

CP195968

Making the Hulkbuster Suit with Fusion 360

Hung Nguyen - SolidCAD

Shaya Ghanbar, P.Eng – SolidCAD

Learning Objectives

- Learn how to model a 3D Free Form Shape in Fusion 360
- Learn how to flatten a 3D pattern and 3D Printing
- Learn how to use Fusion 360 CAM profile cutting and Joint design
- Learn how to use Fusion Joints to develop complex mechanism

Description

In this class, you will learn how to model and make the Hulkbuster Suit, which was featured in the Iron Man movie series, with Fusion 360 software. The Mark XLIV Armor, better known as the Hulkbuster, is Tony Stark's 44th Iron Man suit, made with the help of Bruce Banner. The armor was brought into play to protect Wakanda from Thanos's invading army in this year's blockbuster movie Avengers: Infinity War. We'll explore the digital workflow with Fusion 360. Using ReCap software to convert human scan data to mesh model, we'll use Fusion 360 to model the suit to fit the human mesh. We'll then create pattern creation with ExactFlat Online, lay out a nested flat pattern, and cut out stock sheet using Fusion 360 CAM 2D profile cutting. We'll assemble all the parts together, and the Mark XLIV Armor will be finalized with perfect shape and size. The Hulkbuster Suit model for this class can be viewed on the Fusion 360 gallery.



Speaker(s)

Hung Nguyen

Technical Consultant - SolidCAD

Hung Nguyen has 26+ years of experience in Autodesk Products. He has a strong background in Architectural and Manufacturing fields. He is a BIM & Manufacturing Technical Consultant. Hung also has extensive experience in a diverse range of CAD-related software such as: Revit, Inventor, Fusion 360, Alias, and Simulation to name a few. He has presented multiple times at Revit Technology Conference (RTC), Canadian Festival of Architecture, CanBIM, and Autodesk University from 2013 to 2017.

Shaya Ghanbar, P.Eng

Technical Consultant – Manufacturing SolidCAD, A Cansel Company

As a Mechanical Engineer, Shaya Ghanbar has several years of experience in mechanical component design in the automotive industry and knowledge in design and simulation of advanced remote medical equipment. Shaya graduated in 2010 with Bachelor of Mechanical Engineering with Honors. Based on research for his university thesis, Shaya co-published the Characterization of a Robotic Drug Delivery System Based on Magnetic Propulsion in the IEEE/ASME journal. In 2016, he acquired his Professional Engineering designation in Ontario, Canada. Throughout his engineering career, Shaya has used several CAD and FEA applications such as Autodesk Inventor, ANSYS and Pro Engineer for 2D/3D design and simulation analysis. He has also had the opportunity to use and manage both Vault Professional and PLM 360 for engineering project management. Currently, Shaya is working as a Manufacturing Industry Consultant with SolidCAD. He is taking advantage of his engineering and CAD design experience to help SolidCAD's clients to improve their manufacturing processes and determine methods for time and cost management. Shaya is involved with Autodesk Vault data management consulting, Vault data management implementation, Autodesk Inventor design and iLogic programming training, as well as Fusion 360 consultation.

Introduction

The goals of Project HulkBuster Suit are:

- Uncover the all-in-one environment of Fusion 360
- Create something that can be flattened for cutting
- Create something that is fun and have practical use

With research and learning from past AU, and after several design sessions we converged on the following process workflow:

Product Design-to-Production Workflow

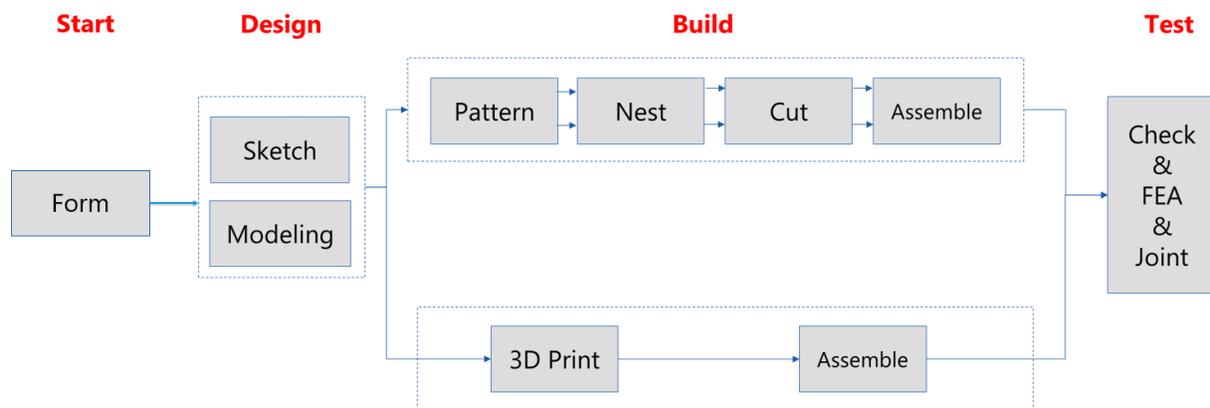


Figure 1

Fusion 360 and its plugin is superior for these tasks:

Start - Form

The 1st one from the left came from 3D scanner. Scans are very useful for digital design since it produces point cloud that can be meshed using on-line meshing service from Recap Pro.

The 2nd and 3rd mannequins can be easily produced by using a software called MakeHuman 1.1.0. MakeHuman is a free and open source software for creating realistic 3d humans for:

- Illustrations
- Animations
- Games
- Zbrush/Mudbox sculpting

MakeHuman provides Macro that quickly size human model based on gender, age, muscle, weight, ethnic background etc. Models from MakeHuman can be exported out as Wavefront obj format. The Wavefront obj can be inserted into Fusion 360 and ready to be converted into T-Spline and Patches.

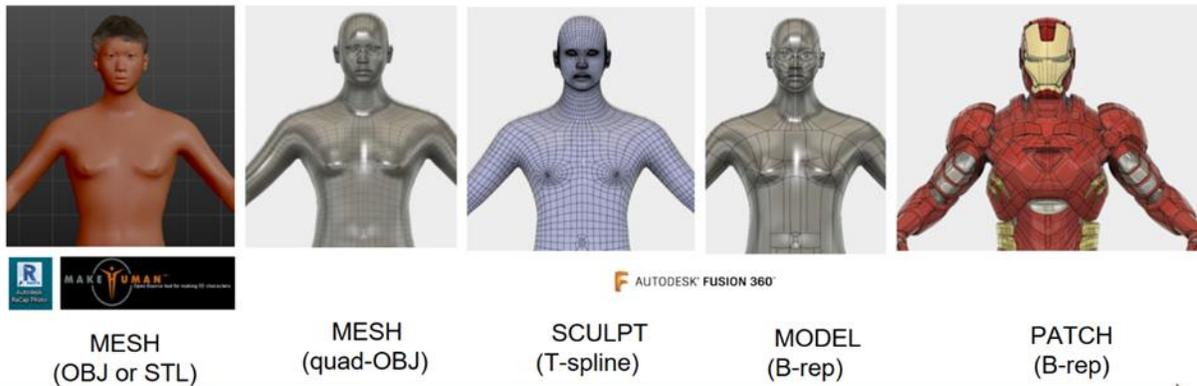


Figure 2

Design – Sketch and Modeling

We used 2 approach for Modeling using Fusion 360 and 3DX Max

1. Using Fusion 360 Sculpting technique

The approach to model the suit involves using Fusion 360 with front, top, and side canvas. These canvases are used to create a series of guiding sculpt plans that form the helmet of the Ironman model. This process is shown in the course [videos](#).

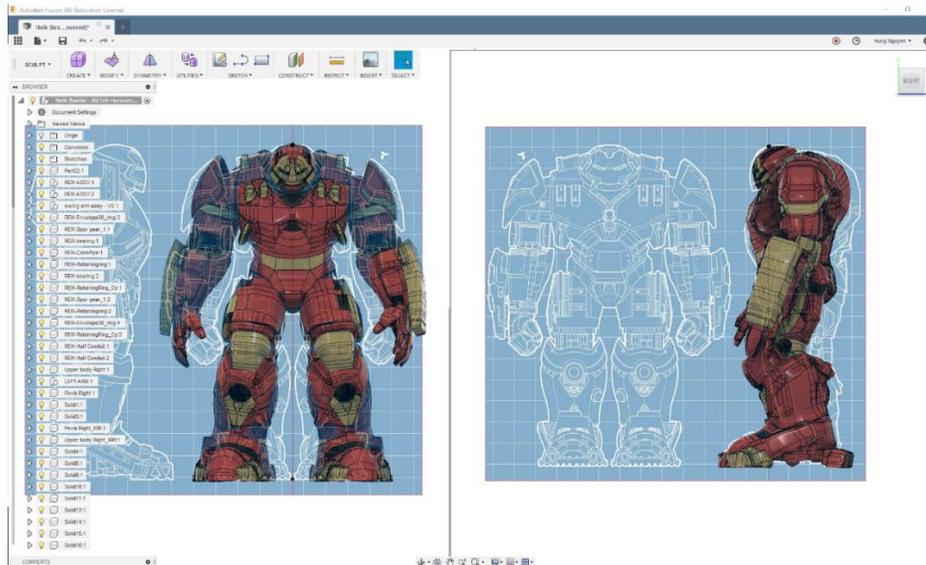


Figure 3

2. Use 3DS MAX Polygon modeling & convert to Fusion 360

In a similar way, 3DS MAX can also be used to create the HulkBuster model. This process is shown in the course [videos](#).

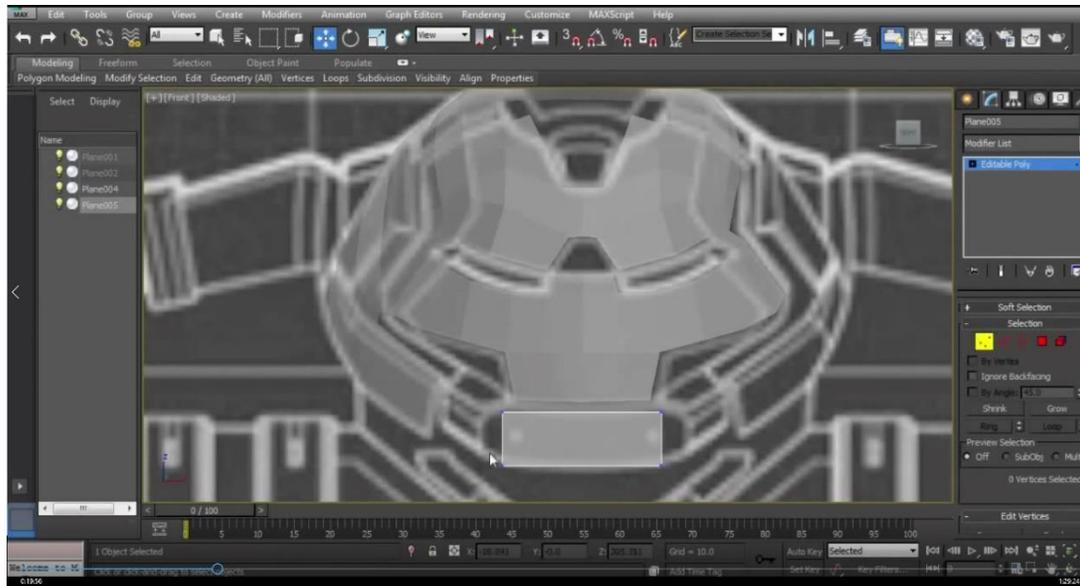


Figure 4

Existing triangulated mesh need to be converted to Editable Poly before inserting into Fusion 360. The steps include:

- Import triangulated mesh into 3DS Max
- Apply Subdivide (WSM) with “Display Subdivision” turn OFF
- Use “Collapse To” to Collapse mesh
- Turn Collapse mesh to Poly mesh
- Apply “Quadrify All”.

Build Method 1 – Pattern Nesting Cutting Assembly

In this method, Sheetmetal or Fabric can be used.

Pattern – Flat out the Suit

The purpose of the patterning phase is to convert complex 3D surfaces into flat shapes than can be cut. There are 2 ways to flatten the Ironman suit for cutting:

- ExactFlat Online
- Pepakura Designer

ExactFlat provides users with access to the same flattening technology found in our desktop solutions while enabling use with any 3D CAD tool and from any web-browser. This product is focused on the needs of manufacturers with critical but infrequent flattening requirements.

ExactFlat Online makes it easy for small teams, start-up companies, students and "Makers" to create innovative textiles or sheet metal products. Steps are:

- Design your product in your 3D CAD tool
- Prepare the 3D model for flattening
- Flatten the 3D model into 2D patterns
- Finish the pattern engineering process

To prepare and get the most out of Exact Flat, we followed several designing principles:
Try to create clean surfaces

- Add seams to surfaces that need to be flatten
- Re-mesh complex forms with Exact Flat
- Use “Pelt” for most preliminary flattening
- Only use 100% optimized patterns

A step-by-step example is shown in the course [videos](#):

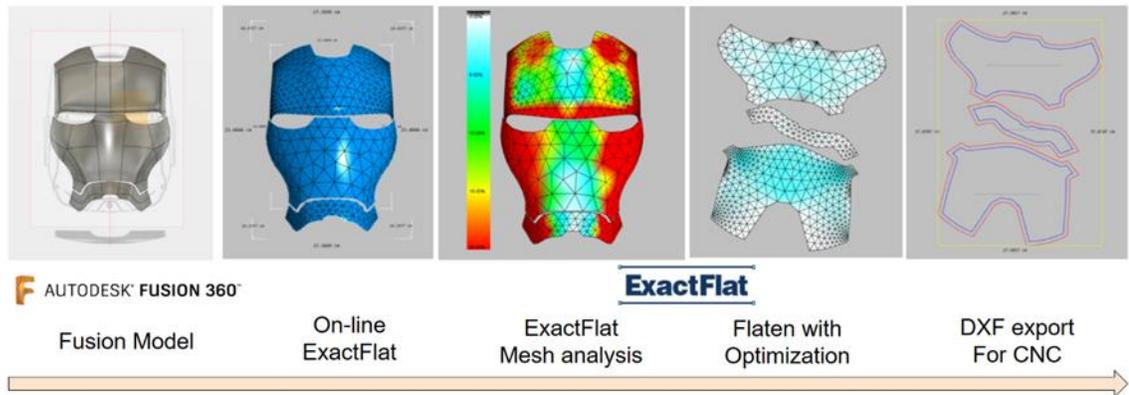


Figure 5

Nesting, Cutting & Assembling

Nesting: Hand nesting is often sufficient. If a large number of patterns are to be nested, it is recommended to utilize nesting software such as Autodesk TruNest to automate the process. TruNest nesting software helps translate, optimize, and manufacture the nest on all standard machines. It works with composites, wood, plastics, glass, sheet metal, cloth, and leather.

Fusion 360 plugin is also available for basic hand nesting. Fusion 360 NESTER is a simple script written by Patrick Rainsberry to lay out flat patterns in Fusion 360. It was specifically useful to use with a CNC Router.

The ExactFlat’s DXFs, can be opened in AutoCAD for extrusion, and exported to Fusion as SAT format for pattern nesting and cutting.

Cutting: Fusion 360 is the first 3D CAD, CAM, and CAE tool of its kind. It connects the entire product development process in a single cloud-based platform. Fusion 360 now has CAM feature to develop cutting paths for laser cutters.

The nesting layout can be used for laser cutters in this [video](#).



Figure 6

Assembling: The Ironman suit was assembled by hand since it was made with ½” rubber sheet. The pieces were glued together. We also took a series of photos for fit check purposes.



Figure 7

Build Method 2 – 3D Printing and Assembly

In this method, 3D printer can be used.

3D Printing

Fusion 360 is an excellent choice for creating models for 3D printing.

It allows you to create not only “prismatic” models such as gears or brackets, but it also allows you create more “organic” models using T-Splines, including characters, plants, and vehicles.

You can use Fusion 360 to create and then edit your objects for 3D printing. You can also bring in models from other software and make modifications, such as de-featuring them by removing small features or blends.

Fusion 360 can export as an OBJ or STL file format that is read by most 3D printing software. It also has the ability to print directly to your 3D printer.

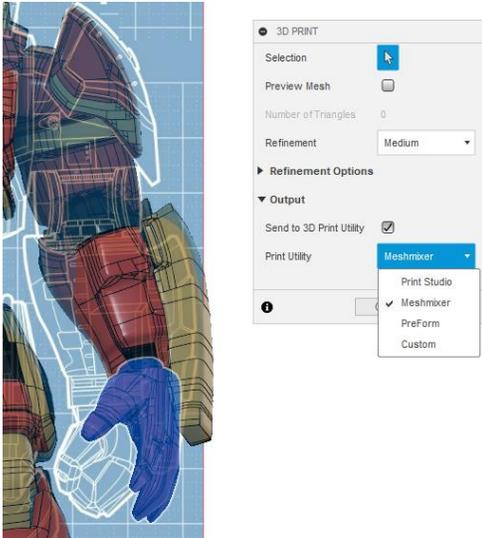


Figure 8

Test - Simulation and Joint Study & Making

In this portion, we'll discuss about Simulation and how to animate joints in Fusion 360

1. Fusion 360 FEA

Our purpose is to find out if the Ironman suit can remain undamaged under an impact force such as a bullet. We setup several Event Simulation studies for the front of Ironman mask. Fusion 360 proves to be the best software for digital prototyping and testing.

The following analysis results show accurately how the mask's material can react against strong impact force:

Case Study #1

Ironman mask is made with Titanium – High strength alloy

Bullet is made with Lead and fired at speed of 450m/s As an Account administrator, you'll need to create a project, assign Project Administrators, and activate services.

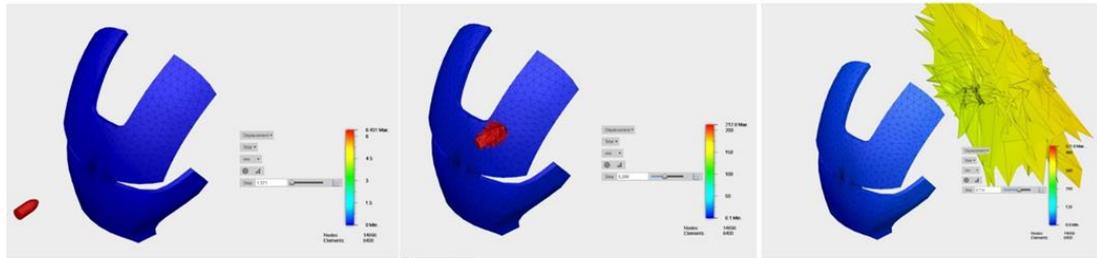


Figure 9: Bullet deflection after hitting Titanium – High strength alloy target

Case Study #2

Ironman mask is made with Copper

Bullet is made with Titanium – High strength alloy and fired at speed of 450m/s.

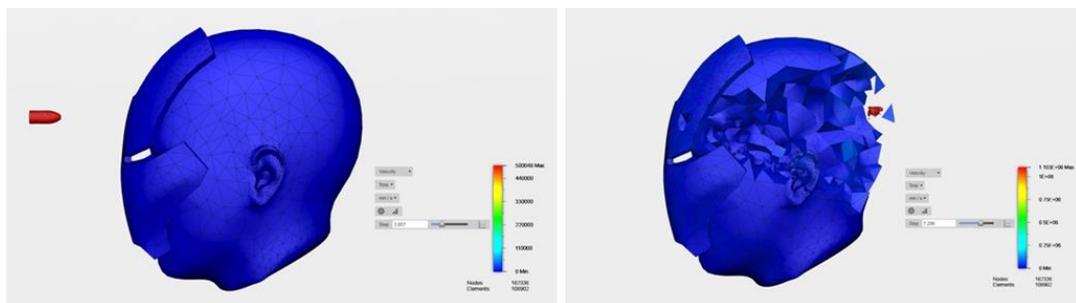


Figure 10: Titanium – High strength alloy bullet penetrates copper mask and target.

2. Joint Study

There are many researches that helps bridge the gap between soft robotics and traditional rigid robotics. For example, researchers from the Wyss Institute for Biologically Inspired Engineering at Harvard University and the Harvard John A. Paulson School of Engineering and Applied Sciences (SEAS) have shown how a multi-layered structure can allow robots to mimic the octopus' kinematics, creating and eliminating joints on command. The structure can also allow robots to rapidly change their stiffness, damping, and dynamics.

<https://wyss.harvard.edu/robot-transitions-from-soft-to-rigid/>

Our purpose is to bring the Hulkbuster to life. We've been studied and researched to tranfer human moves to Robots.



Figure 11: Hulkbuster in Samba dancing move

In our study, we approach a different way of producing soft moment to rigid robotic suit such as the Hulkbuster. The concept was invented by Adam Bakir. Adam is the founder of "Rotatable Envelope Modules Incorporated". His company is focused on a new robotic wrist/arm design concept, "Rotatable Envelope Modules" (REM), which has been patented. Adam's main background is computer science, where he has worked for Carlton University and the Department of Defense.

The REM concept consists of four main components: Spool, envelope, c-clip and slide stabilizer. These components when combined compose a module, where a single module has applications such as a robotic wrist. To assemble a module, one envelope is inserted overtop of one spool, so the two surfaces lay flush. Then four c-clips are inserted around the outer rim of the flush surfaces to ensure the envelope and spools remain in place. There can be a maximum of four slide stabilizers which are positioned on the inside of the module and connected to the spools.

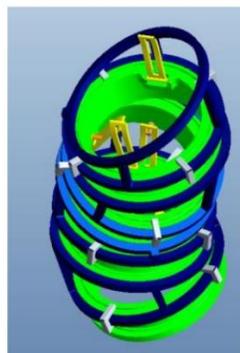


Figure 12: Snake (Multiple REM Modules)

There are three main benefits of this design compared to models that currently exist:

1. Free space available inside of each module is approximately ninety five percent of the total available volume.
2. Each module is individually powered allowing for more joint independence.
3. The articulation of the design can be greater than 180 degrees

4. Joint Making

The joint prototype for Hulkbuster based on REM invention by **Adam Bakir** and **Earl Gifford** is currently developed. The 4 stages of development are below



STAGE 1



STAGE 2



STAGE 3

Figure 13



Figure 14: Stage 4

Conclusion

Product development has changed. So, should the tools. This statement is true for all product design even in fabric or textile-based products. Advance material and additive Manufacturing are shaping everyday designs, but to cope with the rapid changes, not many software allow designers to go from design concept to making except Fusion 360.

In our workflow of design and making a Robot suit, we were able to explore the power of Fusion 360. We explored a digital designing methodology for improving designer productivity through designing digitally which spanned through multiple apps.

This class shows how the comic Hulkbuster suit can be made by combining Fusion 360's direct and sculpting tools or converting 3DS Max model. Flat pattern creation is done by using ExactFlat, nesting, cutting and final analysis can be done with Fusion 360.

Acknowledgment

A very special "Thank You" to:

1. The Autodesk Fusion 360 developing teams
2. Adam Bakir - Founder of Rotatable Envelope Modules Incorporated.
3. Earl Gifford – Design Assistant of REM Inc.

You truly inspired us for putting this session together.

Resources:

- Intgration of Textiles in Fusion 360
- MakeHuman
- ExactFlat Online
- Pepakura Designer
- TruNest
- Photo Bots - Iron Man Helmet 3D Modeling in 3ds Max