SCUTTLE Contributor Guide [DRAFT]

REVISION: 2022.10.24

Part 1: Vision

VISION, VALUES, MISSION, PRINCIPALS

VISION: SCUTTLE Project

The what:

The vision is to create a multidisciplinary technology space that enables users at all areas (education, research, industry) to create new robotics outcomes more effectively than ever before.

To leverage the open-source revolution for more rapid exchange of new ideas.

To exclusively reside in digital manufacturing space for easier iterations, and higher quality prototyping, and lower-effort development.

Allow hardware development to become more Agile, as software has become. Give access to more spaces, (for example all languages) by digitizing, more time-zones by sharing on self-service platforms.

The how:

Mechanical

Make mechanical more like software:
- Parameters are self evident.
- Digital designs – drive down post-processing by solving problems in the design stage.
- Unify design and manufacturing

Source OTS components that are affordable, accessible, and conform to popular standards

Use DFM strategies and create accessible models: parametric, modular, easy to modify.

Software

Write functional modules with less interdependency on other elements; allow developers to work on pieces without breaking the system.

High fidelity nodes: designers take ownership of these nodes and keep them maintained: org makes it worthwhile for the designer.

Beginner nodes: simpler software, detailed documents, examples provided.

Electronics

OTS: conform to popular standards, affordable, and compliant with common tools.

Hi-fi: make designs using industry-standard design tools.

Educational fidelity: make designs using education-ware. Share designs on established platforms.

Quality

Quality becomes parametric by absorbing quality into designs.

Quality becomes automated by pushing design features into machine functions.

Quality improvement becomes self-implementing by tying performance ceiling to standard-quality machines.

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VISION: SCUTTLE PROJECT

We Believe:

Everyone is a learner. Now that technology is evolving at unprecedented rates, the only creators who are relevant are the creators who are learning in parallel with building.

We cannot create technology in a silo, and the disciplines which were once segregated are not interdependent.

Larger value returns will express from creating content that serves the other disciplines than content that is refined only in one space.

Therefore, everyone is a manufacturer. Designers have peak responsibility for manufacturing. Sometimes the manufacturer is just a machine.
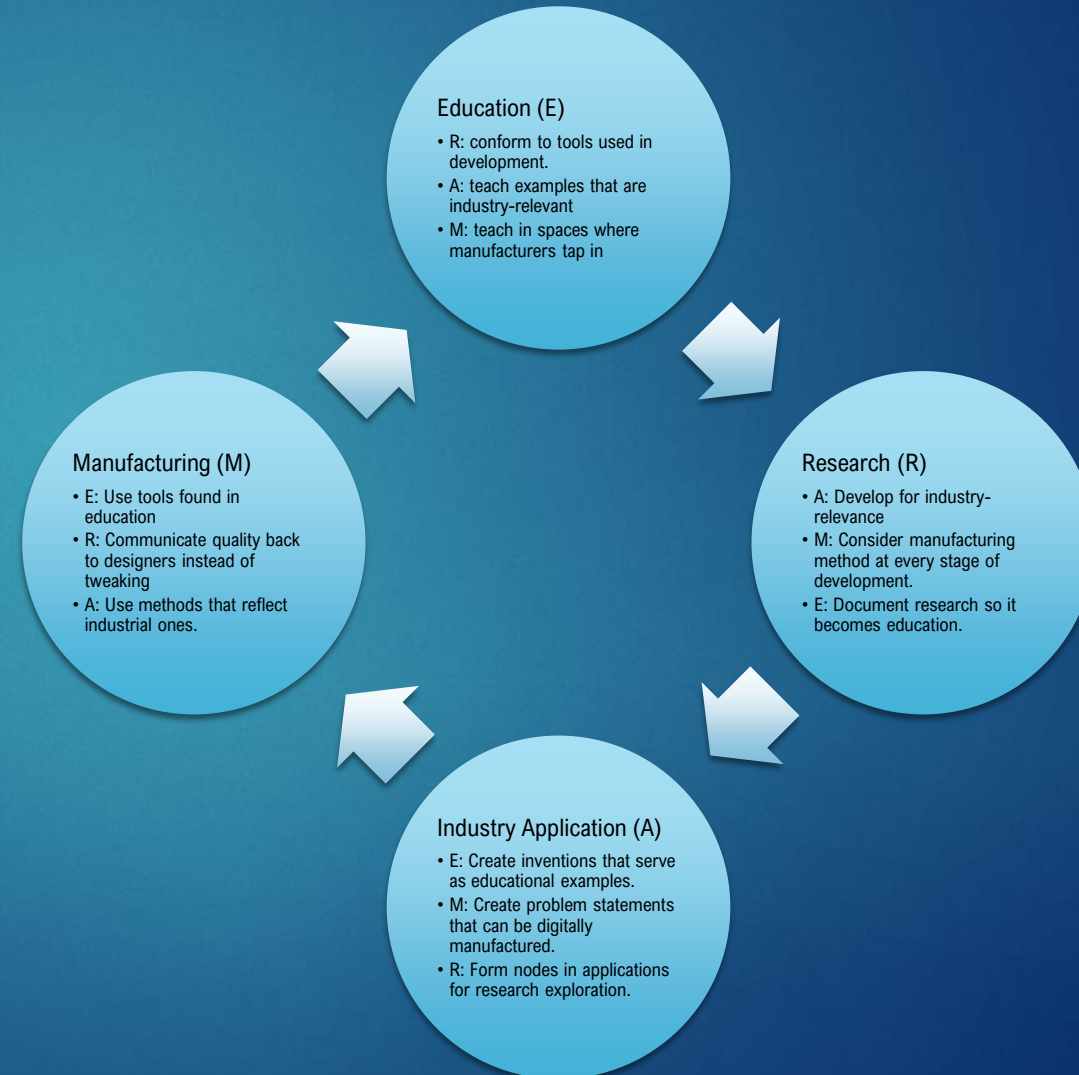
Everyone is a researcher. The least-experienced are becoming the first adopters of latest technologies; they have the most to gain by trial-and-error and they have the least to lose by testing new methods. This means each person with inexperience becomes a researcher.

Open source will ultimately become the only source.

The mission cannot be achieved in one organization; community is necessary.

Application, in time, will be only a byproduct. Within our lifetimes, the needs of consumers and industry will change so frequently that companies will become horizontally integrated across industries. NASA/agriculture will be unified. Healthcare/art will be unified. Construction/software will be unified.

How each facet serves the others:

Education (E)
- R: conform to tools used in development.
- A: teach examples that are industry-relevant
- M: teach in spaces where manufacturers tap in

Research (R)
- A: Develop for industry-relevance
- M: Consider manufacturing method at every stage of development.
- E: Document research so it becomes education.

Industry Application (A)
- E: Create inventions that serve as educational examples.
- M: Create problem statements that can be digitally manufactured.
- R: Form nodes in applications for research exploration.

Manufacturing (M)
- E: Use tools found in education
- R: Communicate quality back to designers instead of tweaking
- A: Use methods that reflect industrial ones.

VISION: Open Source

"Open Source is a secret sauce that repels zero-sum thinkers."

-SCUTTLE Robotics LLC

VISION: Open Source

Community
- Must have retention
- Must have engagement

Contribution
- The community must feedback into the project
- Contributions to other projects may be converted into SCUTTLE contributions

Communication
- New information must be organized to perfectly meet needs of the audience
- The framing of the offering is everything.

VISION: Open HARDWARE

The Backstory

It started with Software
- Open engineering design started with "source code" when it became free to duplicate designs
- Copy/Paste of software duplicates value and costs nothing.
- It also allowed for broader teams to collaborate.

Stuff became free
- Professionally-made software platforms became free because adoption in high volumes is more beneficial than sales in small volumes.
- Offering a freeware allowed the "little guy" publisher to make software capabilities available freely to other "little guys" – think about freelance designers who don't have the resources of a full-scale business, but want to create value in the world.

Community adoption
- The overhead of running a company includes technical support; but publishers realized there's no better support than having a huge number of experts/users helping other users.
- So, forums and channels for sharing and peer-to-peer discussion replaces the overhead of large tech support in organizations.

It stalled after software
- Hardware is less digitized, less free to copy, and is less easy to standardize given that global materials and methods don't always match up.
- So, the first offerings of open hardware were limited (and still mostly are limited) to simply designs of Printed Circuit Boards (PCBs) which, when industrialized, immediately took a path of fully-digital designs.
- All other products in the world have

The Actions

Digitize all designs:
- Make Hardware just like software: Freely copied, freely distributed, open for modification
- Make manufacturing Digital: Guarantee that the end product is a function of the design, not of unique methods

Robust Methodologies
- Variance in hardware reproduction still contains vastly more variables than software.
- Teach methods of design which reduce inputs such as machining skillset.
- Design that which can be reproduced on the lowest performance equipment and thus builds properly on all equipment.

Standardize communication
- We wish for nonexperts to have access to try their own hacks.
- For a software expert, we must present hardware descriptions with simplicity and accuracy.
- Use templates for designs, posts, and documentation to eliminate variables that complicate communication.

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VISION: Educating Others

The inspiration:

How did arrive at standards of producing designs, content, and selected platforms for sharing?

How do characterize our designs and create a culture that supports the mission?

How will folks know "This module was created in the SCUTTLE community?"

How will we keep pace with an evolving industry instead of getting left behind?

Anything worth doing is worth doing well
- designs
- software
- demos

Well-done creations are worth sharing.
- Share CAD
- Share software
- Share demos

Shared creations are worth documenting.
- Models: Parametric
- Code: commented
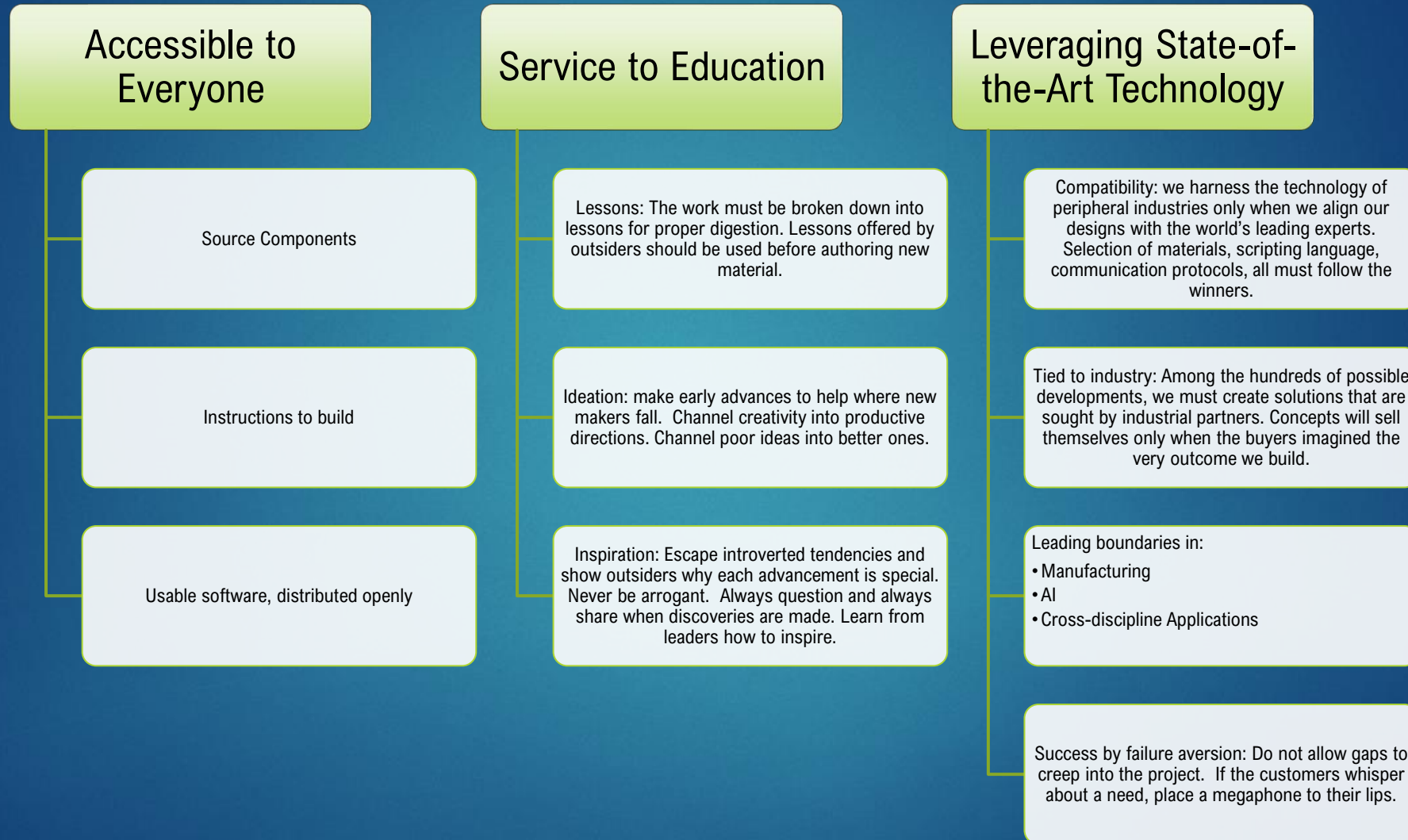- Videos: with explanations, links

Documented creations deserve explanation.
- Create entry-points for education
- Describe the design goals, weaknesses, strengths

Good explanations reach the audience.
- short videos to tell how it's done.
- back-links to design docs included in videos.
- authors take ownership, answer questions

VISION: SCUTTLE Project Priorities

Accessible to Everyone

- **Source Components**
- **Instructions to build**
- **Usable software, distributed openly**

Service to Education

- **Lessons:** The work must be broken down into lessons for proper digestion. Lessons offered by outsiders should be used before authoring new material.
- **Ideation:** make early advances to help where new makers fall. Channel creativity into productive directions. Channel poor ideas into better ones.
- **Inspiration:** Escape introverted tendencies and show outsiders why each advancement is special. Never be arrogant. Always question and always share when discoveries are made. Learn from leaders how to inspire.

Leveraging State-of-the-Art Technology

- **Compatibility:** we harness the technology of peripheral industries only when we align our designs with the world's leading experts. Selection of materials, scripting language, communication protocols, all must follow the winners.
- **Tied to industry:** Among the hundreds of possible developments, we must create solutions that are sought by industrial partners. Concepts will sell themselves only when the buyers imagined the very outcome we build.
- Leading boundaries in:
  - Manufacturing
  - AI
  - Cross-discipline Applications
- **Success by failure aversion:** Do not allow gaps to creep into the project. If the customers whisper about a need, place a megaphone to their lips.

VISION: SCUTTLE Project

1. SCUTTLE isn't a device – it's a vehicle for advancing people and projects.
   1. We cross-pollinate useful technologies that are siloed
   2. We treat with preference components that are refined, supported, and mass-adopted
   3. As we learn, we teach
   4. As we teach, we listen for inputs from more experienced teams

Learning & discoveries

1. are fed back to the community.

Quality

- above quantity.

Robustness

- above features.

Discovery of value in every step.

- Avoid wastefulness when things don't go as planned.
- Integrity = capturing the value of mistakes

Standardization

- is a means to greater leaps.

Search

- far and wide for the wheel before reinventing.
- It's out there. Look harder.
- If it isn't out there, the most evolved step preceding the wheel is out there. Study it, then proceed.
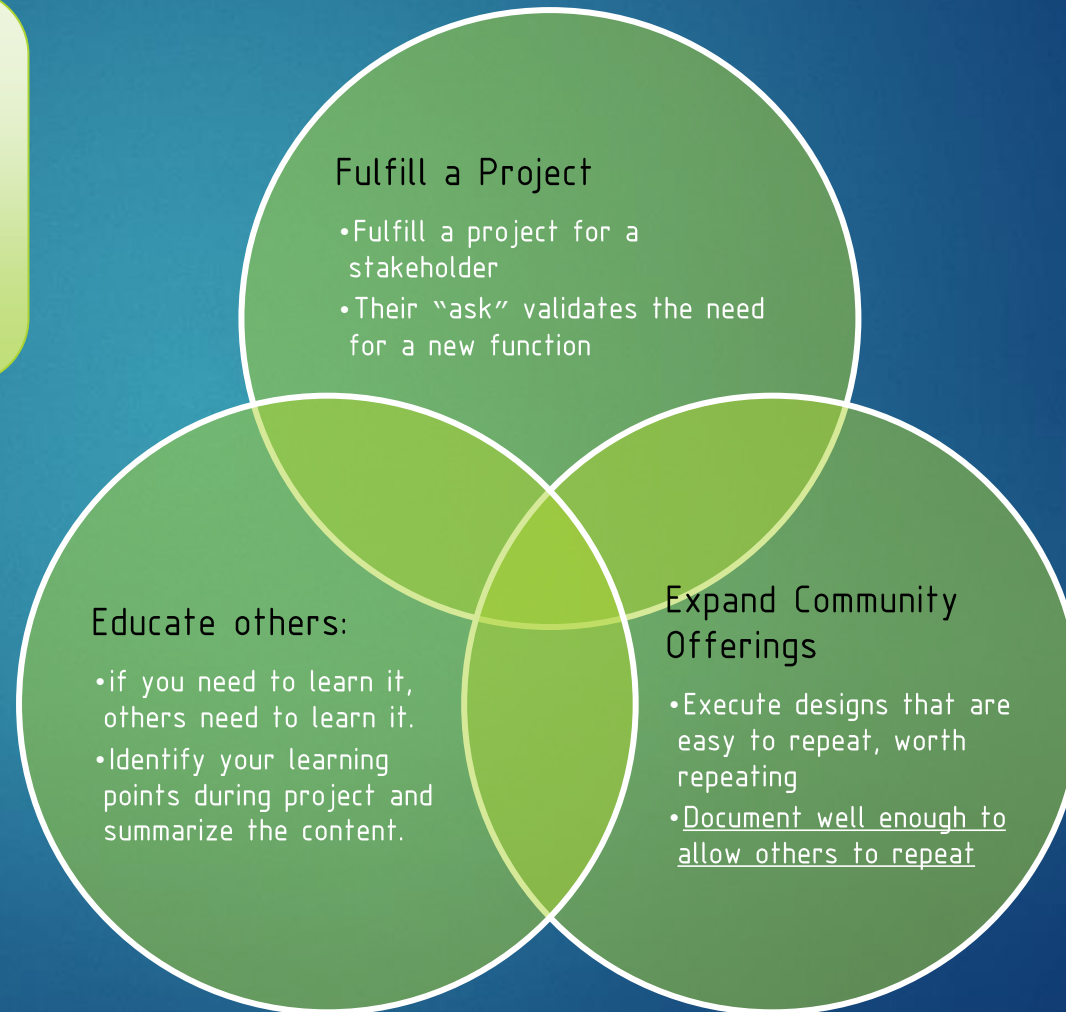
Stay out of zero-sum territory.

- If the value output from an action cannot be duplicated ► red flag.
- If an exchange is made which does not build/create ► red flag

PRINCIPAL: Synergize projects by overlapping goals

▶ **How do I select a new project to build?**

    ▶ When you select a project and generate ideas, consider how your outcomes can benefit more than one objective simultaneously.

Fulfill a Project

- Fulfill a project for a stakeholder
- Their "ask" validates the need for a new function

Educate others:

- if you need to learn it, others need to learn it.
- Identify your learning points during project and summarize the content.

Expand Community Offerings

- Execute designs that are easy to repeat, worth repeating
- Document well enough to allow others to repeat

VALUES ▶ Adopted: Open Source Strategy

Three Pillars of Open Source

Project-Community Fit

Persona: Developers

Measure: GitHub Stars

Product-Market Fit

Persona: Users

Measure: Downloads

Value-Market Fit

Persona: Buyers

Measure: Revenue

PROJECT LEADER

Owns Roadmap and Innovation for Open Source project

COLLABORATOR

Work on Codebase

ADOPTED VALUES: Eliminate Muda

3 Kinds of Waste:
From Toyota Production System

▶ Muda: waste

▶ Mura: imbalance

▶ Muri: overload
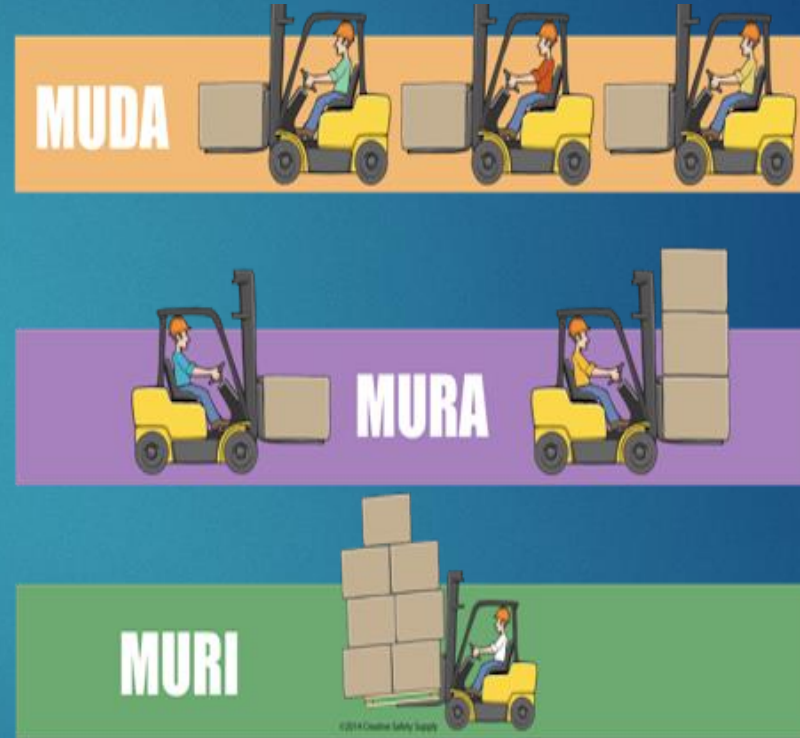
PRINCIPAL: Don't Reinvent the Wheel

A) Look at Present	B) Look at Future
Don't reinvent the wheel	<u>Don't</u> invent tools obviously needed by industry.
Do design for compatibility with the wheel	<u>Do</u> invent integrations for what is obviously needed
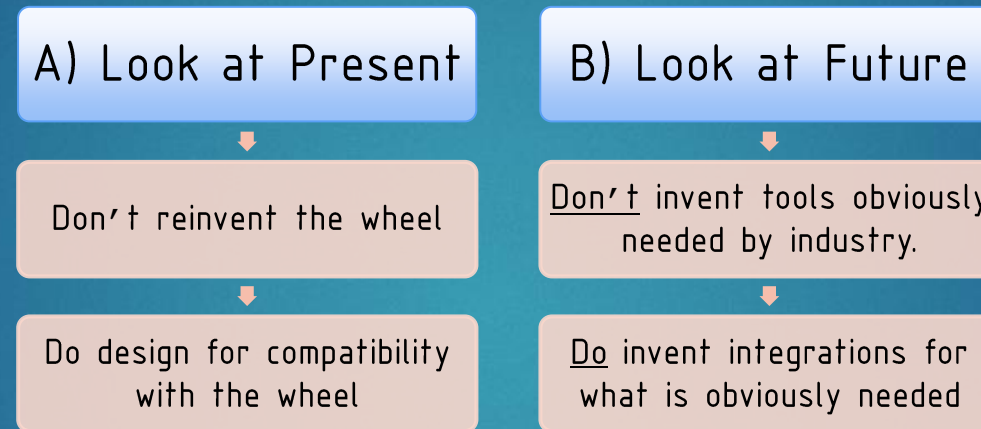
▶ Explanation: we create the most value by building:

  ▶ content that is (and will be) unaddressed by other parties

  ▶ Designs that "fills the gaps" between disconnected technologies

  ▶ That leverages more than its own weight, using refined tech

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VISION: WHAT MAKES THE SCUTTLE COMMUNITY?

SCUTTLE Community (est 2018)

- Open-source designs, exchanged
- How-to videos, shared
- Prototype Robots built with SCUTTLE
  - for fun
  - for R&D

MXET 300: Mobile Robotics (est 2017 Jan)

An engineering course at Texas A&M that uses SCUTTLE as a teaching tool.
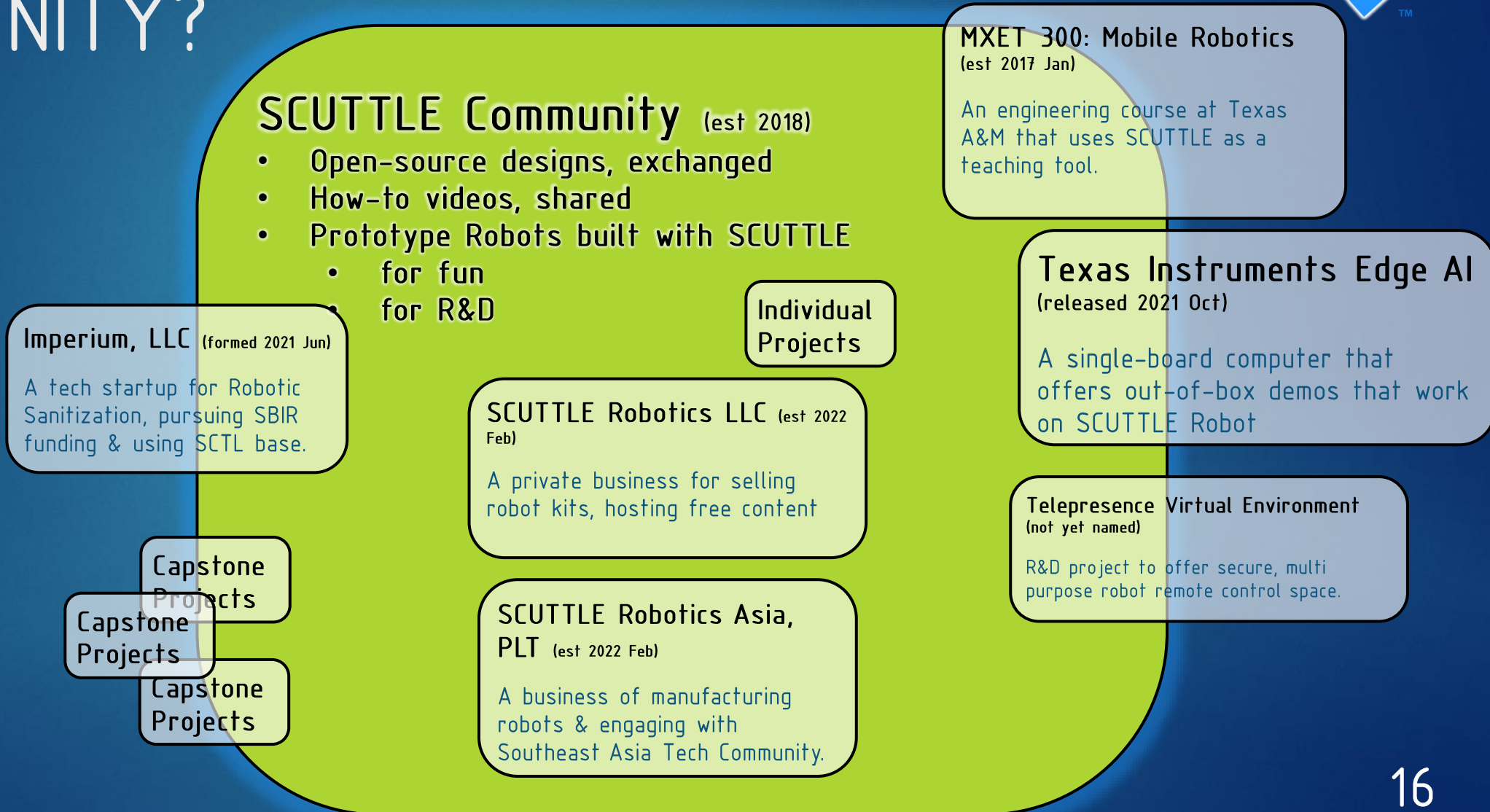
Texas Instruments Edge AI (released 2021 Oct)

A single-board computer that offers out-of-box demos that work on SCUTTLE Robot

Telepresence Virtual Environment (not yet named)

R&D project to offer secure, multi purpose robot remote control space.

Imperium, LLC (formed 2021 Jun)

A tech startup for Robotic Sanitization, pursuing SBIR funding & using SCTL base.

Individual Projects

SCUTTLE Robotics LLC (est 2022 Feb)

A private business for selling robot kits, hosting free content

SCUTTLE Robotics Asia, PLT (est 2022 Feb)

A business of manufacturing robots & engaging with Southeast Asia Tech Community.

Capstone Projects

Capstone Projects

Capstone Projects

Part 2: Standards

STANDARDS, PROCESSES, HOW-TO

STANDARDS: Licensing

Creative Commons	• We will begin to use a creative commons "attribution" license in 2021. • Attribution 4.0 International
Copyrights:	• SCUTTLE Robotics LLC to register copyrights as advised.
Software Hosting	• What are the implications of hosting CAD models on grabCAD? • See grabCAD Terms
Publishing Explanations:	• Background on Creative Commons found in Youtube Video (link on thumbnail) ▶

Attribution-ShareAlike 4.0 International (CC BY-SA 4.0)

STANDARDS: For Publication

- ▶ Font for titling:
  - ▶ DS ISO BOLD
- ▶ Names:
  - ▶ Refer to project: SCUTTLE Robot Project
  - ▶ Refer to the machine: SCUTTLE Robot
- ▶ Brands:
  - ▶ SCUTTLE™ team internally-published items include "TM" (use ALT-0153 short key)
- ▶ Hashtags:
  - ▶ #SCUTTLErobot, #SCUTTLEproject
- ▶ Colors:
  - ▶ SCUTTLE Blue color: #0A6ECC
  - ▶ Background Color: #064074
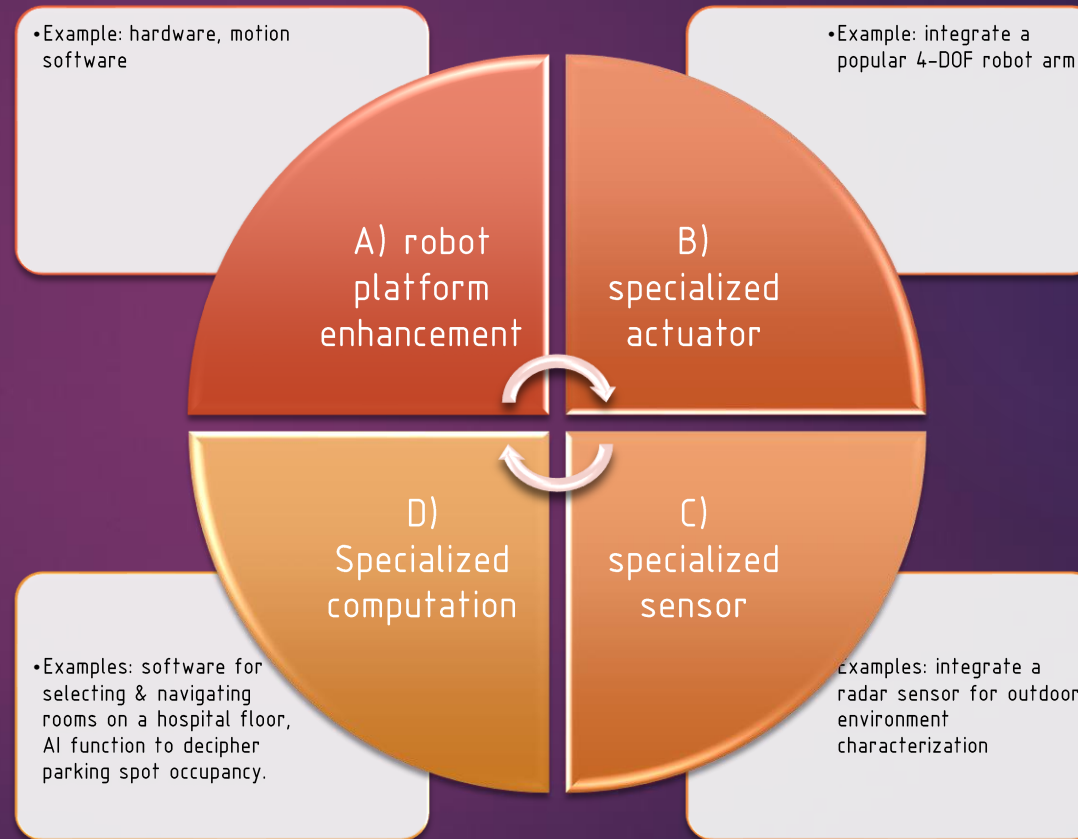
Color: #0A6ECC

Color: #064074

HOW TO: Generate Robotics Idea

How to choose a design to build?
Where does my creation fit into
the SCUTTLE community?

Categories of Potential Designs

- Example: hardware, motion software

A) robot platform enhancement

- Example: integrate a popular 4-DOF robot arm

B) specialized actuator

D) Specialized computation

C) specialized sensor

- Examples: software for selecting & navigating rooms on a hospital floor, AI function to decipher parking spot occupancy.

- Examples: integrate a radar sensor for outdoor environment characterization

More Resources: ASQ.org

HOW TO: Build a Student Video Contribution

(updated 2021.12.09)

REQUIRED

- The video shows one added element such as:
  - New actuator
  - New sensor
  - New function
  - (new means not documented so far)
- Audio is clear and coherent
- Video is posted properly on youtube:
  - 1080P or 4K resolution
  - Listed on youtube (not "unlisted")
  - Title clearly describes what's unique
    - Bad: "Our Final Project for MXET 300"
    - Good: "Scanning Bar Codes with a Mobile Robot
  - Description tells what's in the video.
  - Do not select "made for kids" as this prohibits adding to playlists
- Video footage clearly shows sensor/actuator/function in action
  - (not just footage of ppt slides)

DESIRED
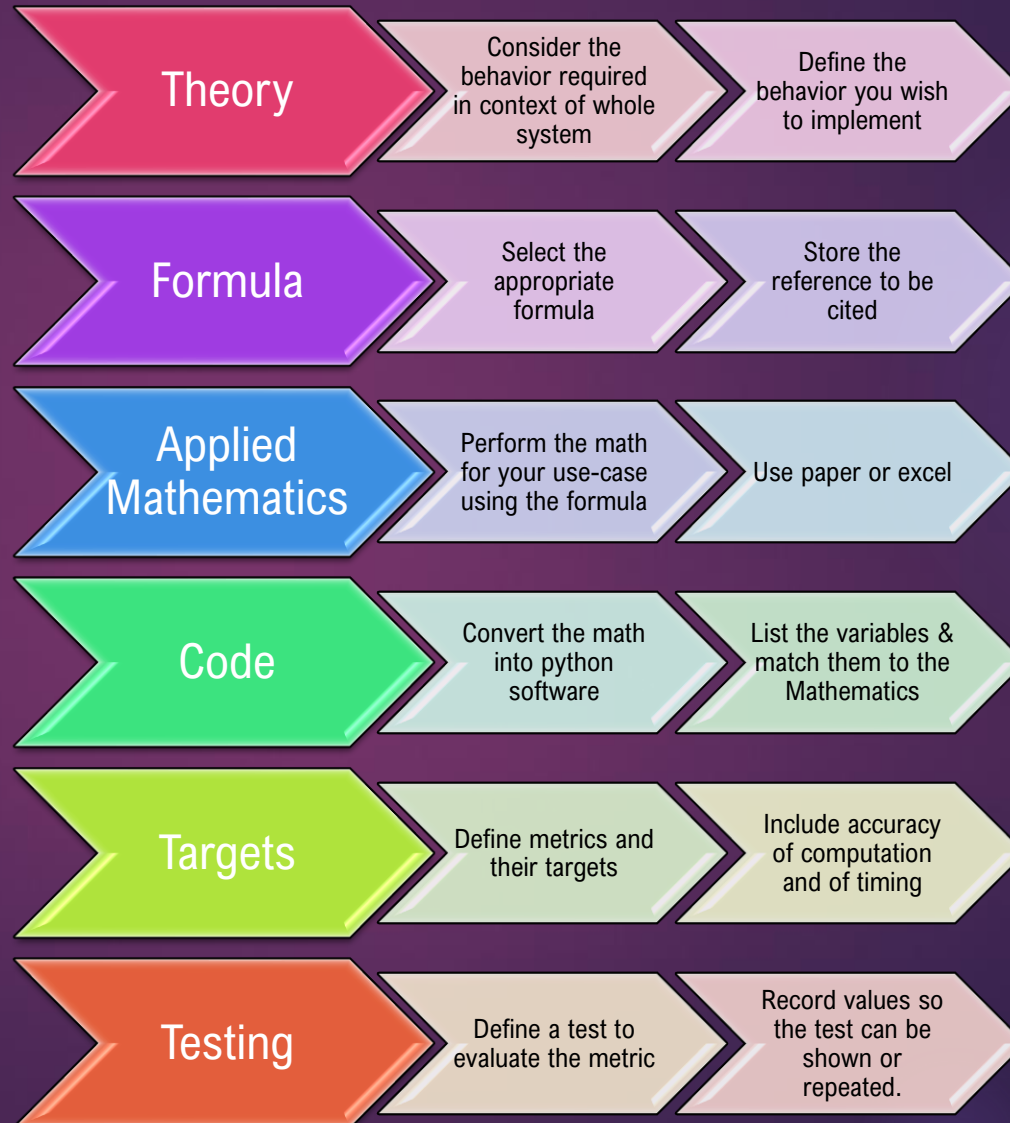
- Length less than 6 minutes
- Include links to software
- Tell where you got your parts
- Include links to components
- Describe what external library was used
- Confine the video to just 1 unique topic (don't explain everything about the project)
- Use a script to make your audio recording
- Include as much close-up footage of your sensor/actuator/functions as possible

PROCESS: Software Development

How can I (contributor) develop software that meets the desired quality of the SCUTTLE brand?

Theory
- Consider the behavior required in context of whole system
- Define the behavior you wish to implement

Formula
- Select the appropriate formula
- Store the reference to be cited

Applied Mathematics
- Perform the math for your use-case using the formula
- Use paper or excel

Code
- Convert the math into python software
- List the variables & match them to the Mathematics

Targets
- Define metrics and their targets
- Include accuracy of computation and of timing

Testing
- Define a test to evaluate the metric
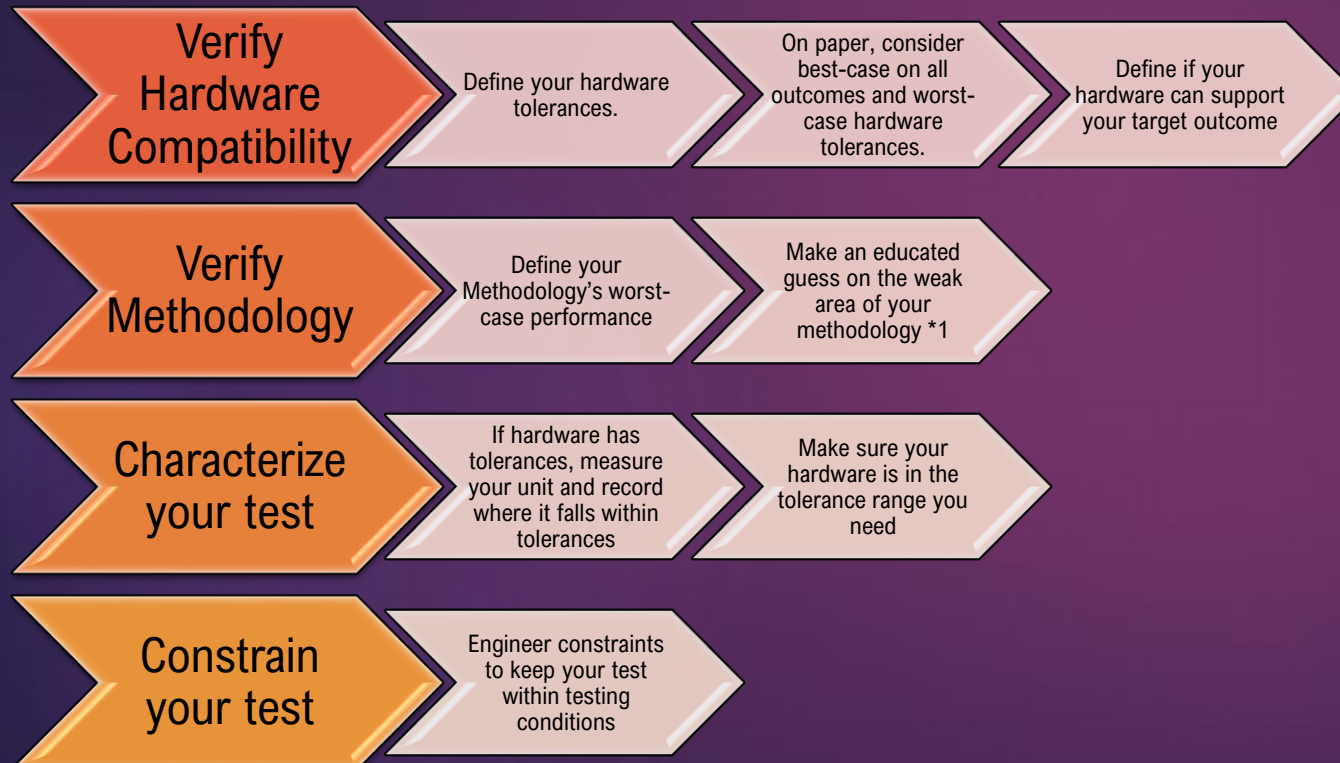- Record values so the test can be shown or repeated.

PROCESS: Calibration

Calibration is the task (as a verb) and the data (as a noun) that lies between the sensor and the clean information that a robot can act on. It is the main task required in integrating a new sensor. It is the main task required to refine existing sensor data for a new application.

Design of Experiments Part 1 [validate your experiment plan]

Verify Hardware Compatibility
- Define your hardware tolerances.
- On paper, consider best-case on all outcomes and worst-case hardware tolerances.
- Define if your hardware can support your target outcome

Verify Methodology
- Define your Methodology's worst-case performance
- Make an educated guess on the weak area of your methodology *1

Characterize your test
- If hardware has tolerances, measure your unit and record where it falls within tolerances
- Make sure your hardware is in the tolerance range you need

Constrain your test
- Engineer constraints to keep your test within testing conditions

If you are a scientist, you can run a trial that fails. A developer is the same a scientist who is only successful if the hypothesis proves true.

Story:
A bird dies. Scientist query "can I resuscitate a bird using electromagnetism?"

Outcome: no, you cannot.

Scientists boss: Great work! You generated data!

*1) example: the wheel odometry stacks up errors

HOW TO: Get Questions Answered

Authors should:

Manuals
- Include appropriate email at the bottom of each PDF page

CAD Models
- For Native CAD, post online using your user login so you're notified when people comment.
- For STL files, post on gitHub so you (the designer) can be discovered.

Wiring
- Include your email at the bottom of a drawing page.

Users should:

User Manual
- inquire with email listed at the bottom of pdf pages

CAD model
- STL files – these are found on github. post an issue on github
- grabCAD files – ask a question in the comments at the bottom of the page

Wiring:
- Refer to Wiring Diagram
- Email the contact email listed on the PDF

Projects:
- Reach out to the project publisher.

Videos
- Log in and comment on the video – the author will get a notification.
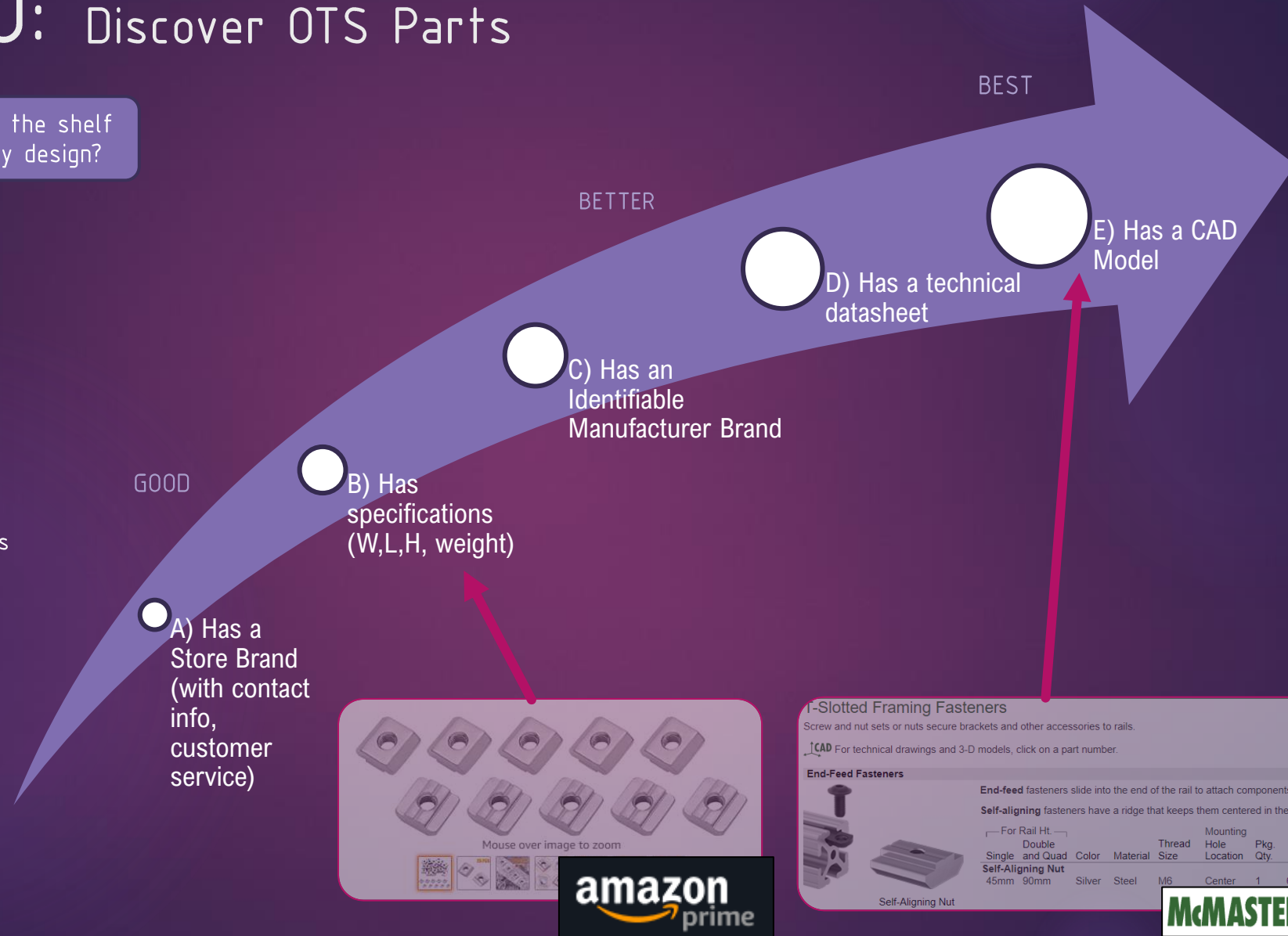
HOW TO: Discover OTS Parts

BEST

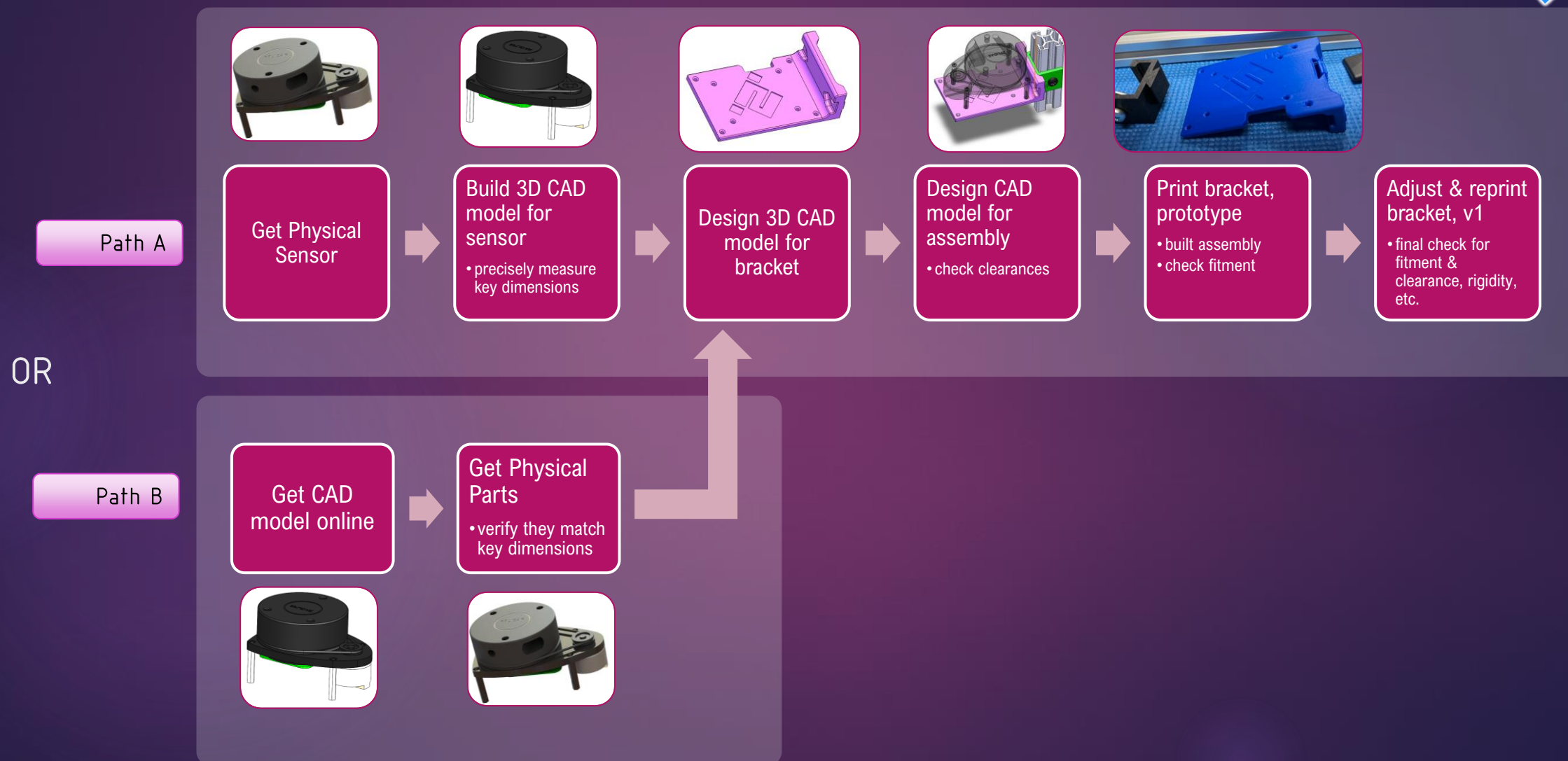How can I select the best off the shelf (OTS) parts to integrate in my design?

Look for:

▶ Better quality of parts. Usually offered for several years, consistent availability, offered in multiple countries. Has a customer service line.

▶ Also usually costs higher shipping rates, requires customer login on website,

▶ Usually has higher prices for small hardware, requires more bulk quantity of purchase.

BETTER

E) Has a CAD Model

D) Has a technical datasheet

C) Has an Identifiable Manufacturer Brand

GOOD

B) Has specifications (W,L,H, weight)

A) Has a Store Brand (with contact info, customer service)

Mouse over image to zoom

amazon prime

T-Slotted Framing Fasteners

Screw and nut sets or nuts secure brackets and other accessories to rails.

CAD For technical drawings and 3-D models, click on a part number.

End-Feed Fasteners

End-feed fasteners slide into the end of the rail to attach components.

Self-aligning fasteners have a ridge that keeps them centered in the T-slot.

	For Rail Ht.					Mounting		
	Double	Color	Material	Thread Size	Hole Location	Pkg. Qty.		Pkg.
Single	and Quad							
Self-Aligning Nut								
45mm	90mm	Silver	Steel	M6	Center	1	6000N119	$2.76

Self-Aligning Nut

McMASTER-CARR.

HOW TO: Develop a Quality Bracket

Path A

| Get Physical Sensor | → | Build 3D CAD model for sensor
• precisely measure key dimensions | → | Design 3D CAD model for bracket | → | Design CAD model for assembly
• check clearances | → | Print bracket, prototype
• built assembly
• check fitment | → | Adjust & reprint bracket, v1
• final check for fitment & clearance, rigidity, etc. |

OR

Path B

| Get CAD model online | → | Get Physical Parts
• verify they match key dimensions |

HOW TO: Share a Design on GrabCAD

How can I (contributor) post a CAD design for the best results?

Solidworks

- Use "Pack and Go" to generate simple Solidworks folder.
  - This omits unused files
  - Flattens all files into one folder
- Pack into a folder called SOLIDWORKS or other native CAD.
- Make a simple name: this will become the hyperlink permanently
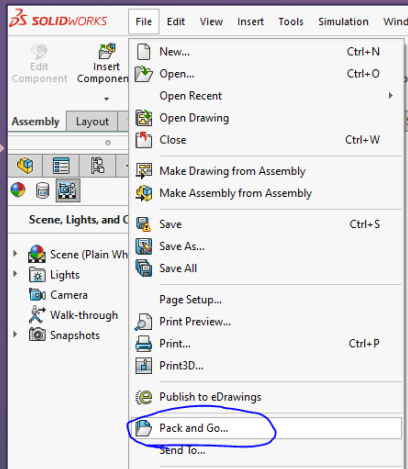
Export STEP files, images, and original CAD.

For 3D-printed parts, please export STL files.

Put files in unique folders.

Upload Folders on grabCAD

Describe the design (BOM, prints, and links to get parts)

Set your featured image

Link a video of your example

Model name

Realsense Camera Mount

Description

Link to double-ball mount on amazon:
https://www.amazon.com/dp/B096Q2FYHV

Requires these fasteners:
1/4-20 locknut (with nylon insert)
M5 x 30mm machine screw

Tags (separate with commas)

mobile robot × | scuttle robot × | camera × | joint × | pivot × | ball mount × | 3D Camera ×
stereo vision × | camera mount × | threaded ×

Video URL (from youtube or vimeo)

grabcad.com/library/realsense-camera-mount-1

Description:
- Describe the purpose of the design.
- Link parts found at vendor sites
- Describe required fasteners and their quantities.

Tags: please use "scuttle robot" as a tag – grabCAD gives immediate SEO for searches.

Files (23)

Realsense Camera Mount /

	SOLIDWORKS	Folder	October 12th, 2022
	IMG	Folder	August 2nd, 2022
	STEP	Folder	August 2nd, 2022
	STL	Folder	August 2nd, 2022

Edit Gallery

Drag and drop thumbnails to re-order your model gallery. The first thumbnail is the def...
Add or remove renderings and CAD files from the gallery by dragging them across the line.

Shown in gallery (23)

img_realsense_b... | ball_head_assy.S... | threadJntV1.STL | wrapJntV1.STL

IMG_2278.JPG | IMG_2280.JPG | IMG_2282.JPG | IMG_2283.JPG

Edit Photos: Place the best photo as the first in queue. This will be the thumbnail. Set the STEP assembly second.
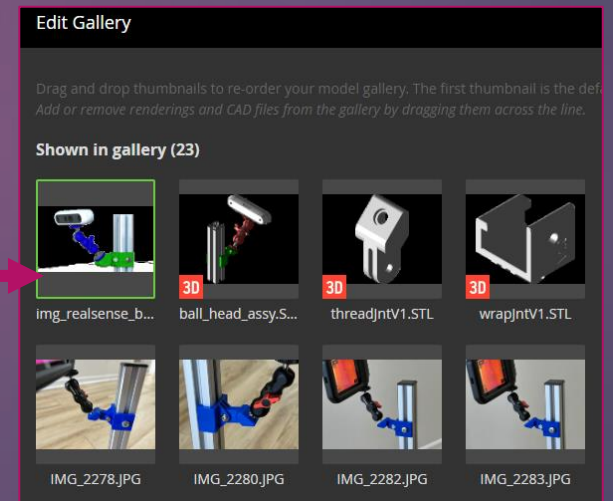
Video: If you have a video showing how to build the design, include the link.

SOLIDWORKS File Edit View Insert Tools Simulation Wind...

- New... Ctrl+N
- Open... Ctrl+O
- Open Recent
- Open Drawing
- Close Ctrl+W
- Make Drawing from Assembly
- Make Assembly from Assembly
- Save Ctrl+S
- Save As...
- Save All
- Page Setup...
- Print Preview...
- Print... Ctrl+P
- Print3D...
- Publish to eDrawings
- Pack and Go...
- Send To...