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Using Advanced Features in Generative Design

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Learning Objectives

- Discover advanced preview features of Generative Design.
- Explore new ways to improve your design.
- Get familiar with best practices of presented features.
- Learn how to overcome challenges with presented tips.

Description

Generative Design software has been helping Autodesk Fusion 360 users to design, model, and manufacture products for many years. During this time, it's been constantly updated with additional functionality under preview features named Experimental Generative Solvers and Features. This preview contains advance features that will help you improve your design in ways unavailable through the default workflow. Tools allowing symmetry definition or setting displacement limits will give you more control over the outcomes. Frequency and buckling limits will let you design safer parts that could be used in a dynamic environment. Remote loads and constraints will enhance your modeling strategy, simplifying it and allowing you to model new conditions. These are just a few tools that we'll discuss during this class. You'll learn the capabilities of advanced features and gain knowledge on how to use them. The class will cover best practices and tips that can help you overcome possible challenges.

Speaker(s)

Grzegorz Borowski is a Senior Product Owner in the PDMS division, currently responsible for development of solvers used in Generative Design and Generative Modeling. He graduated with a M.Sc. degree in Mechanical Engineering, specializing in Finite Element Method (FEM) simulations. After studies he worked as a CAE Engineer for several different companies in Automotive Industry. He joined Autodesk in year 2016 as a Software Engineer in Test.

Tomasz Kasperek, Ph.D. is a Senior QA Analyst at Autodesk. Member of the development NASTRAN Team. He is a certified expert of Mechanical Engineers and Technicians Association and a court expert. He has practical experience in the industry as well as in the research and development departments. He specializes in structural and fluid structure interaction analysis (FSI) including vibration, fatigue and thermal loads. Tomasz is an author of publications in

scientific journals like “Archives of Machine Design”. In addition to Autodesk, he has worked with software like Ansys, Abaqus, CodeAster or OpenFoam. He is a simulation certified instructor and a regular speaker at many specialized trainings i.a. in the Kingdom of Bahrain, Persian Gulf. He performed numerous technical expertises in fields including energy and military industry.

Agata Kura is a Product Owner in the PDMS division, currently responsible for development of Generative Design and Generative Modeling User Interface. She graduated with a M.Sc. degree in Civil Engineering, specializing in Building and Engineering Structures. After studies she worked as a Structural Engineer for several different companies in AEC Industry. She joined Autodesk in year 2013 as a Quality Assurance Engineer.

What are Advance Features in Generative Design?

Generative Design introduces additional advanced features thru several preview options. This presentation covers two preview options:

- *Experimental Generative Solvers & Features*
    - Symmetry
    - Remote loads
    - Remote constraints
    - Point Mass
    - Remove Rigid Body Modes
    - Frequency
    - Buckling
    - Displacement limits
- *Die Casting*
    - Die Casting Manufacturing method

Preview Features are available for all Generative Design users. Once preview is enabled, new options will appear on Fusion ribbon.

Experimental Generative Solvers & Features enables additional option under Study Settings called Alternative Outcomes. Selecting this option can provide additional outcomes, its number depends on study configuration.

Introduction to Advanced Features

Experimental Generative Solvers & Features Preview

Symmetry option drives shape generation by enforcing symmetrical constraints in your design. Generative Design supports up to three orthogonal symmetry planes. Setup needs to be symmetrical in terms of preserves and obstacles (loads, constraints can be unsymmetrical). Exporting outcomes with symmetrical constraints should

Remote load is used to define point loads that are not directly on the preserves. Commonly used for simulation of assemblies without modeling of each component. Remote loads can be attached only to faces.

Remote constraint is used to define constraints that are not directly on the preserves. Commonly used for simulation of assemblies without modeling of each component. Remote loads can be attached only to faces. Option allows to constrain each Translation and Rotation degree of freedom in global coordinate system. Such flexibility allows to simulate various mechanical connections such as ball, cylindrical or revolute joints. Selection of degrees of freedom should be done with caution to ensure that setup is fully constraint.

Point Mass represents the effects of an external component attached to the generative model. It has an effect only with gravity load or frequency limit. Point mass should be realistic otherwise it might cause numerical issues.

Point masses will not affect the mass target or mass minimization values. Information shown in Explore will include only mass of created design, not entire assembly (with point mass).

Remove Rigid Body Mode is recommended for stabilizing generative study when model is not entirely constrained. Commonly used for simulation of assemblies.
Before using this option make sure that the loads are balanced in the direction where the constraints are applied. It is recommended to use this feature without constraints at least in direction of applied force.

Frequency limit is used to prevent resonance phenomena in designed part by including limit of first natural frequency. This feature can extend time of outcome generation.
It is good practice to select minimum first mode frequency higher than probable excitation frequency.

Buckling limit is used to prevent loss of stability of a design under compression loading. Buckling occurs more ofted in slender structures. Generative Design allows only single loadcase with this feature. Due to this limit it is advised to choose the most critical load case for your design.

Displacement limit allows you to set maximum allowable displacement for your outcomes. It can be applied globally to entire design or locally to any chosen surface, edge or point. Limit is set in each direction in global coordinate system.
Small displacement limits can prevent material reduction, choose realistic limits.

Die Casting Preview

Die Casting option allows to set specific manufacturing constraints to your setup such as:

- Ejection direction
- Draft angle
- Minimal and Maximal thickness

It’s important to ensure that setup meets requirements for Die Casting manufacturing. Option does not support some of other advanced features like: Symmetry, Remote Loads/Constraints, Point Mass, Remove Rigid Body modes, Frequency, Buckling.

General Good Practices

Generative Design is simple to use but very powerfull tool. In order to obtain best results it is recommended to follow few simple rules while setting up your study and exploring results:

- Preserve, Obstacles and Starting Shape
  - Avoid relatively small / thin geometries
  - Ensure realistic "line of sight“ between all preserve geometry
  - Avoid interference between preserves and obstacles
  - Use starting shape to drive your design
  - Avoid thin starting shape
  - Starting Shape must be connected to preserves
  - Avoid unnecessary detail (i.e. engraved part numbers, complex geometry)

- Material
  - Use realistic material data

- Boundary conditions
  - Loads and constraints should be realistic
  - Avoid low loaded unloaded setups
  - Resultant load at given preserve should be a nonzero value
  - Avoid loads on small area

- Manufacturing methods
  - Not every setup is valid for each manufacturing method
  - Tool dimension should be reasonable compared to user setup
  - Ensure that obstacles are not preventing material removal

- Resolution
  - Change resolution based on your setup. Complex setups need higher resolution
  - Accurate resolution does not guarantee better results

- Before results generation
  - Investigate model carefully for any Pre-Check warnings. Any warning can have a direct effect on result
  - Use Previewer for validation of your setup

- Exploring and exporting your results
  - Carefully investigate proposed results
  - Check status of chosen outcome
  - Check potential warnings by hovering over thumbnail of chosen outcome
  - Export chosen design and validate it in Fusion Simulation