Week 12: Composites

22.4. 2015

This week we will learn about composites.

The agenda: http://academy.cba.mit.edu/classes/composites/index.html

Composites: http://academy.cba.mit.edu/classes/composites/composites.png

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materials
      compression vs tension
         epoxy + carbon fiber
         concrete + rebar
         fiberglass
         FR1, FR4
         tire
         adobe
         wood
      fiber
         chopped, filament, tape, fabric
         glass
         carbon
         aramid, Kevlar
         natural: cotton, silk, bamboo, wood, linen, burlap, ...
      matrix
         epoxy
         polyester
         phenolic
         urethane
         wax
         cement
         natural: plant resins, sugars, ...
      laminate
   vendors
      West System
      AeroMarine
      Jamestown Distributors
      Fiberglass Supply
      Entropy Resins
      Smooth-On
      Aremco
      Ashland
      DuPont
      US Composites
      Hexcel
      Exel
      Gurit
      Toray
   design
      plies
      radius of curvature
      cores
      spar, rib, skin
      digital
   processes
      compaction, infusion, volume fraction
      open, closed mold
      wet lay-up, pre-preg, RTM, VARTM
      compression molding
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- vacuum bagging
  - mold, release, laminate, core, peel ply, bleeder, breather, bag, sealant tape, pump
- autoclave
- pultrusion
- clear coat
- molds
  - machined
  - folded
  - skinned
- safety
  - particles, inhalation, rashes
  - respirators, googles, gloves
  - fumes, ventilation
  - net-shape

Assignment:

Design and make a 3D mold (~ft2), and produce a fiber composite part in it.

Class:

Materials:
https://docs.google.com/spreadsheet/pub?key=0AtIlZyLn99e6dGRleUJTY043a3FucUhFUVVBYTdxS3c&single=true&gid=0&output=html

compression vs tension
- epoxy + carbon fiber
- concrete + rebar
- fiberglass
- FR1, FR4
- tire
- adobe
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fiber
- chopped, filament, tape, fabric
- glass
- carbon
- aramid, Kevlar
- natural: cotton, silk, bamboo, wood, linen, burlap, ...

matrix
- epoxy
- polyester
- phenolic
- urethane
- wax
- cement
- natural: plant resins, sugars, ...

Lay up a fabric

Fiber glass used in boatbuilding
Stay away from glass fiber and carbon fiber – respirators needed and body protection, ventialation

Aramid – for armour and bulletproof vest

100 yrad roll, LA linen 15-inch Natural Jute Burlap Roll
Naturally sourced
The body can break this down
It makes high performance structures

Matrix – epoxy – West Marine: http://www.westmarine.com/

Polyester –

Resins – Super Sap 100 (Enthropy Resins) – Protection and ventialation.

Laminate: http://www.fablabbcn.org/2012/05/fab-lab-skate/

Vendors:

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AeroMarine
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Design of the part

Single ply of the fabric,imbued with the resing that is not a composite. You need multiple plies. Radious of curviture, difference of the pathlength. Tension builds up on the top layer that prevents it from bending. How you orient the fibers is of essence.

Common thing to do is to have a a few plied + core + Luminum honeycomb, used in aerospace.

Wings – joining of composits is a weakness

Loops of fiber, linking them into a structure.
Digital composits.

Processes

Compaction and infusion
Common beginner mistakes – spread and layers being too close.
Core is needed for the resins to get through them.
Close together, but not touching.
Fibers as close together as their size.
Better to have less resin.

Roughly equal volume fiber and resins. Compaction and infusion.
Tooling – standard way is: ....

Open – versus closed tools (more control, better finish)

We then need to introduce the resin.
Open: Lay a ply of fabric onto the tool, manually spreding fiber and resin.

Closed tool – inject the resign into the tool, needs to be strong.

Wet layout –

Two sided mould – and then squiz it. Couple of ways to do it.
Mill the foam tooling, put a layer on top - Jorgensen tool clamp set

Hyperstatic moulding – to do compression moulding

Vacum bagging – generated larger forces than vacuum molding:
http://www.westsystem.com/ss/assets/HowTo-Publications/Vacuum-Bagging-Techniques.pdf

mold, release, laminate, core, peel ply, bleeder, breather, bag, sealant tape, pump

autoclave

pultrusion

clear coat –

Milling the foam – make a rubber mould from that and then a concreate mold. Smart mold that can heat as well as squiz.

Machining the mould – laser cut

Industrial shrink wrap – TRO-TECT

Don't do your part in one go. Number of ways to make tooling.
Don't waste much time on the first piece.
Make a cupon – used in industry, make test parts.

100% linen – finer weave than the burlap

Warner 250 tool Wall covering Perforator

Morning Glory Great Glory – batter

50 pack space saver vacuum storage bags – jumbo size
Shock vacuum. Zip lock on the side.

Mann release spray

Spreaders

Brake Bleeder and Vacum ...

Shop vacuum – not designed the run continuously, to be used with the disposable bags

Molds

Machined: http://academy.cba.mit.edu/classes/composites/machine.jpg

Folded: http://academy.cba.mit.edu/classes/composites/fold.png

Skinned: http://www.shrinkwrapcontainments.com/

Safety

Particles, inhalation, rashes
Respirators, googles, gloves
Fumes, ventialation
Net-shape:

Assignment:

Design and make a 3D mold (1 sqft) and produce a fiber composite part in it

Start with proces, coupon, test parts, make the whole thing

Good week to play with 3D tooling

Gesso – painters use it to prime canvasses

Close tooling – compression tooling

Burlap (Strigi)

Modelled a bowl shape in Rhino

Saved the bottom and top parts in a .stl file format

The files are opened in Partworks 3D

Make mm cm -

Check that top is selected on the model

Thickness – 100 mm

Under material size and margins

Under Material size move selection to lower left corner (from center)

Z zero sets the location where it starts calculating all the cutting from

Click Symmetrical

Click model silhouette – Apply

Depth of Model below Surface (to be adjusted only when you want a nice finish on top)

Cut Plane Position – not changed

Roughing toolpath

Chose 0.5 inch endmill

Edit parameters – click

Pass depth – set to 0.78 Inch (or the depth that the tool will cut in one go)

The stepover was set to 0.2 – 40%

Spindle speed – set to 12000 (default setting – judging according to the material – qualities

Feed rate – 3.0
Plunge rate – 3.0

Tool Number – 1.0 (no change – for automatic tool changing, not relevant here)

Toolpath parameters

Rapid clearance gap – distance that the tool clears off the top of the milling action) – 5.00 mm – In relation to the limits of the machine (20 cm +)

Machining allowance (damages to the material have to be accounted for) – 1.0 mm

Strategy

Z level – Raster X

Side displayed...

Top clicked

Calculate ....

S

Explanation –

Finishing toolpath

Ball Nose 0,25 inch selected

Spindle Speed 12000

Feed Rate 6.0

Plunge Rate 6.0

Rapid clearance gap 5.0 mm

Raster Angle – 135 degrees (does not matter for this design what to use.

Cut out toolpath – skipped

Preview Machining

Preview – no change

Post Processor – Shopbot TC (MM)

Roughing Toolpath Save

Finishing Toolpath Svve

Shopbotting

Shopbot wiki: http://shopbotwiki.com/index.php?title=Main_Page

See instructions on using the shopbot:

Techniques: http://shopbotwiki.com/index.php?title=TechniquesMain

Materials: http://shopbotwiki.com/index.php?title=Materia
http://wiki.fablab.is/wiki/Shopbot_fr%C3%A6siv%C3%A9llMain

Finnfoam – material used for the shopbotting of mould:
http://www.finnfoam.com/

Guidelines on compositing:
fabacademy.org/archives/2014/students/zitek.scott/week11.html