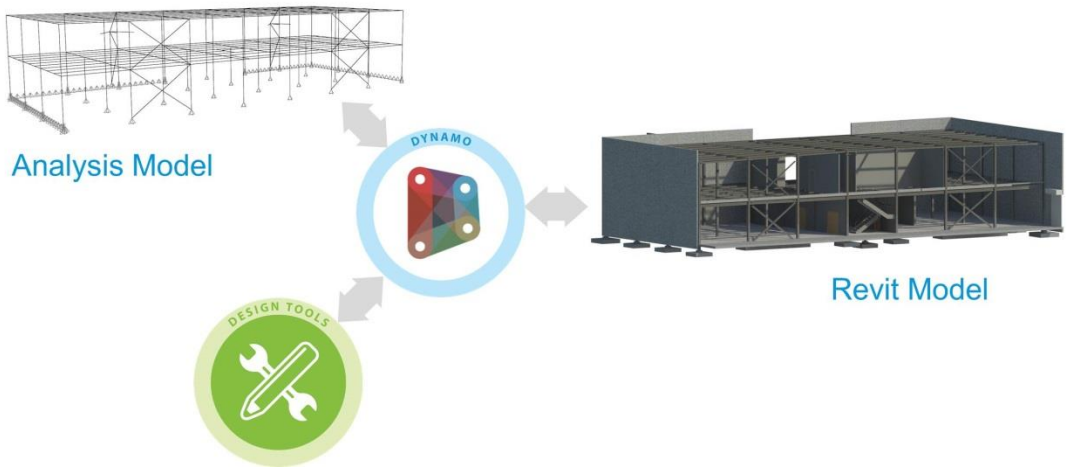

FIGURE 4: ITERATIVE DESIGN PROCESS THROUGH DYNAMO

Example Automated Workflow

The workflow shown below connects the Revit model with SAP2000 and Microsoft Excel (Figure 5). This workflow could be applied to various different design tasks.

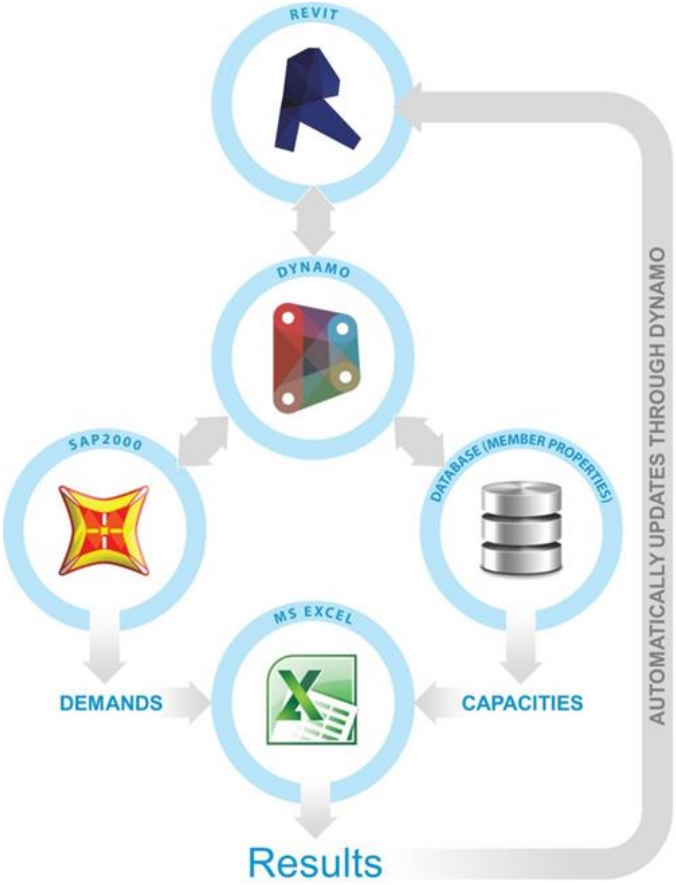

FIGURE 5: EXAMPLE AUTOMATED WORKFLOW

Conclusion

The 3-D integrated analysis and design workflow presented in this handout only scratches the surface of the potential interoperability between different types of software. Lidar scanning, drone imaging, cost estimating, and quantity take-offs are just some of the many design tools that could be integrated into this workflow.

Our workflow is simply a representation of one of countless possible processes that can take place utilizing Revit and Dynamo as key types of data transfer software. With Dynamo, engineers and designers can continually add design tools and integrate software to accommodate ever-changing design requirements and capitalize on the progression of technology. The versatility of this workflow allows users to apply whichever tools they are most comfortable with and believe will give them the best results.

Dynamo has opened the door to unlimited possibilities for the engineering community. For engineers, the opportunity to focus on creative problem-solving solutions rather than repetitive calculations and data transfer is crucial to the advancement of the profession.