An Informal Introduction on Mechanical Design and Manufacturing

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What is my (academic) story?

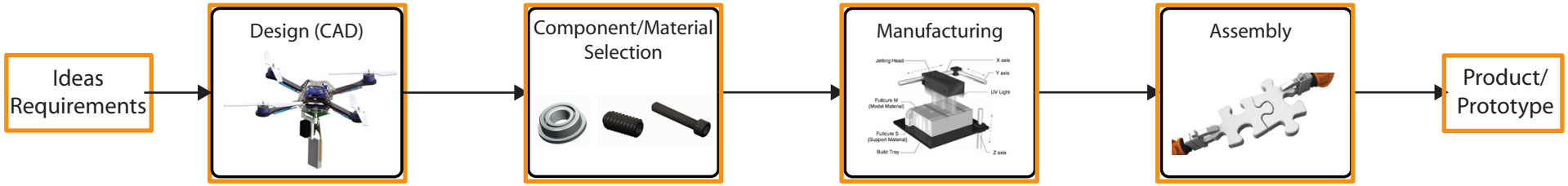
Assistant Professor(?), METU Electrical & Electronics Eng.

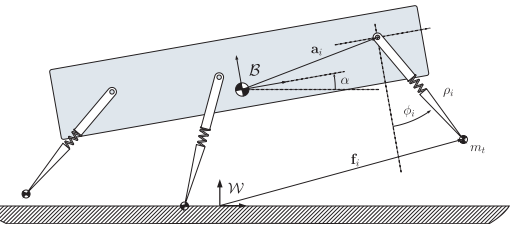
PhD from JHU Mechanical Engineering

MS from METU Electrical & Electronics Eng.

BS from METU Mechanical Engineering

Design Process (OL)





Ideas, requirements

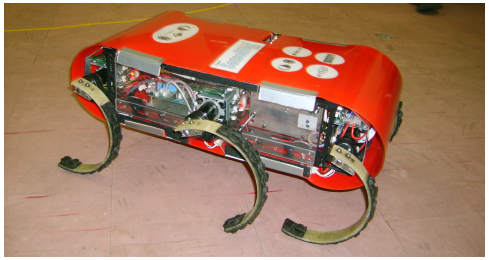
Design (CAD)

Component/material selection

Manufacturing

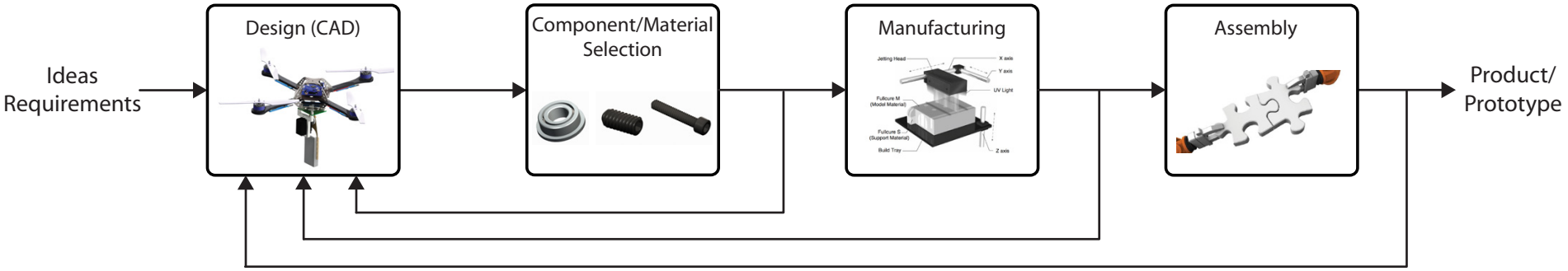
Assembly

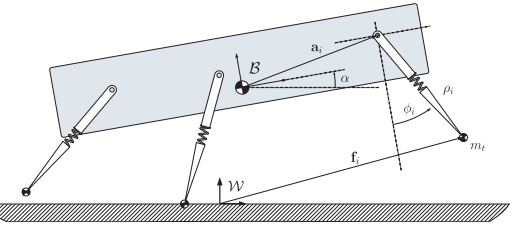
Product/Prototype



Ankarali et al. 2011 & Saranli et al., 2011

Design Process (CL)





Ideas, requirements

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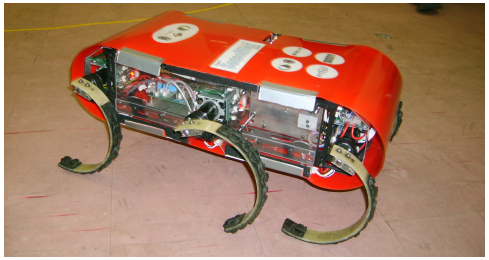
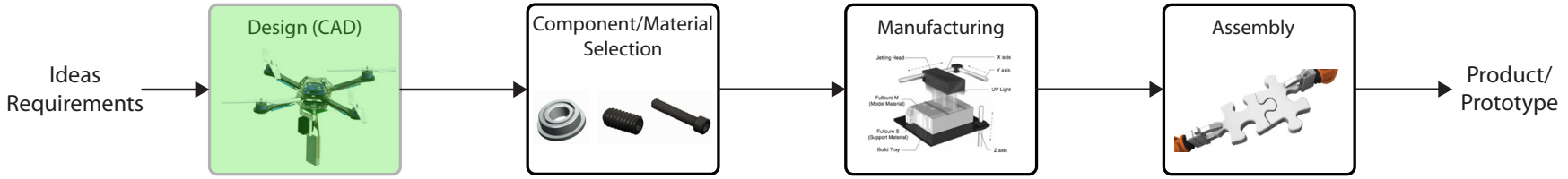
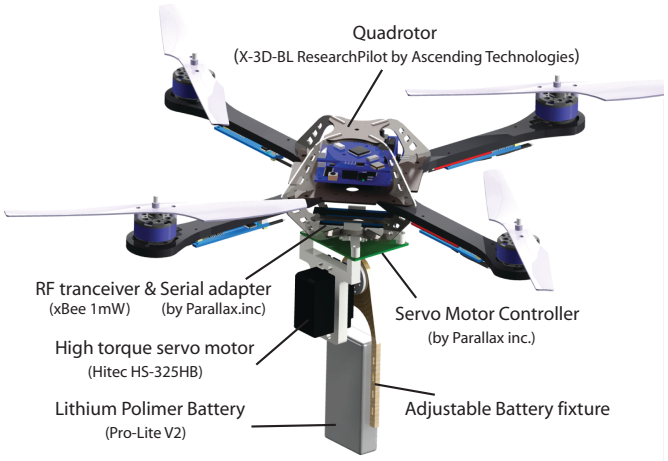
Feedback reduces uncertainty

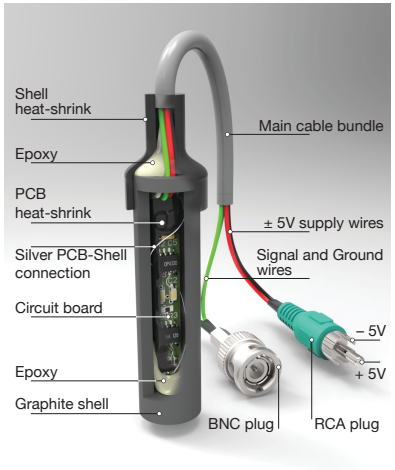


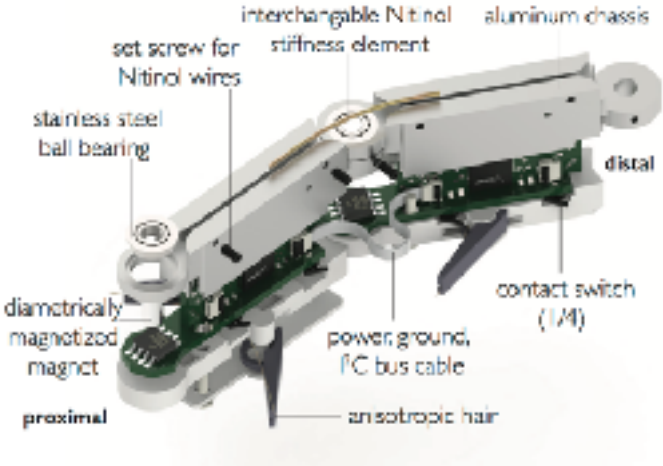
Design (CAD)



- USE CAD software
- If your design looks good, then your final product will probably be good

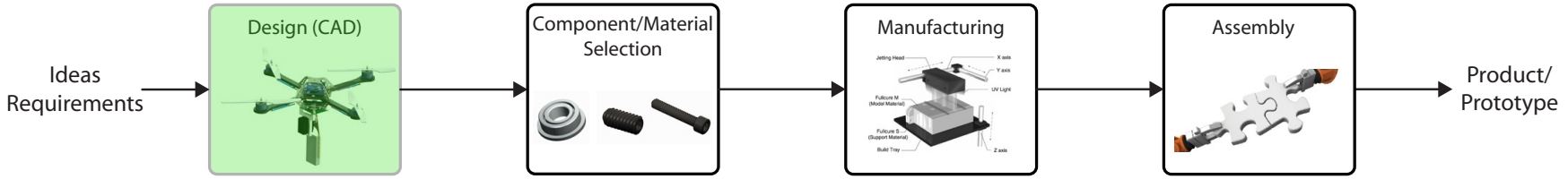




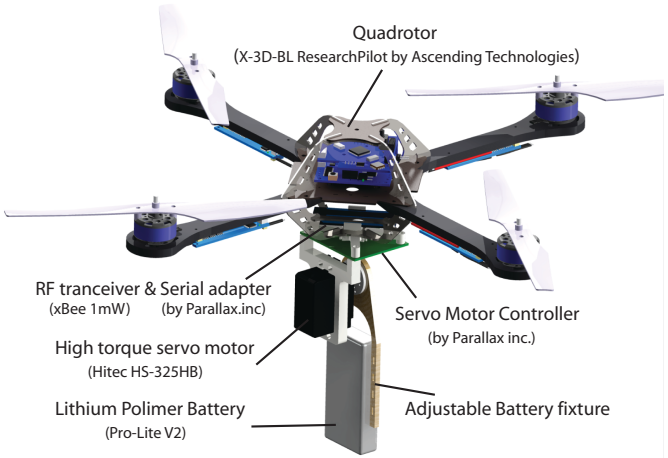


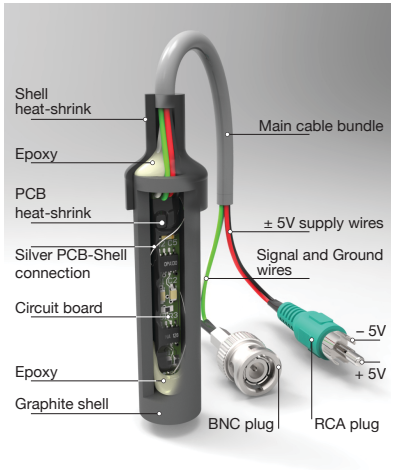
CAD designs by Dr. Alican Demir

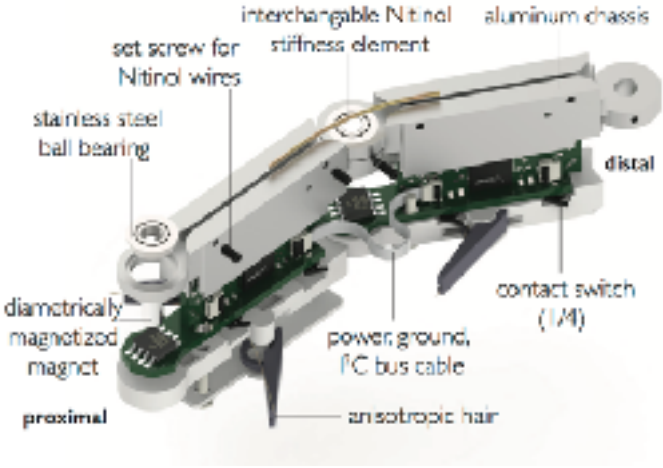
Design (CAD)



- Take advantage of open source CAD drawings of the commercial components
- Improve/update your design considering the other steps

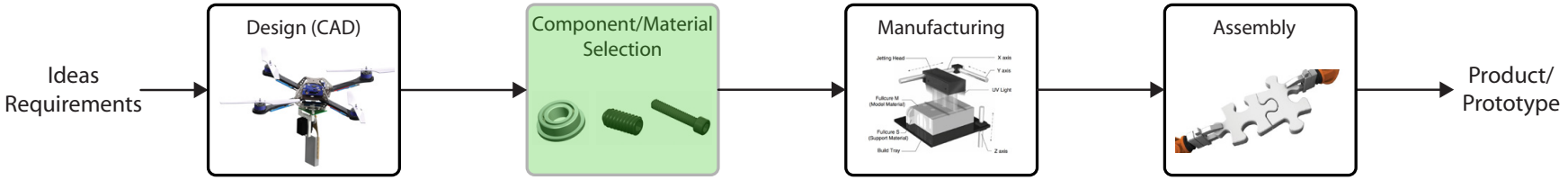






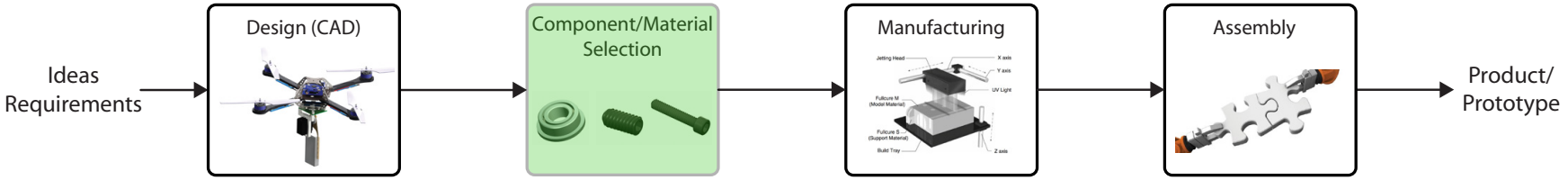
CAD designs by Dr. Alican Demir

Component/material selection



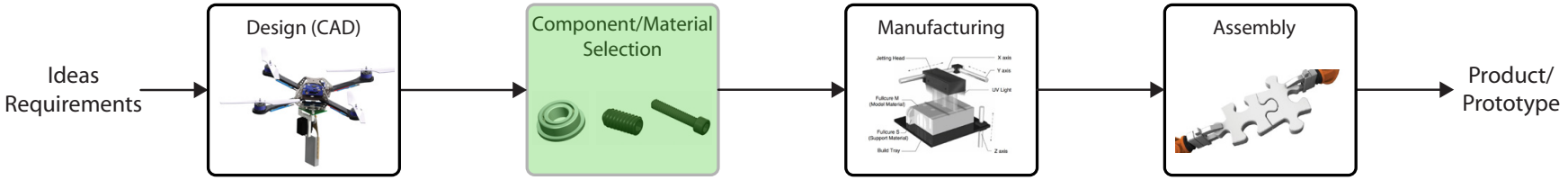
Probably, it won't work

Component/material selection

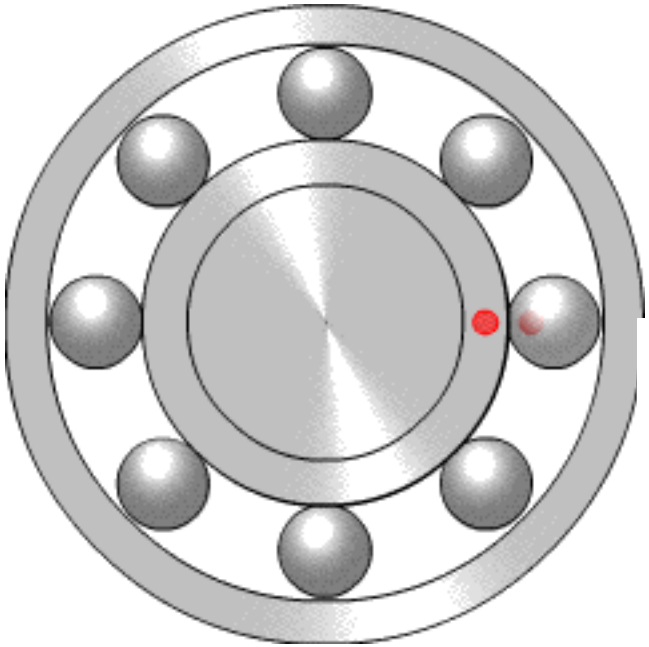


Now, it may work

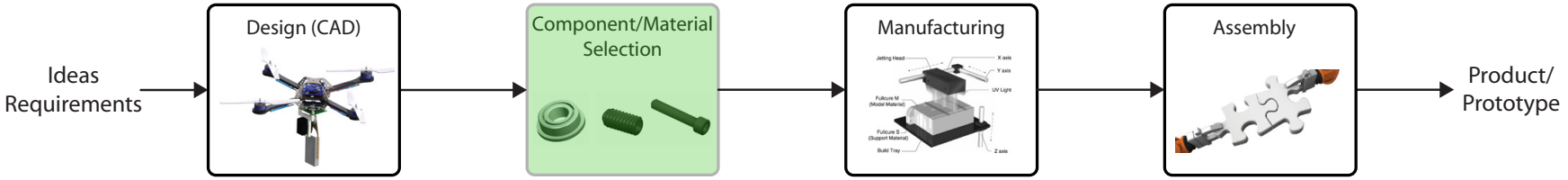
Component/material selection



Have ever seen this ?

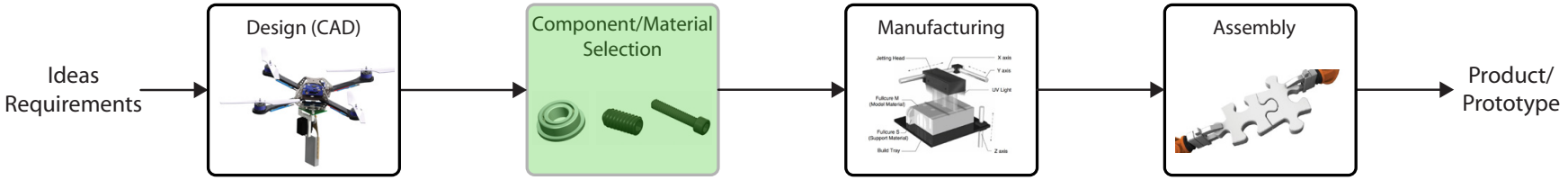


Component/material selection

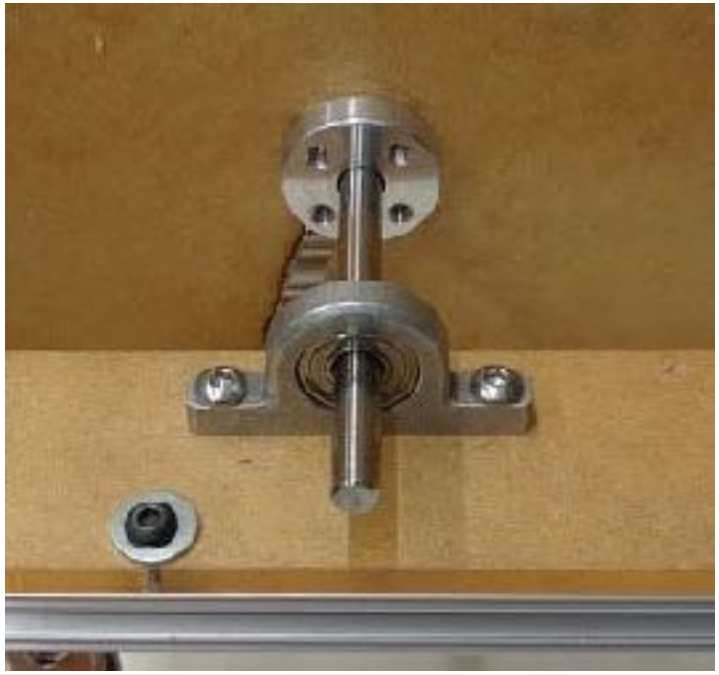


Most convenient type of ball bearings

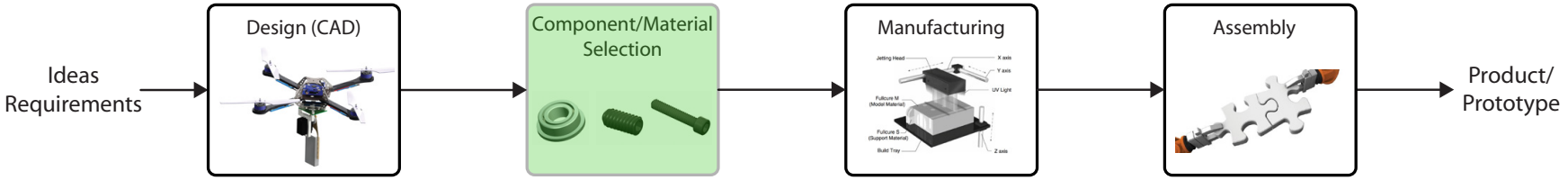
Component/material selection



Example ball bearing unit mounting



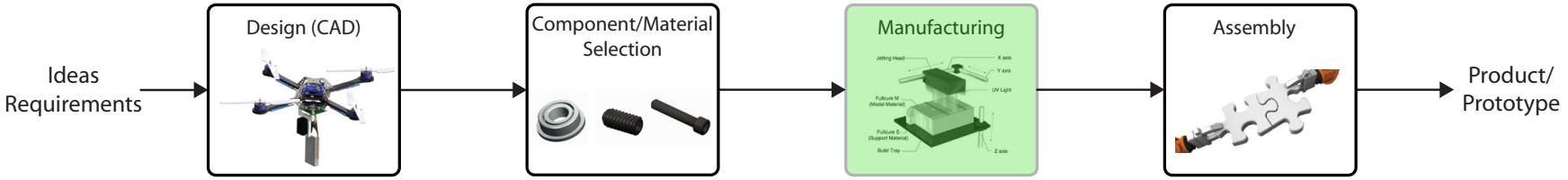
Component/material selection



Alternative: Custom bearing/ball bearing housing

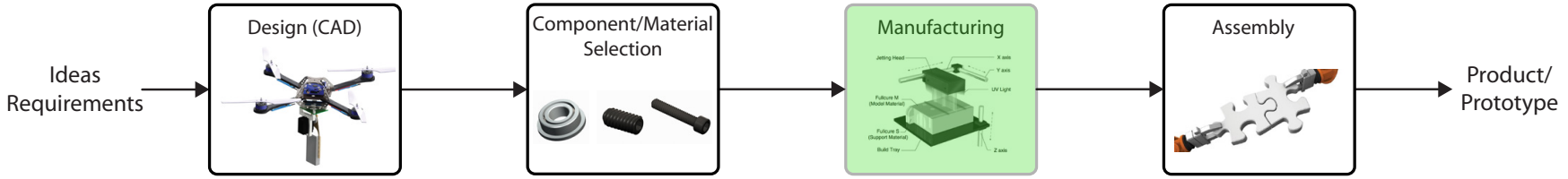
May require some gluing

Manufacturing



3D Printer: It's a huge privilege for you, so use it

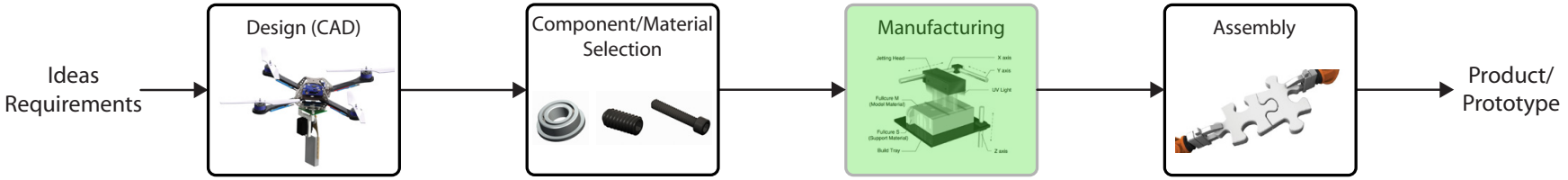
Manufacturing



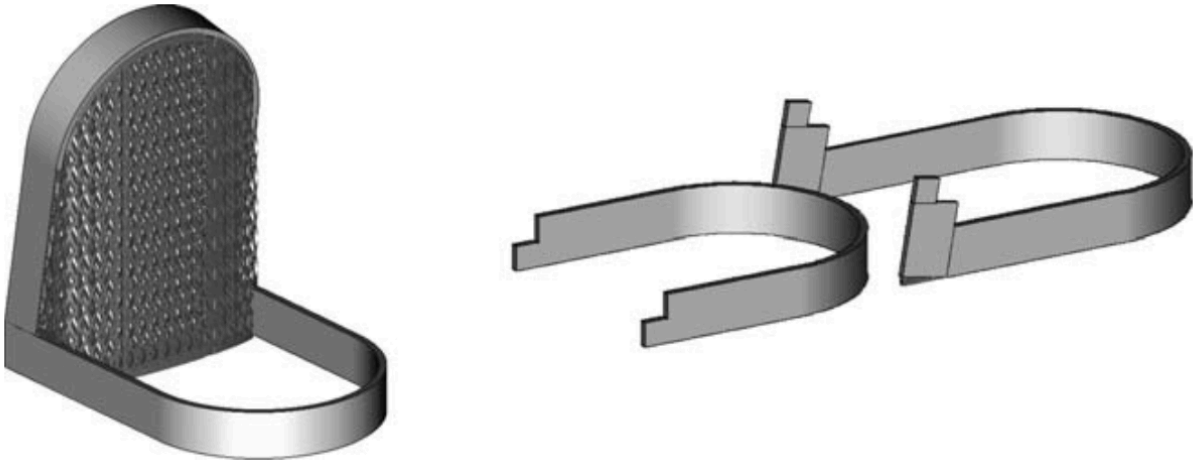
- **Design for 3D Printer**
- Part orientation is important
- Minimization of support material
- Inclusion of undercuts and other manufacturing constraining features
- Reduction of part count in assembly

Courtesy of Dr. Ulas Yaman

Manufacturing

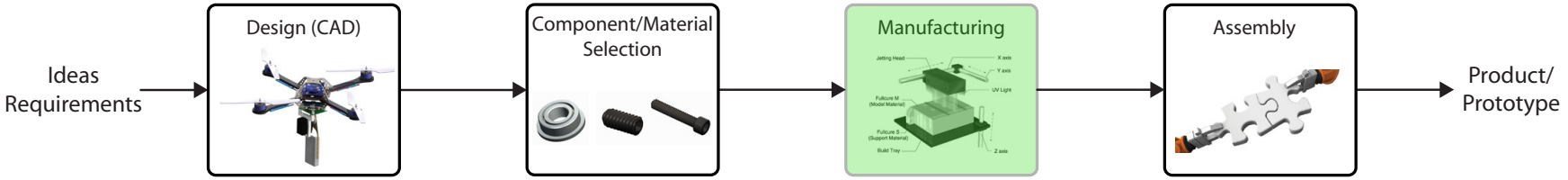


- The build on the left can be broken into the two builds on the right, which may be stronger and can be assembled together later
- Note the reduction in the amount of support material and the reduced build height



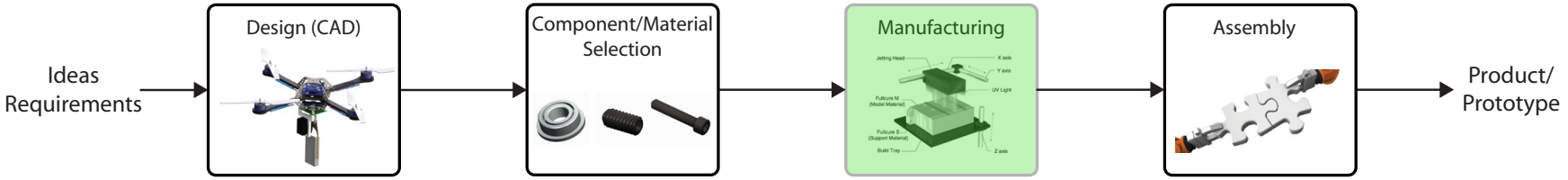
Courtesy of Dr. Ulas Yaman

Manufacturing

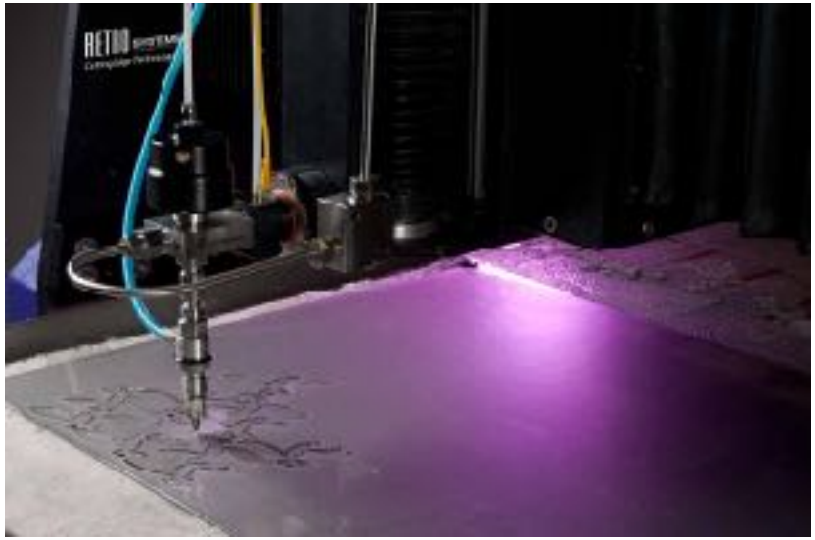


- **Material properties**
- Good enough for many applications
- **Secret trick**
  - Soak the 3D printed part into a super glue (loctitie) pool and you will obtain a stronger material
  - Note that holes and other passages will be (partially) filled with glue. Thus, design your part considering this and you may need to to some cleaning

Manufacturing

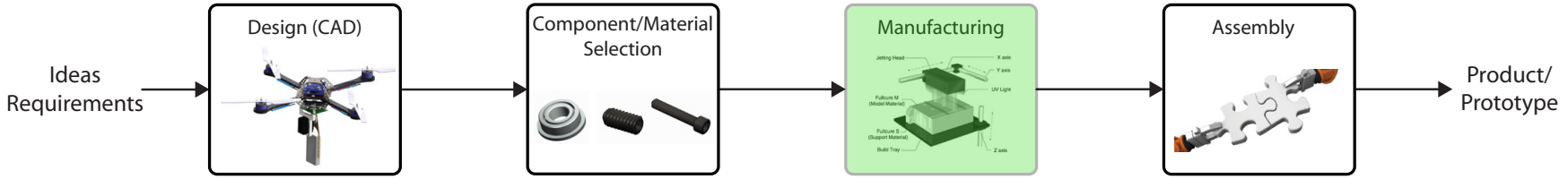


Sheet cutting: Laser or water-jet



Courtesy of Dr. Ulas Yaman

Manufacturing

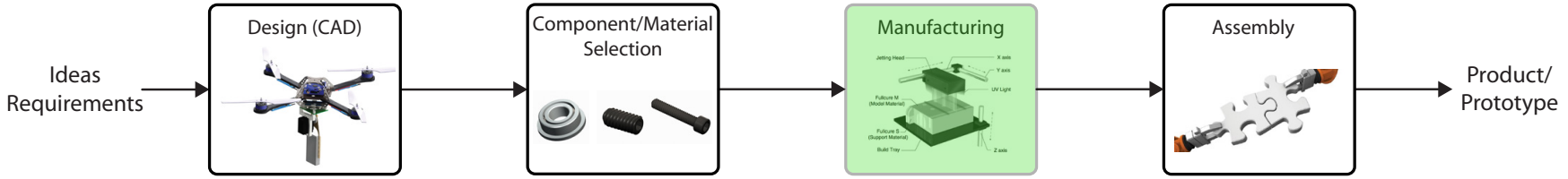


Sheet cutting: Laser or water jet

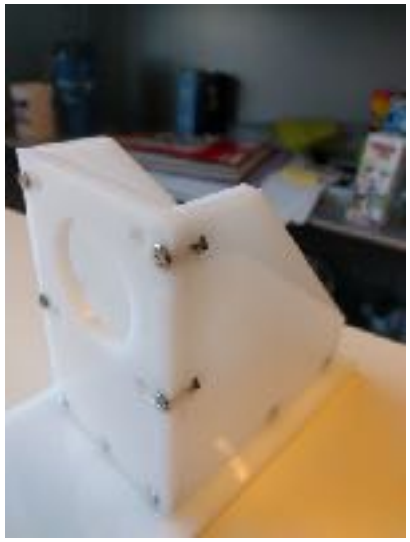
Common materials: Plexiglass (acrylic), polycarbonate (lexan), aluminum, wood, …

Courtesy of Dr. Ulas Yaman

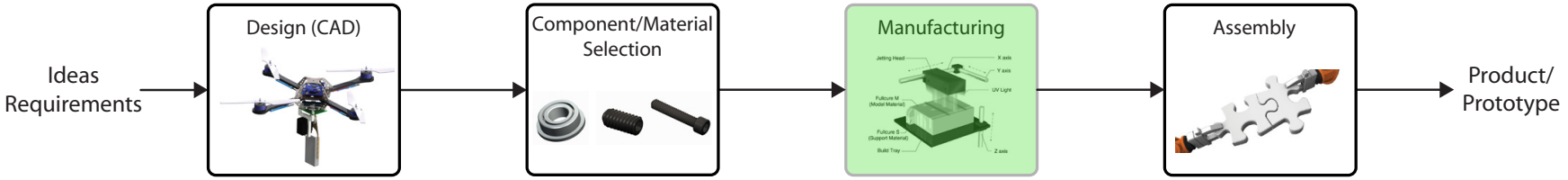
Manufacturing



A sturdy structure design method based on sheet cutting

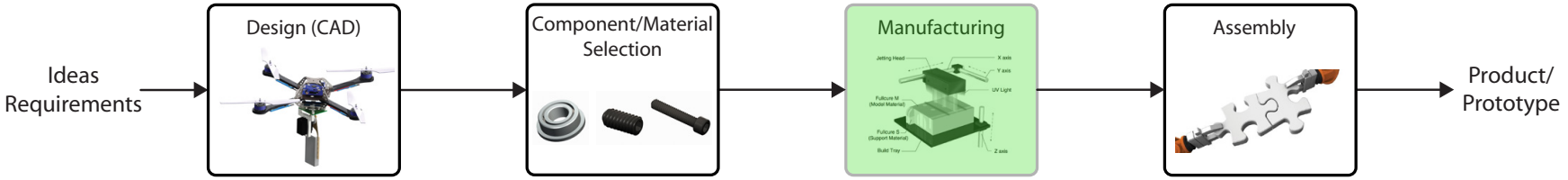


Manufacturing



Machining (Hand or CNC): Turning & Milling

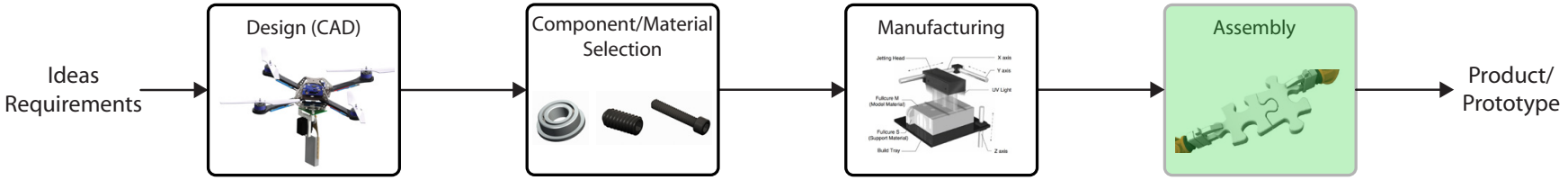
Manufacturing



Machining (Hand or CNC): Turning & Milling

Sometimes machining is unavoidable

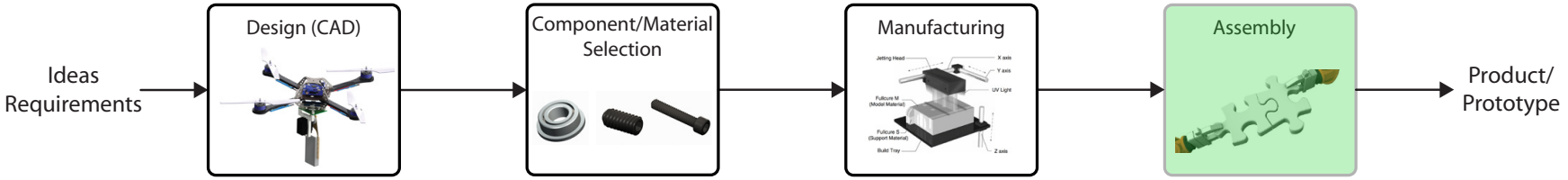
Assembly



This is NOT an assembly tool

Use these folks instead

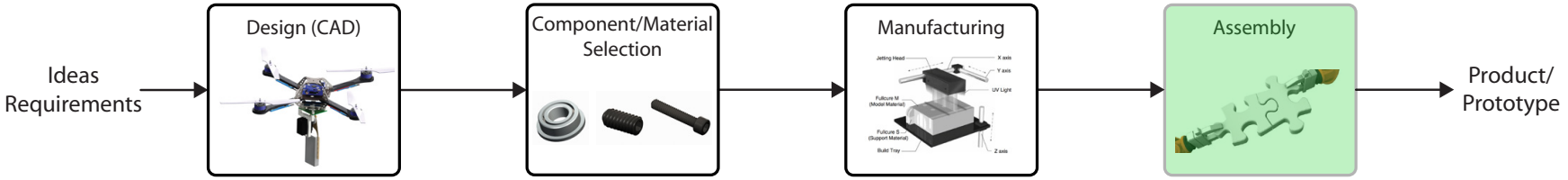
Assembly



Is there a way to build structures with minimal amount of manufacturing?

YES: T-slot framing (a.k.a LEGO for engineers)

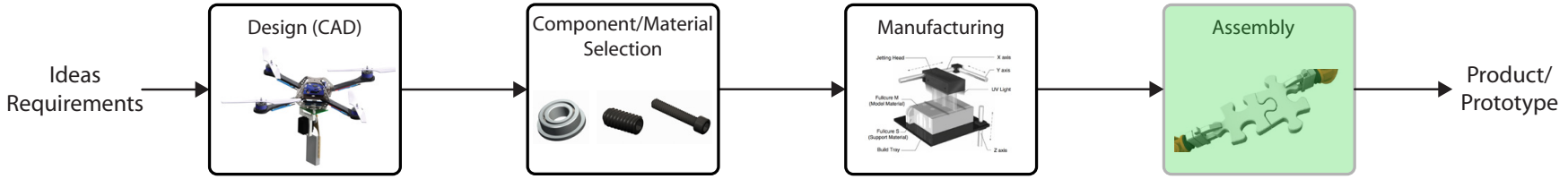
Assembly



T-slot framing

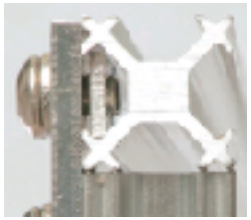
- Widely used for industrial and hobby robotics and similar applications
- Can build giant structures as well as miniaturized ones
- They are precise and strong enough to build real machines

Assembly

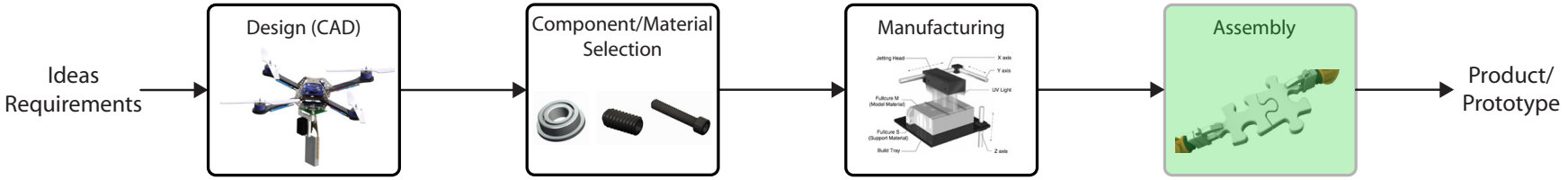


- T-slot systems consists of square extruded aluminum beams, various special connectors and the hardware

- The modularity is based upon the T-slot concept of their profiles
- The “T” shaped slots present on all sides, allow for infinite positioning along the axis.



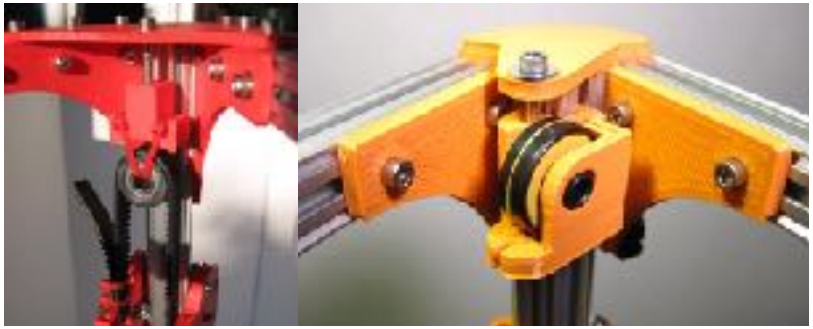
Assembly



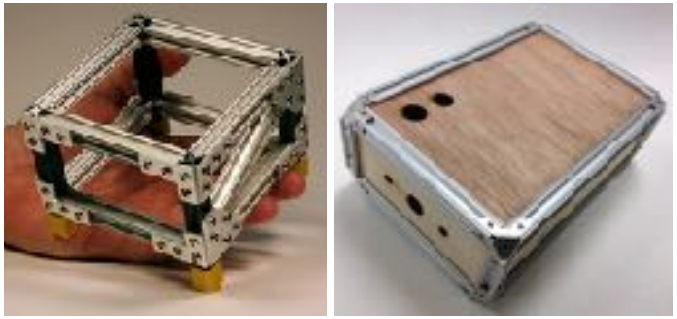
T-slot framing example connections and topologies

T and L shaped corners

Motor mounting

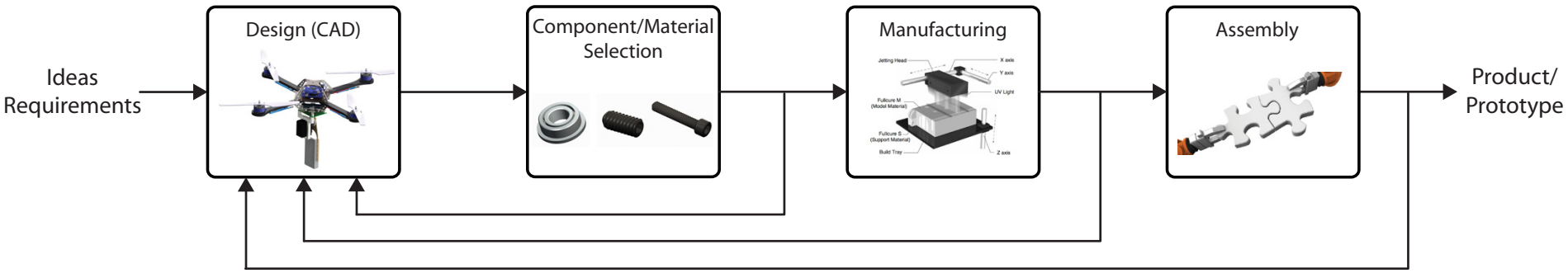


T-slot + 3D Printing



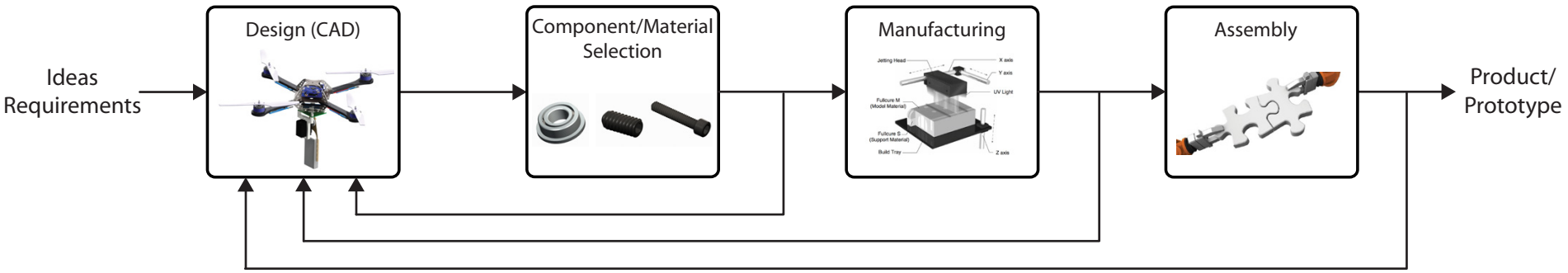
Enclosures

Quiz ?



What is the trick for increasing the material strength of 3D printed parts ?

Questions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