DSL 124
Design with contemporary technologies

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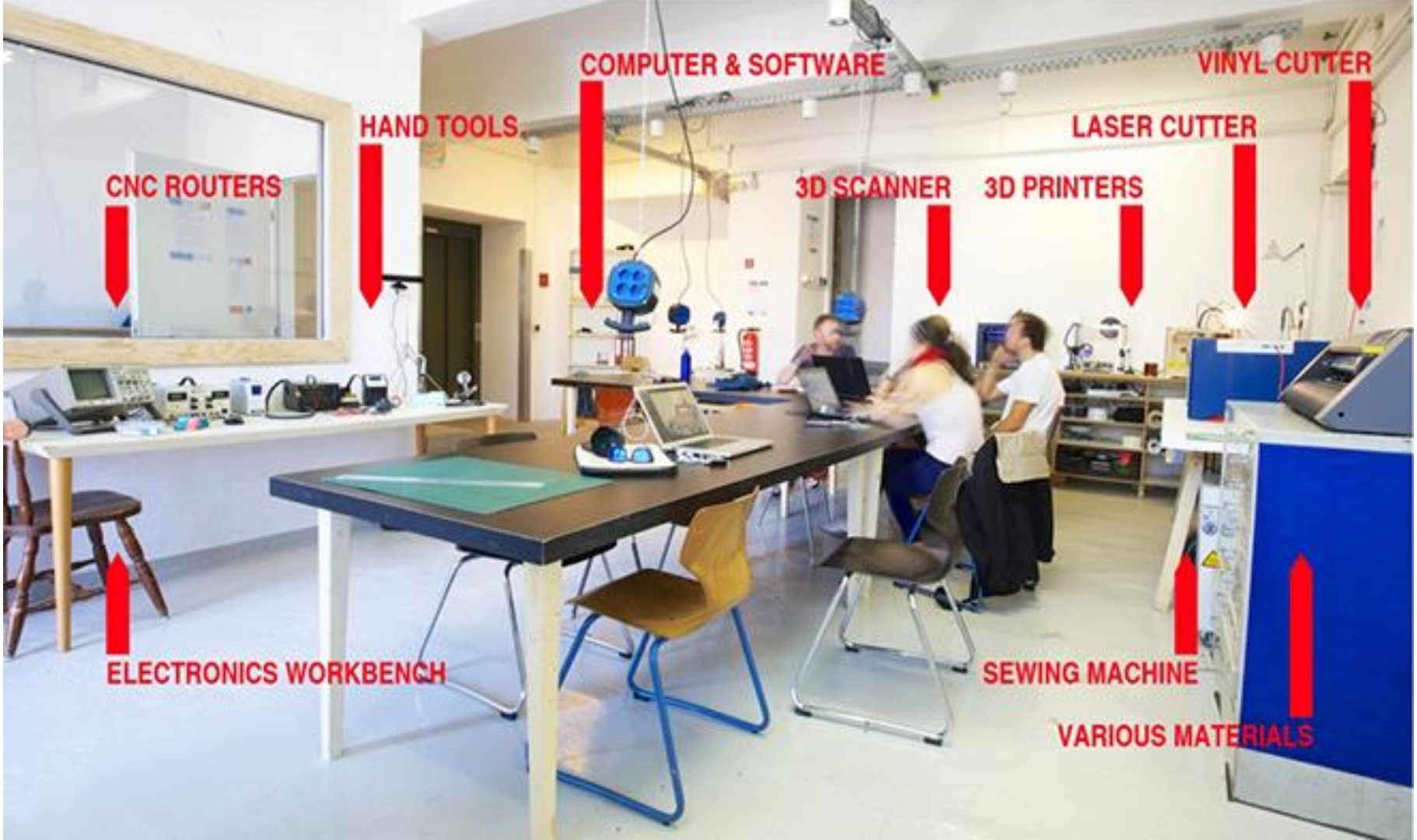
Dated: 05th January, 2023


COMPUTER & SOFTWARE
VINYL CUTTER
HAND TOOLS
LASER CUTTER
CNC ROUTERS
3D SCANNER
3D PRINTERS
ELECTRONICS WORKBENCH
SEWING MACHINE
VARIOUS MATERIALS

Overview

1
- Design Thinking
- Sustainability

2
- Digital, Electro-mechanical Prototyping
- Digital Fabrication

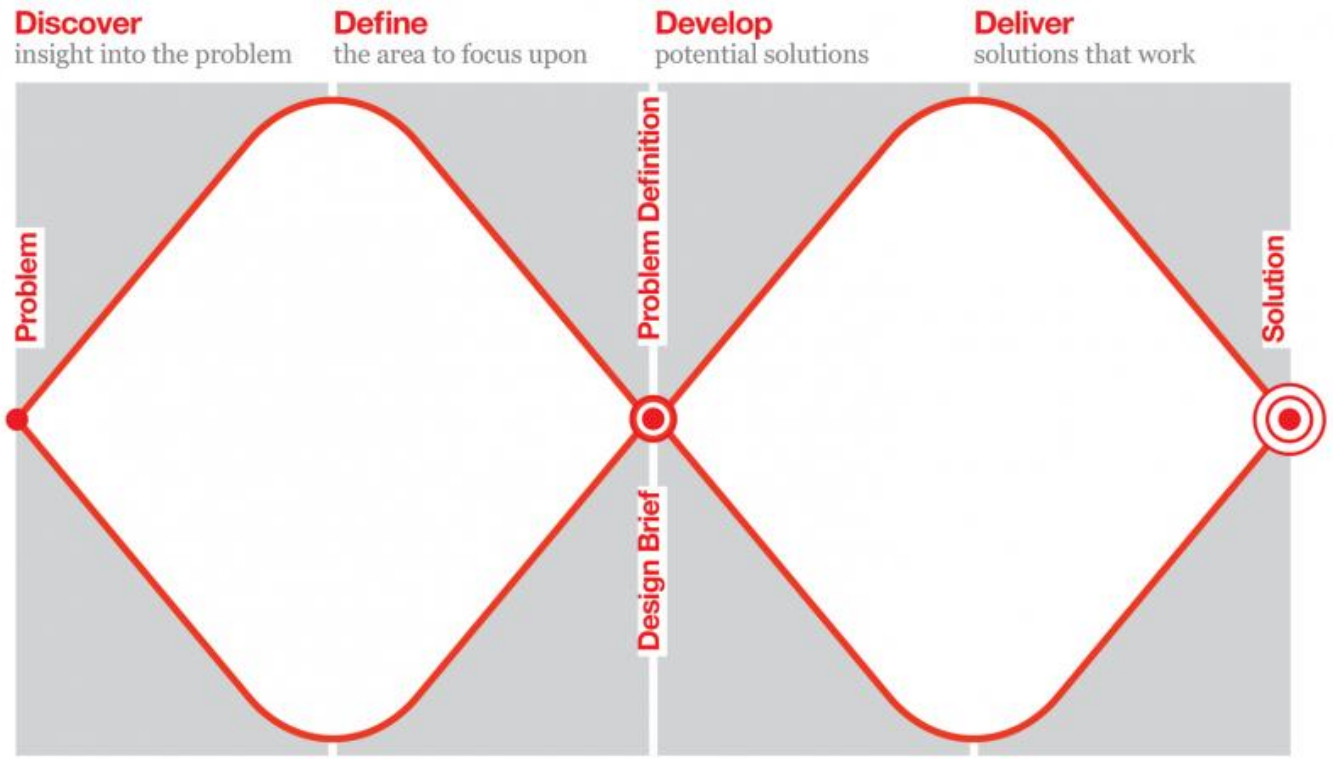
3
- Learning by doing
- Makerspaces

4
- Case study 1: Change.Makers boot camp
- Case study 2: Air pollution monitoring

Overview

1. **Design Thinking**
   - **Sustainability**
2. Digital, Electro-mechanical Prototyping
   - Digital Fabrication
3. Learning by doing
   - Makerspaces
4. Case study 1: Change.Makers boot camp
   - Case study 2: Air pollution monitoring

Double diamond design process



Solving the right problem, before solving the problem right!

Design process at work

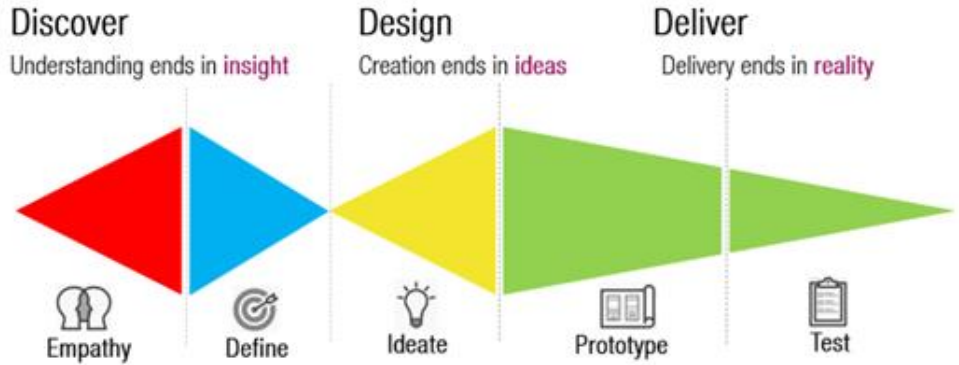
airbnb

From near collapse to conquering the market

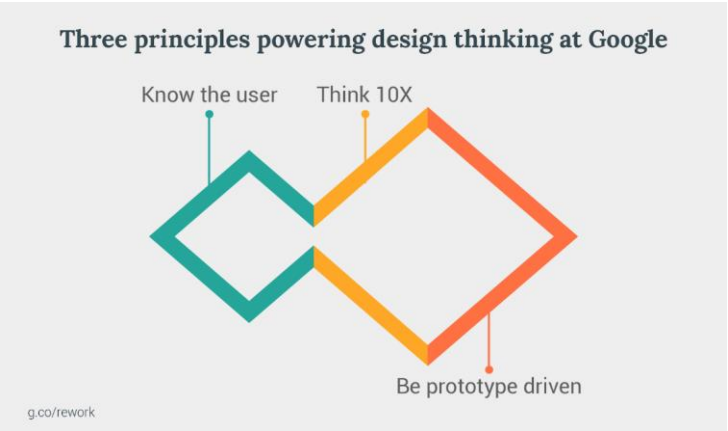
- Airbnb attributes its market dominance to user-centred design.
- When they about to go bust at $200 revenue per week Airbnb discovered that all of the photos for their listings were low quality and unattractive
- Airbnb decided to replace the amateur photos with high-quality photos and it worked.

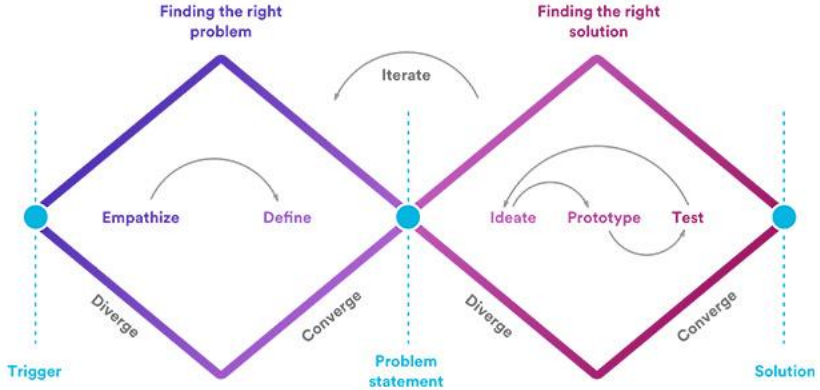
> **"Going out to meet customers in the real world is almost always the best way to wrangle their problems and come up with clever solutions"**
>
> Joe Gebbia of Airbnb with First Round.

Design Thinking



Design Thinking is an iterative and non-linear process in which we seek to understand the user, challenge assumptions, and redefine problems in an attempt to identify alternative strategies and solutions that might not be instantly apparent with our initial level of understanding.





Design Thinking at work

Design Thinking with Tim Brown, co-CEO of IDEO

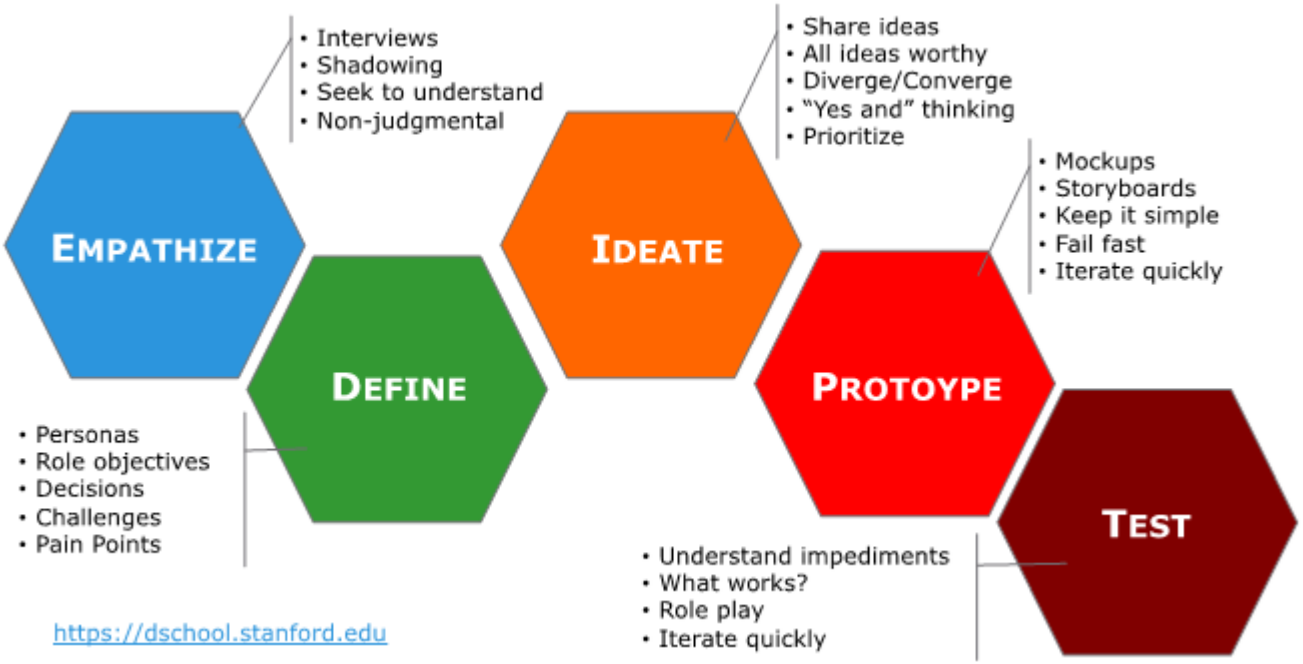
[Link to the talk]

1. Divergent thinking (instead of convergent thinking, exploring possibilities)
2. Integrated, holistic thinking (instead of analytically focusing on one part of the problem). Work to resolve desirability, feasibility, viability.
3. Design is human-centered, meet needs – instead of starting from technology or business.
4. Can apply to any product or system (digital or physical)
5. Prototyping speeds up the innovation process. How fast at prototyping?
6. Build movements

[OpenIDEO: Social Impact Powered By Design Thinking]

7. Design is moving from consuming to creating meaningful, participative experiences
8. Collaboration, trust, playfulness
9. Design every aspect of business
10. ASKING THE RIGHT QUESTION is important.

Stanford d.school Design Thinking process



Sustainability

- How many of you like to spend time with nature?
- More products generate more waste for the planet.

So what kind of products should we build?

- More energy use means more climate change events.
- How do you address water pollution from industries?
- Vehicular emissions in cities a main cause of air pollution.

"The world has enough for everyone's need but not enough for everyone's greed" – Mahatma Gandhi.

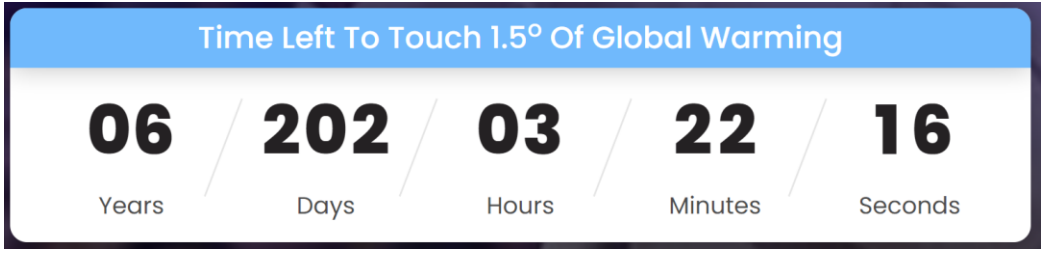
Sustainability

The study of climate change and sustainability would be the “new computer science.” [Stanford Gets $1.1 Billion for New Climate School From John Doerr.]

[#THE MOST IMPORTANT BRIEF OF OUR TIME]

“And there are still design awards that look at aesthetics and function without considering any other impacts.”

[The Action for Restoring Environment (ARE) Conference]



Design Thinking: what problem would you like to solve?

Link to the video

How to:

tackle air pollution?

keep mountains clean?

avoid road accidents?

address climate change?

health care challenges

rural issues

improve tax compliance

other examples…

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- **Digital Fabrication**

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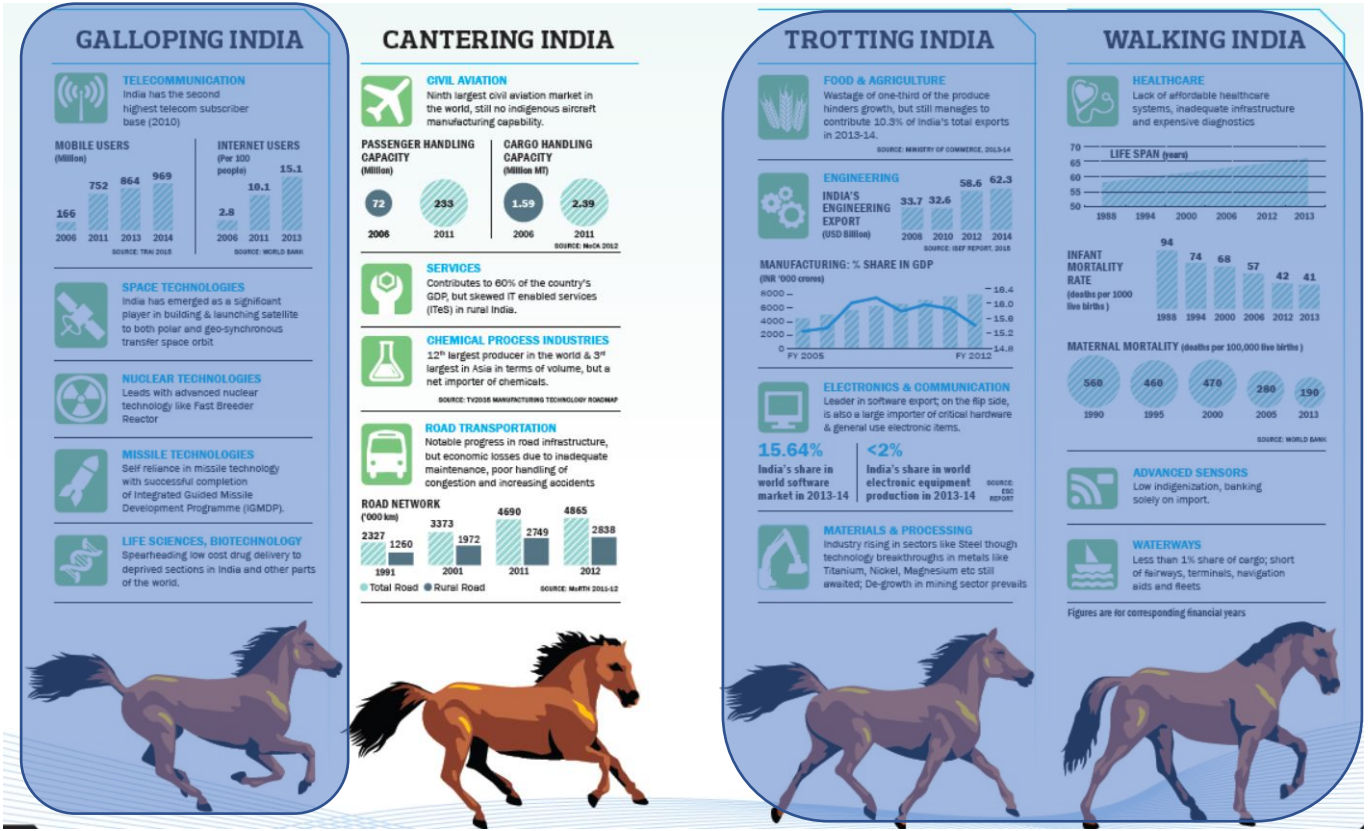
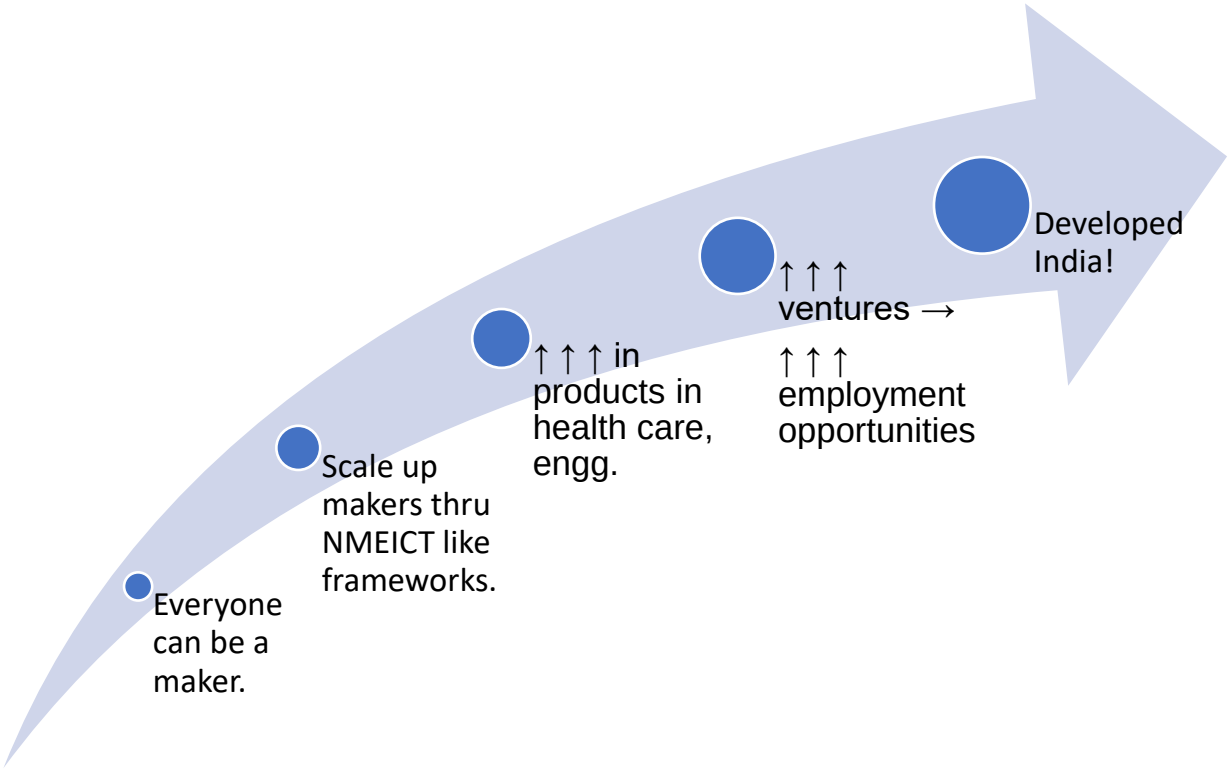
Technology Vision 2035, TIFAC, Govt. of India, 2015



↑ ↑ ↑ indigenous design and manufacturing is the need of the hour

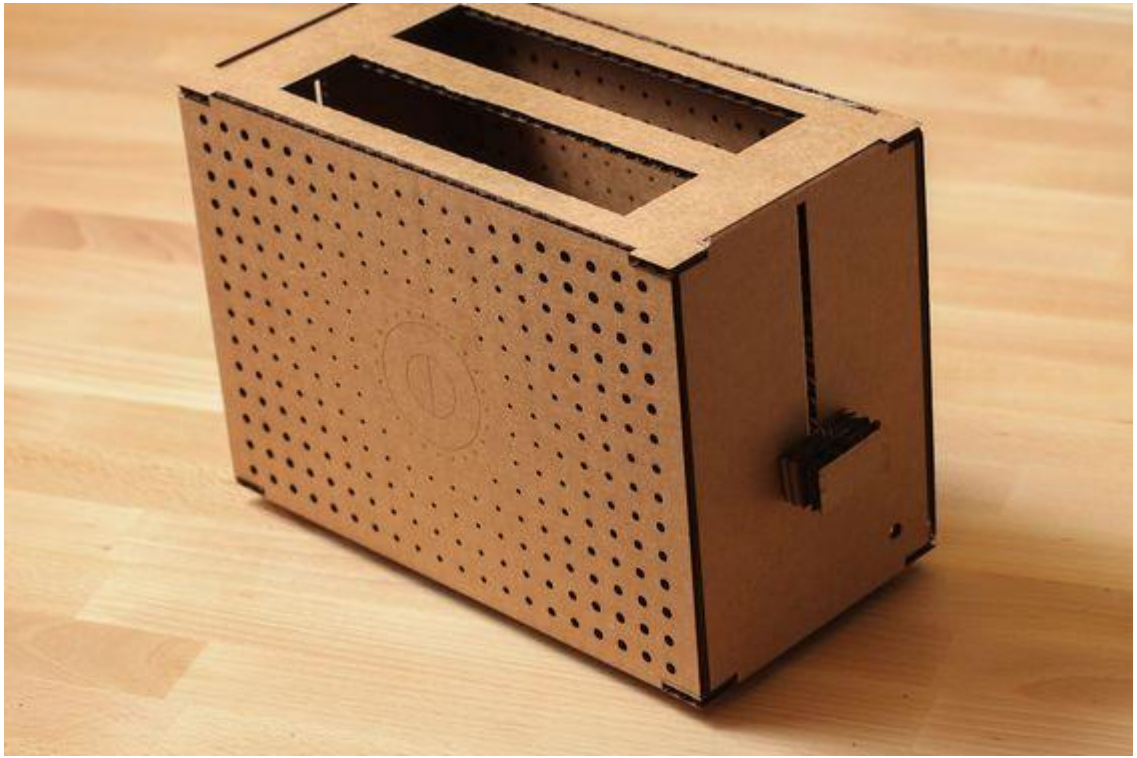


Mock up prototypes

Fail fast.

Fail early.

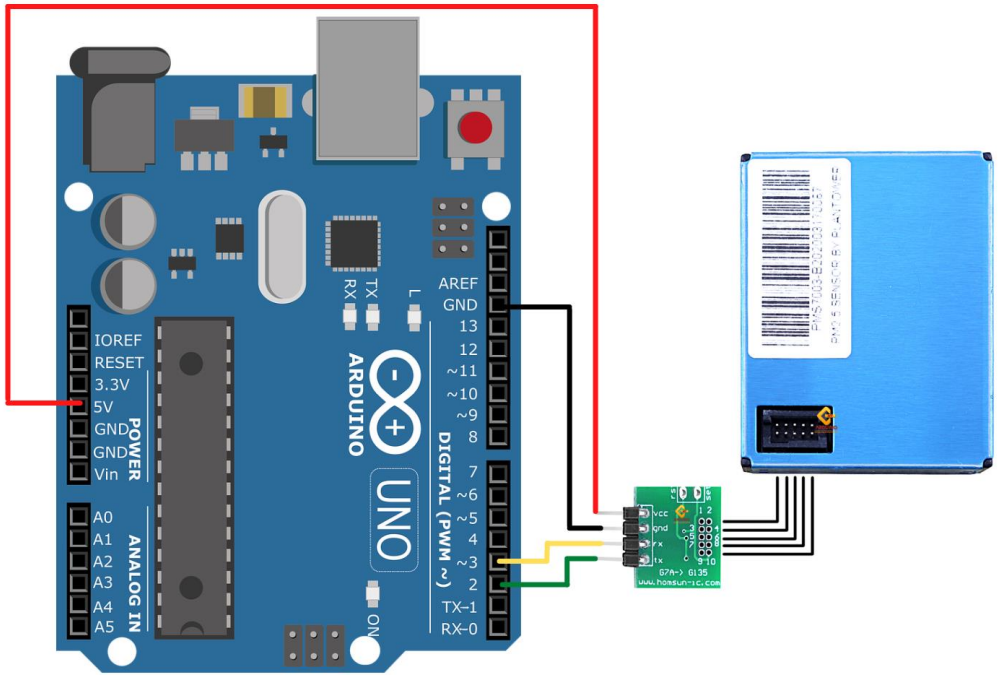
Fail often.



Low cost sensors for IAQ monitoring

What is my motivation?

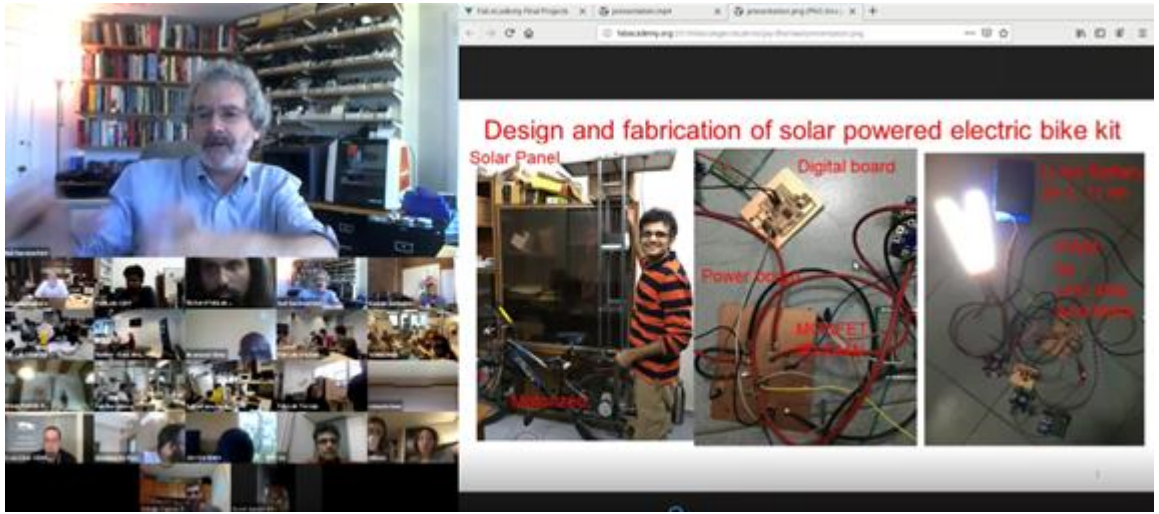
UNO	PMS7003
3.3v	3.3v
GND	GND
2	Tx
3	Rx



https://github.com/vyomaniitd/PM2.5---PMS7003

A breath of fresh air

How to make almost anything?



Prof Neil Gershenfeld CBA, MIT

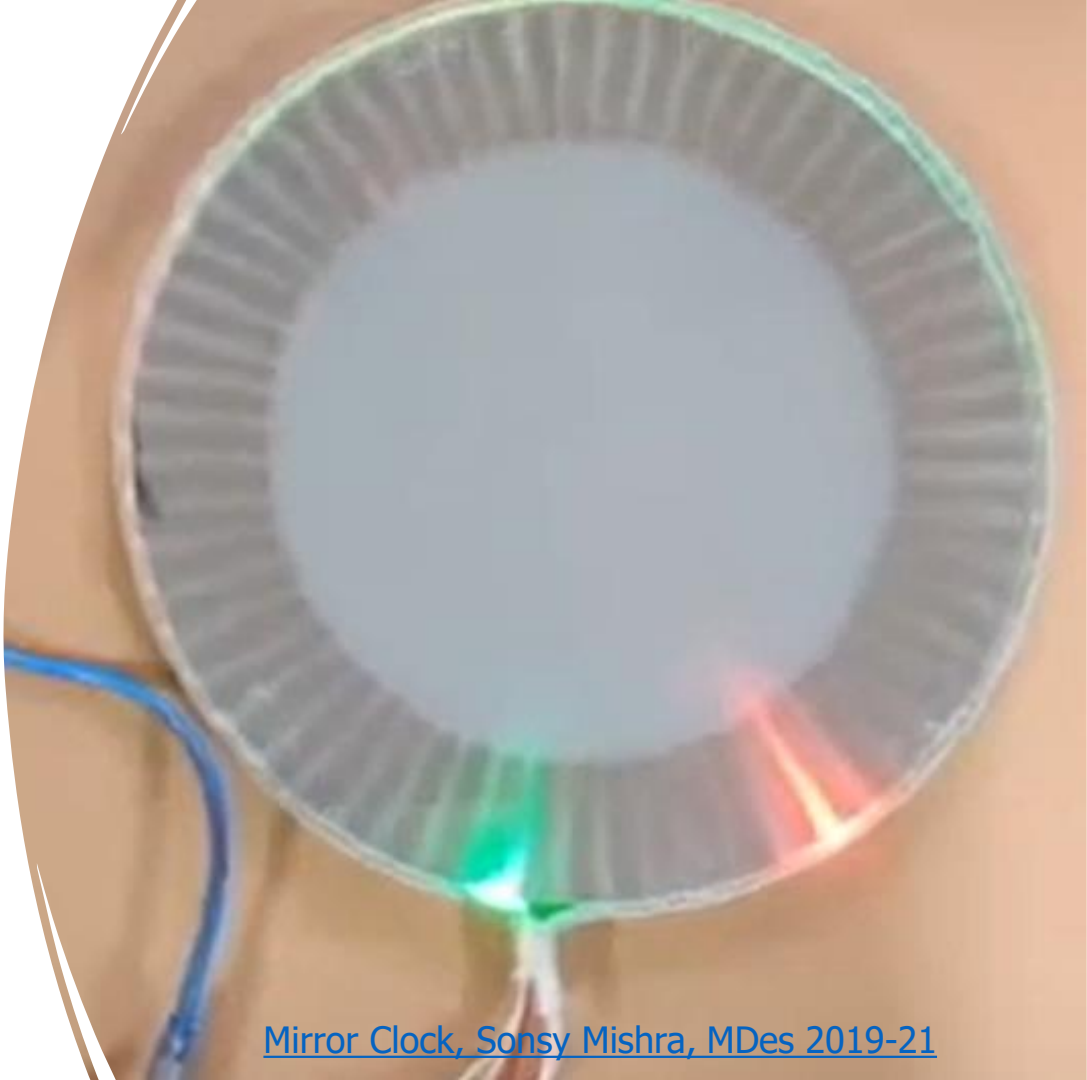
Designers, Engineers, Managers

Projects Screambody

Jan 16: principles and practices, presentations, introductions
Jan 23: project management
Jan 28 *recitation*: version control
Jan 30: computer-aided design
Feb 06: computer-controlled cutting
Feb 11 *recitation*: projects
Feb 13: electronics production
Feb 20: 3D scanning and printing
Feb 25 *recitation*: tools
Feb 27: electronics design
Mar 06: computer-controlled machining
Mar 11 *recitation*: design
Mar 13: embedded programming
Mar 20: molding and casting
Mar 25 *recitation*: machines
Mar 27: input devices
Apr 03: output devices
Apr 08 *recitation*: programs
Apr 10: applications and implications
Apr 17: break
Apr 24: networking and communications
Apr 29 *recitation*: economy
Apr 30: mechanical design
May 08: interface and application programming
May 13 *recitation*: education
May 15: machine design
May 22: wildcard week
May 27 *recitation*: events
May 29: invention, intellectual property, and income
Jun 06: project development
Jun 12: project presentations
Jun 14: project presentations
Jun 17: project presentations
Jun 19: project presentations

Courses at IITD

- Functional prototyping using digital fabrication techniques
- Course website
- Submission format
- Studio based learning, hands-on experiential learning
- Peer to peer learning (helping each other, each one with different strengths)
- From "**What** to learn to make?" To "**How** to learn to make?"



Mirror Clock, Sonsy Mishra, MDes 2019-21

Topic 0: Applications of Mechatronic Prototyping

- Projects from DSL 732, DSL 810
- Fab Lab projects
- Instructables, DIY websites
- Sketch your project Interactive Musical Bench

Smart Cane, Assistech Lab, IIT Delhi

Topic 1: Website Design for Course Mgmt

- Portfolio, digital repository for others
- html (www.w3schools.com)
- html, css template provided by us
- html, css template of your choice Self stabilizing box
- Project Management, Spiral Development

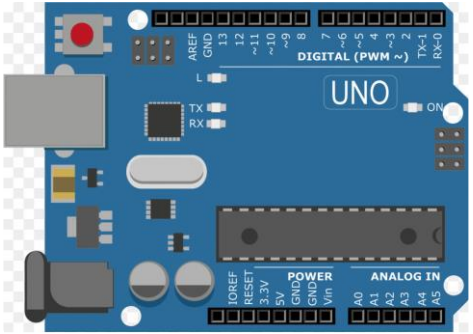
Fab Academy Notes Video (29:40-39:40)

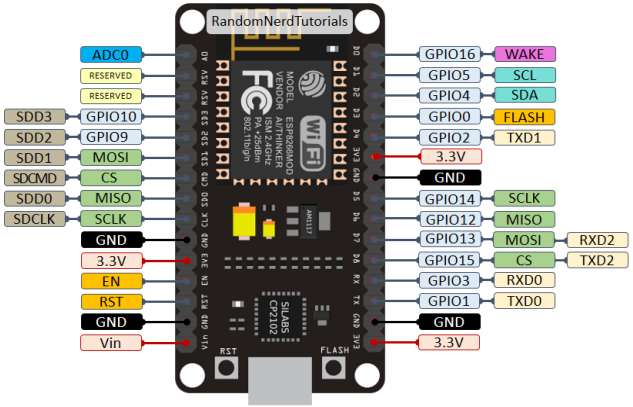
Demand side vs. Supply side Time Mgmt.

Bottom up vs. Top down debugging

Topic 2: µC programming

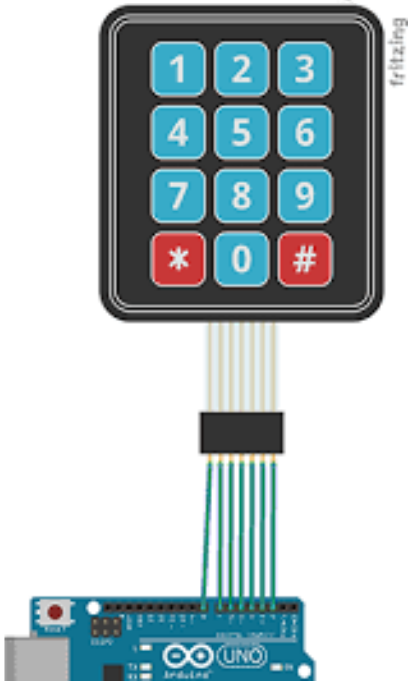
- Basics of programming, algorithm, flowcharts.
- Arduino hardware, IDE, libraries
- Arduino kit with examples
- LEDs, RGB LEDs.
- Push buttons, Buzzers.
- Electrical safety and handling
- LED name
- Basic musical instrument
- Tinkercad Simulations – Cdr Venkat Aditya





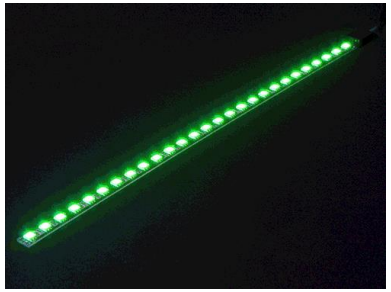
Topic 3a: Input devices

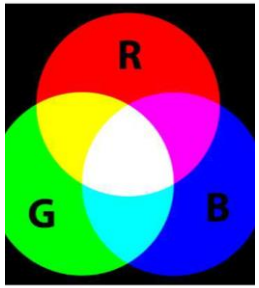
- Sensor features, datasheet
- T+RH sensor, proximity sensor, keypad module with uC
- Sensors in your smart phone (Talk to Me)

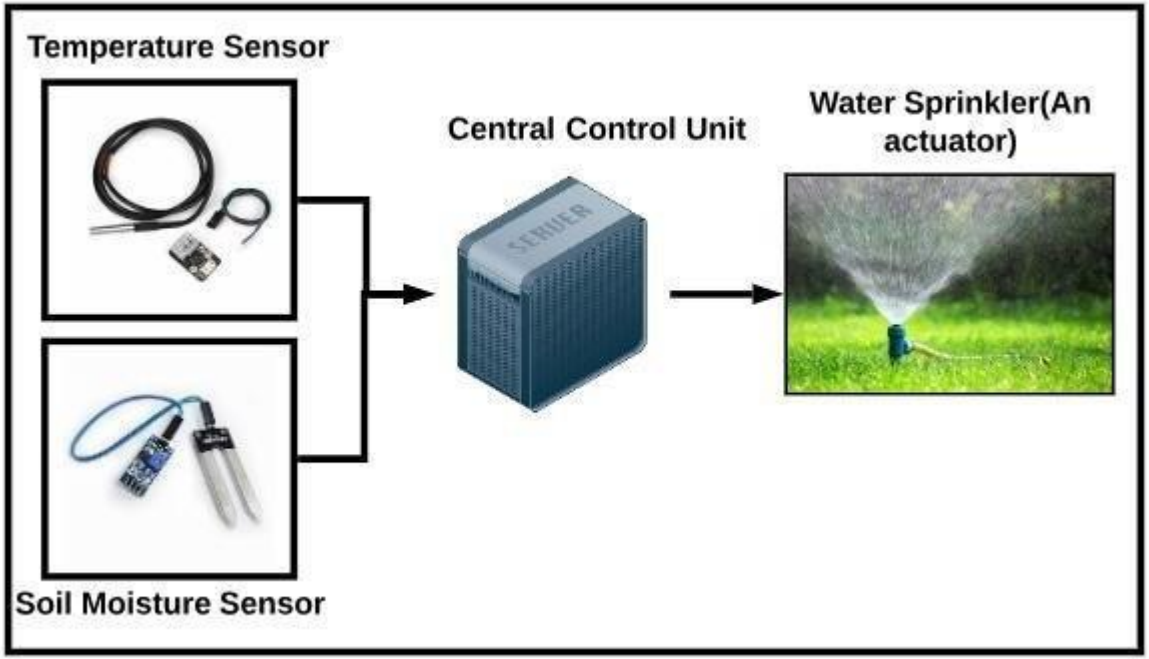


Topic 3b: Output devices

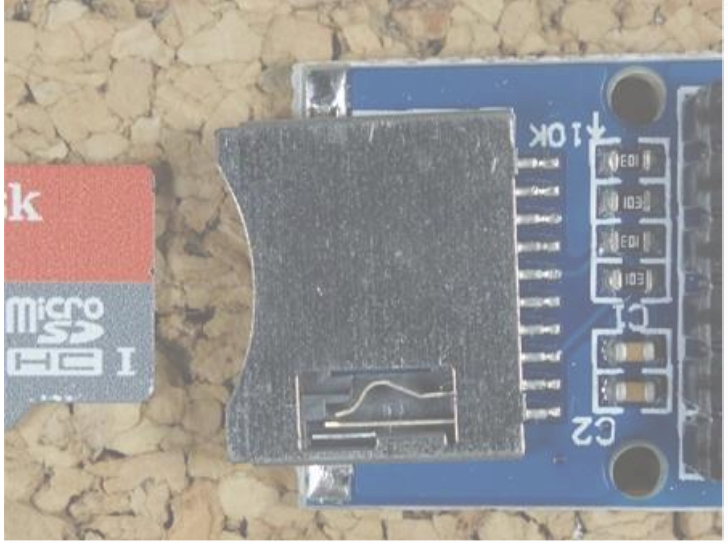
- RGB LEDs, Displays, Speakers, Servo/Stepper Motors
- Ultrasonic + LED display
- Pressure sensor + speakers
- All terrain robot

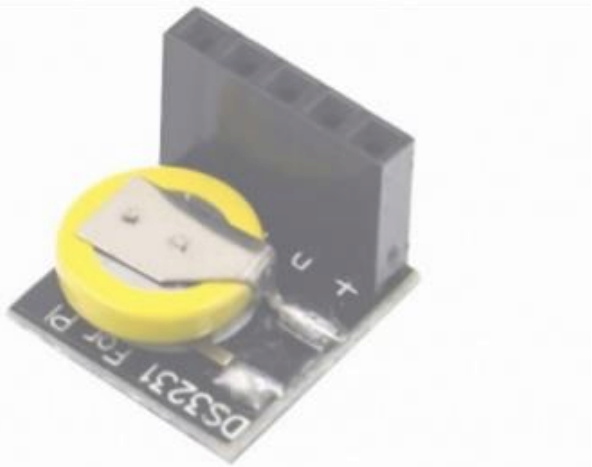




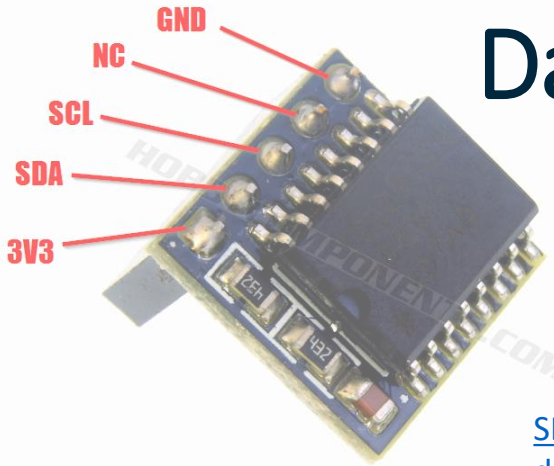


Source: https://www.researchgate.net/figure/Sensor-to-actuator-flow-in-an-Automatic-Water-Sprinkler-system_fig1_342150780

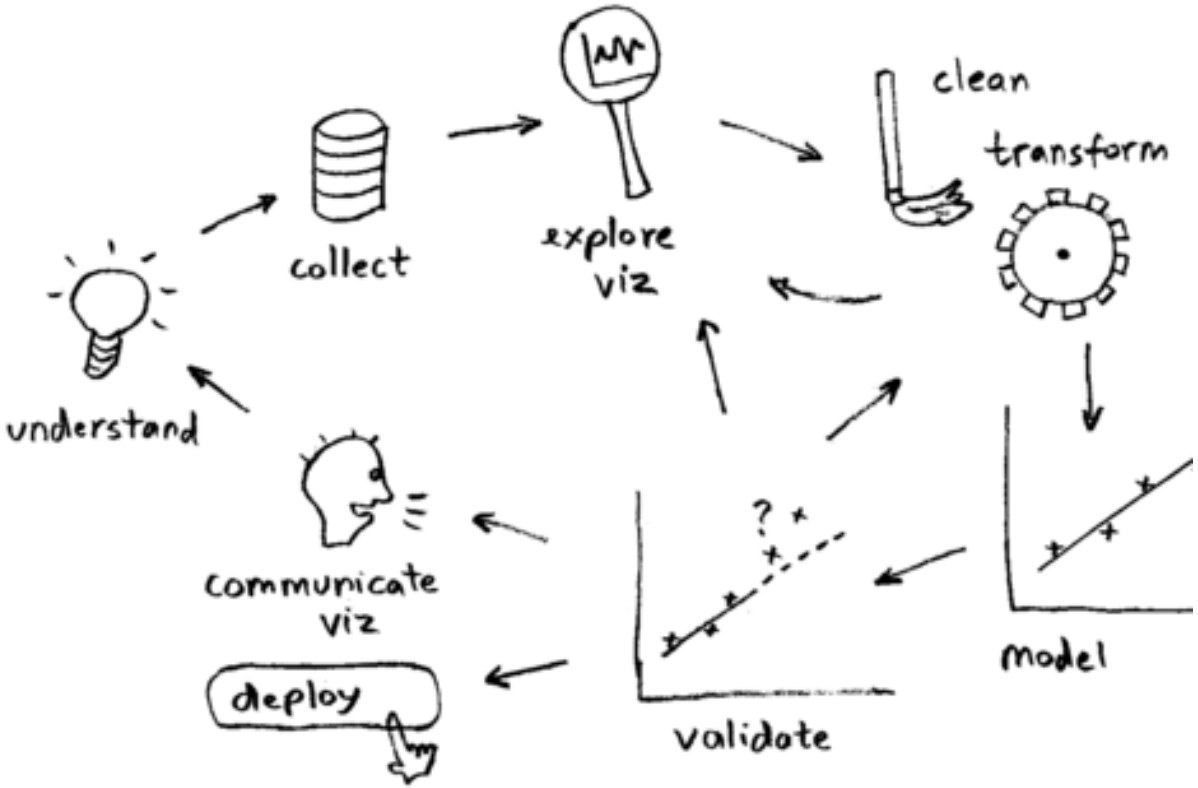




Datalogger



SD Card Module Part
ds3231 rtc pin layout Part Arduino tutorial

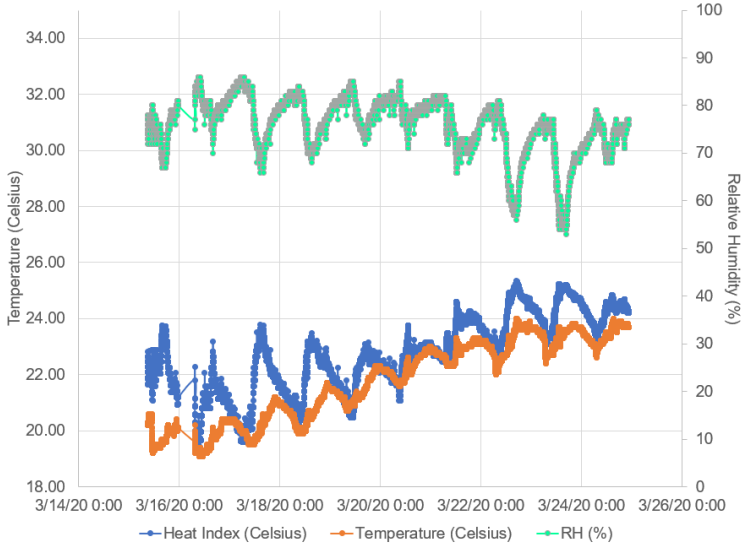


Topic 3c: Data science workflow

DSL 810: Data Driven Design https://web.iitd.ac.in/~jay/dsl810/dsl810_autumn2020/dsl810.html

Source: http://datascience.la/data-science-toolbox-survey-results-surprise-r-and-python-win/

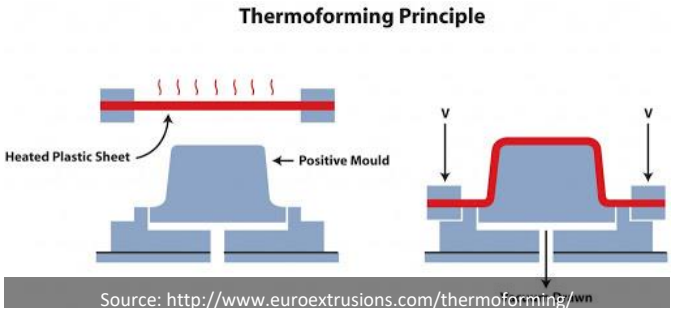
Experimentation and data analysis
Heat Index profile for my room
NodeMCU + DHT11 + ThingSpeak



Observations
1. 48500 data points
2. T, Rh every 18 sec for 10 days
3. Cyclical pattern
4. Daily temperature increase
5. In the context of COVID-19, this analysis helps to know what Temp, Rh to avoid which is conducive for the virus
6. Thermal comfort in the hostels

Topic 4: Hand and Power Tools, Thermoforming

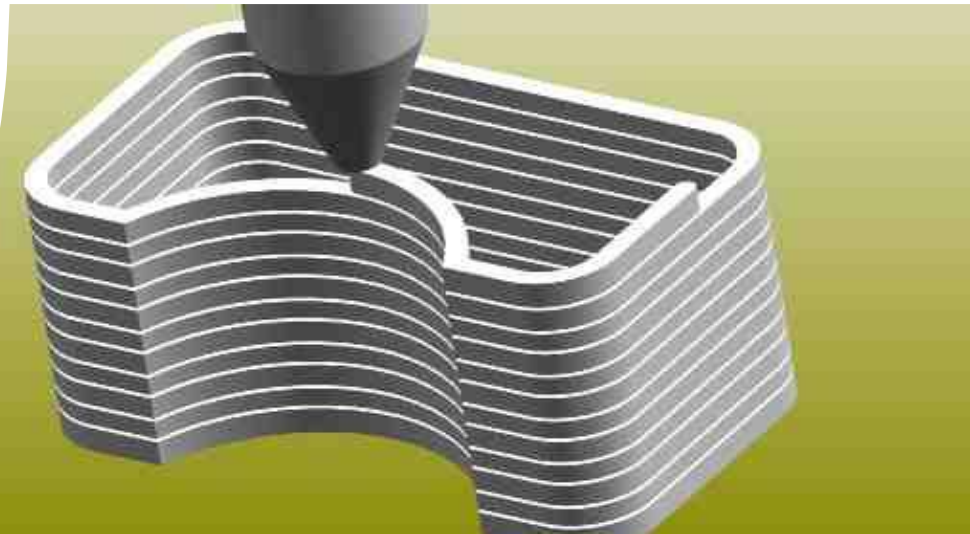
- Manufacturing of metals, processing of plastics, thermoforming
- Makerspace training videos Atul Kumar documentation (Metal and wood working)



Source: http://www.euroextrusions.com/thermoforming/

Topic 5: 3D Printing

- Material deposition layer by layer (additive manufacturing)
- Plastic, Metal, Glass, Mortar, Carbon Fibre – 3D printing
- Different methods of 3D printing Stereolithography
- Generative Design
- Sonsy Atul



Note: 2D and 3D CAD learn in CAD class

Source: https://3d-print-works.com/blogs/news/chocolate-3d-printer

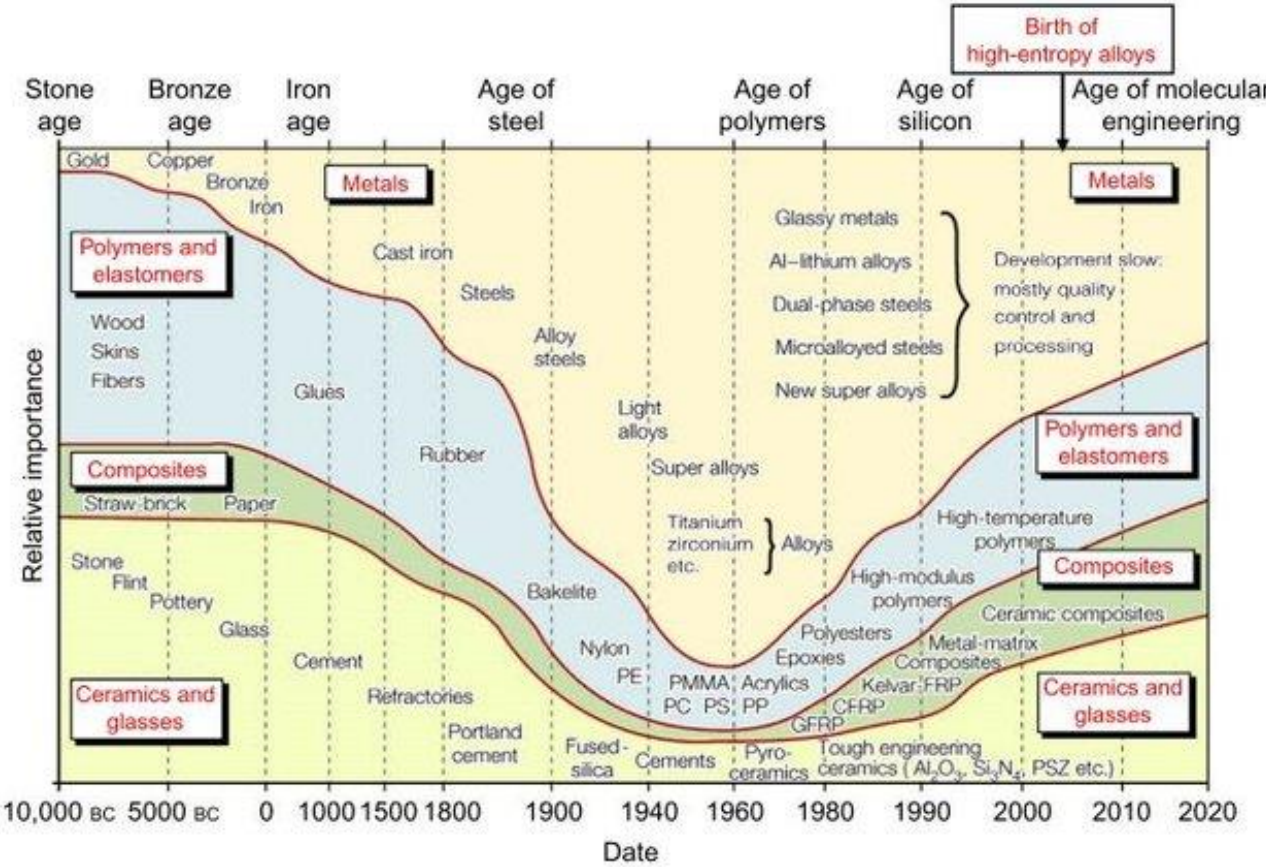
3D Scanning

- Digitally capturing shape of object
- Milk Scanner
- Reverse engineering (photogrammetry), elevation mapping (LIDAR), internal body structures (CT scan), motion capture, Digital avatar (virtual try-on), Apps on phones

https://3dtechtronics.com/best-3d-laser-scanning-services/
https://medium.com/geoai/reconstructing-3d-buildings-from-aerial-lidar-with-ai-details-6a81cb3079c0

Topic 6: Materials, DFM/DFA

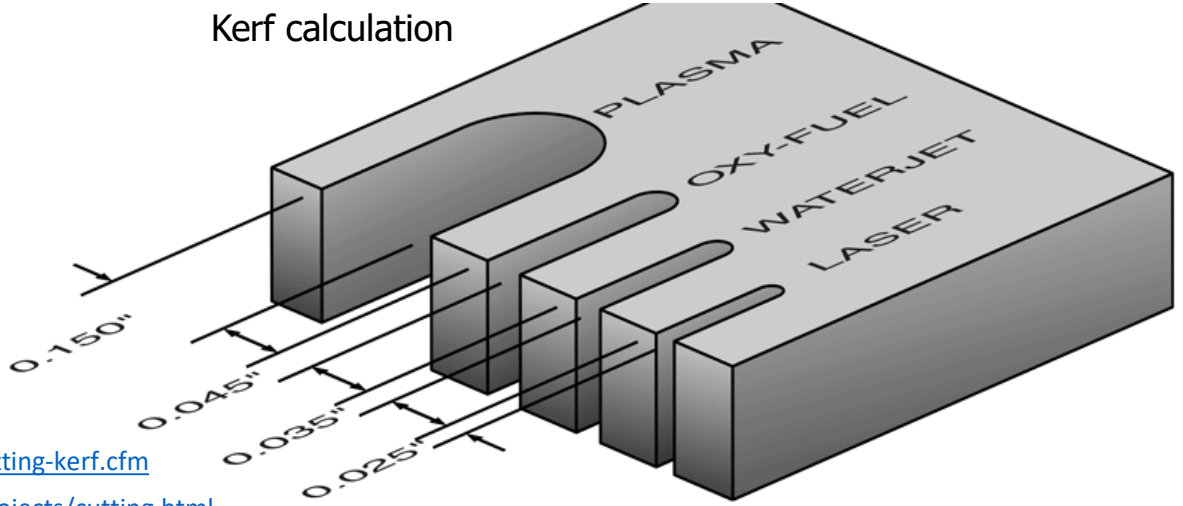
- Material properties, classification, selection
- Cambridge Engineering Selector
- Design for Manufacture, Design for Assembly considerations
- Manufacturability evaluation



https://www.researchgate.net/publication/340967691_HEAs_High_Entropy_Alloys_for_advanced_systems_and_engines_Examination_Committee/figures?lo=1

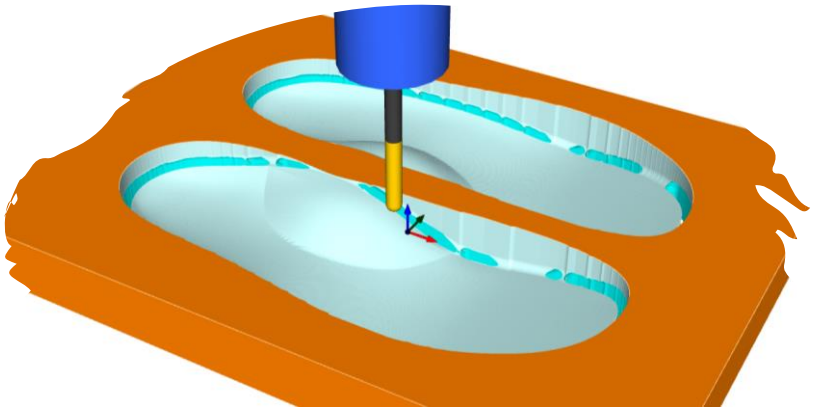
Topic 7: Computer controlled cutting

- Laser, waterjet, vinyl, plasma, wire EDM cutting
- Machine characterization
- Kerf = f(speed, power, thickness, material)
- Pressfit kit
- Fits and tolerances



https://www.esabna.com/us/en/education/blog/what-is-cutting-kerf.cfm

http://fab.academany.org/2018/labs/fablabaachen/groupProjects/cutting.html



Topic 8a: Computer controlled machining

- Subtractive manufacturing
- Roland MDX-540 3D milling, CNC router 2.5D milling to make something big
- Custom Orthotic, Opendesk, Shelter
- Make a scaled model first.
- G-code, rough cuts/finish cuts, kerf, test cuts

https://archello.com/story/15687/attachments/photos-videos/9

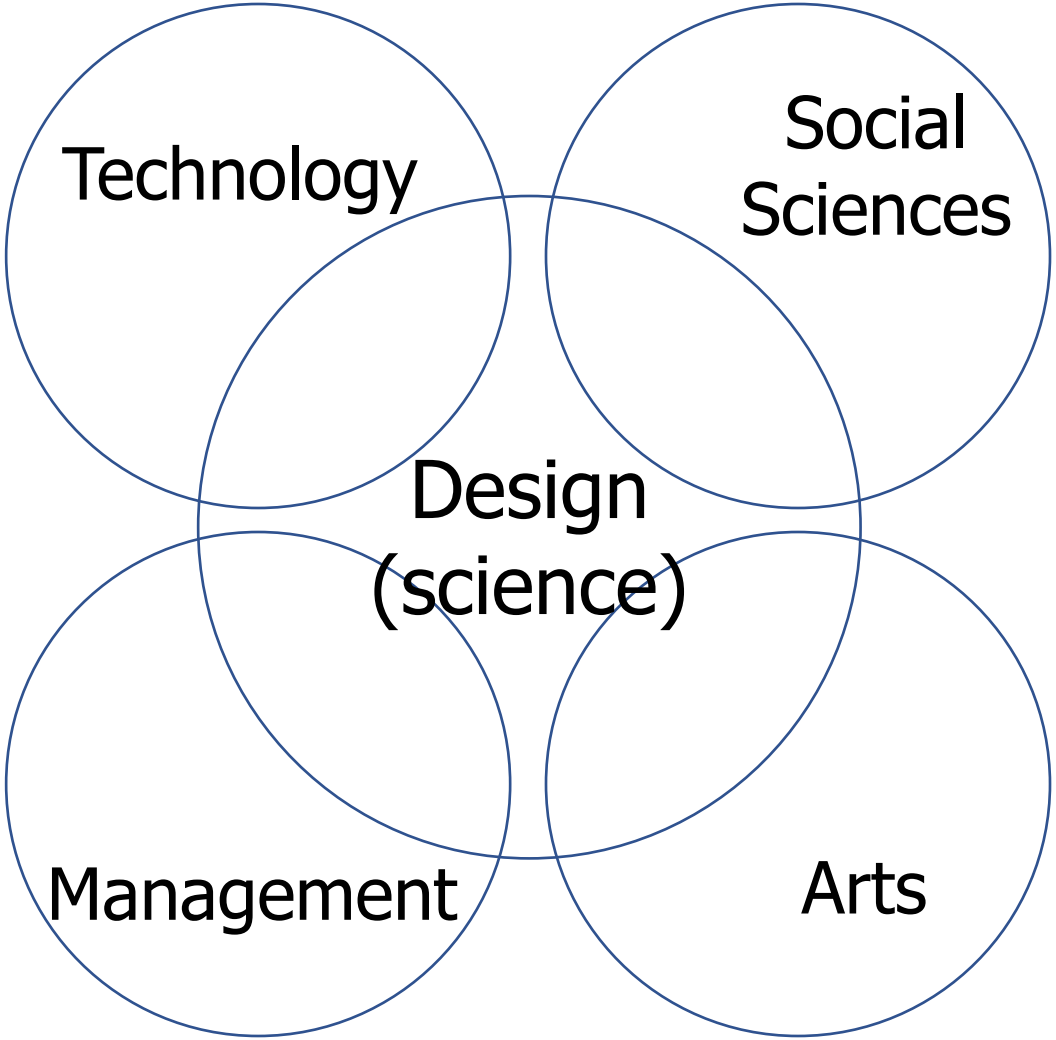
https://mecsoft.com/blog/orthotic-2-sided-machining-in-rhinocam/

Topic 8b: Molding and casting

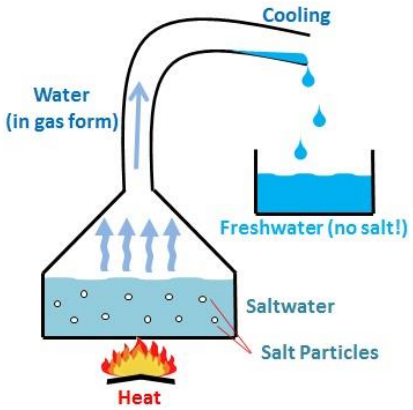
- Three step process - 1st Mold (wood, wax), counter-mold (silicone), cast (water, epoxy)
- Vehicle body design
- sand metal casting, Pewter sand casting
- PDMS molding for micron size devices

http://fabacademy.org/2019/labs/akgec/students/jay-dhariwal/assignments/week10/

One science, science for impact



First principles method



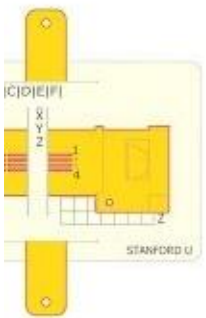
Water filter – plant xylem

Waste-water treatment

Biology, Chemical engineering, Mechanical engineering, Nano-technology, Social Sciences

Examples of One Science: SOLVE water

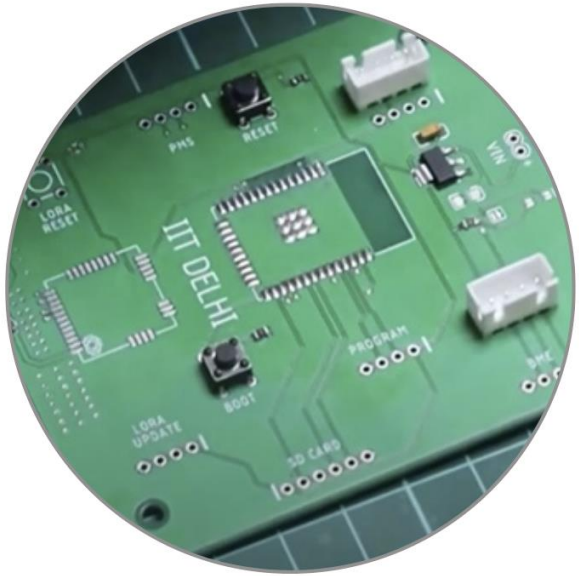
Pranav Mistry's sixth sense device, Dr Abdul Kalam,
Manu Prakash's foldscope, Prof Hugh Herr's bionic limbs project



Science for impact

What would you like to make?

- Fab Lab projects
- Instructables, DIY websites



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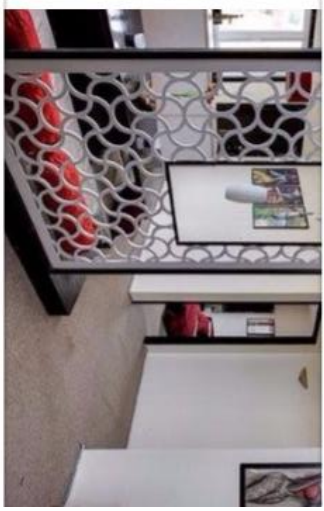
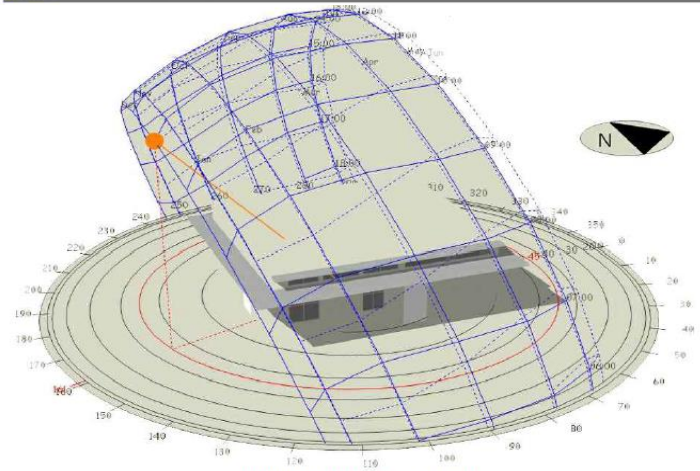
   • Case study 2: Air pollution monitoring

Macro Scale: Solar Decathlon Europe 2014

Time lapse of the house



House Design: Passive Solar Architecture



SUN PATH ANALYSIS FOR MUMBAI

Interiors of the House

THE ENERGY SPECIALISTS

Team Shunya

Engineering and architecture students, Mumbai

POWERHOUSE In 2014, a group of 70 students from IIT-Bombay and Rachna Sansad's Academy of Architecture built a zero-energy, solar-powered house—H^0—and became the first Indians to participate in the Solar Decathlon in Versailles, France. The project was planned to address India's growing energy and housing demands.

DESIGNER'S DREAM H^0, a 70-sq-mt prefabricated house, uses only solar power for its energy needs and can accommodate six persons. It has an open kitchen, two bedrooms, a dining area and a multipurpose space which can be converted into a bedroom when required and two toilets. The house, which is estimated to cost Rs 35 lakh, is equipped to handle earthquakes and floods. *by Moeena Halim*

HITTING A HOME RUN

"My primary aim is to reduce the cost of building the H^0 as much as I can."

JAY DHARIWAL, member, Team Shunya

RANGAN BANERJEE (SEATED), HoD , ENERGY SCIENCE AND ENGINEERING, IIT-BOMBAY, WITH TEAM SHUNYA MEMBERS

MANDAR DEODHAR

Makerspace at IIT Delhi

Would you like to share your Learning by Doing/ Tinkering/ Making experience?

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[Change.Makers](#) summer boot camp 2022

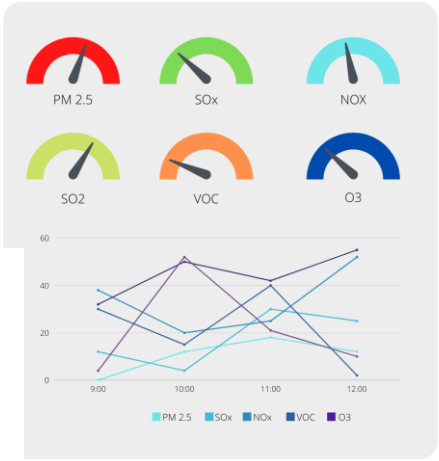
[Press release from IIT Delhi](#)

Calibration and Network Deployment of Low Cost Pollution Sensors

Data cloud

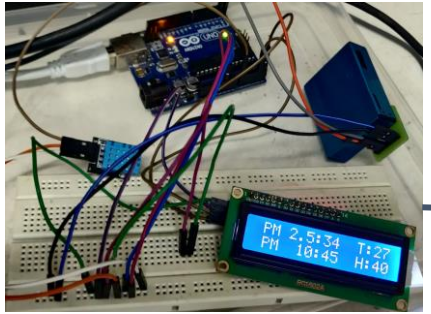
Network of low-cost sensors and network calibration

Sensor calibration

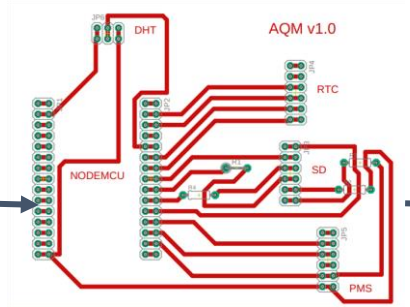


Pollution data analytics and dashboard

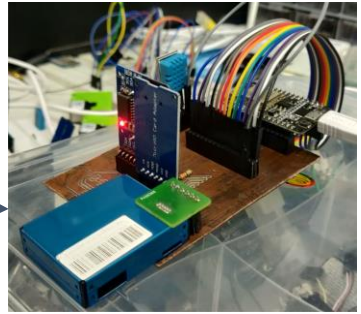
Co-PIs: Prof. Seshan Srirangarajan & Prof. Jay Dhariwal, IIT Delhi



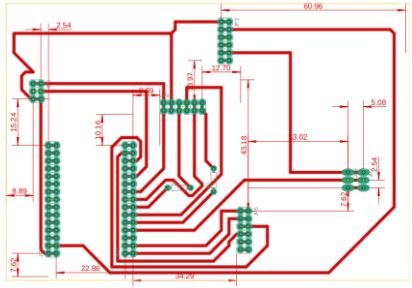
Initial testing

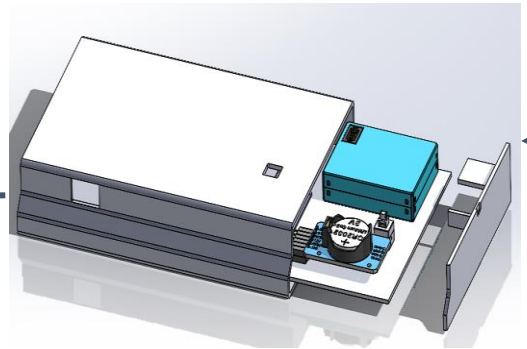


Board Design

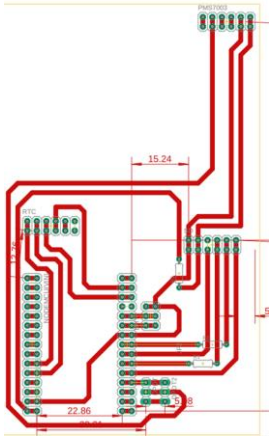


Testing on PCB



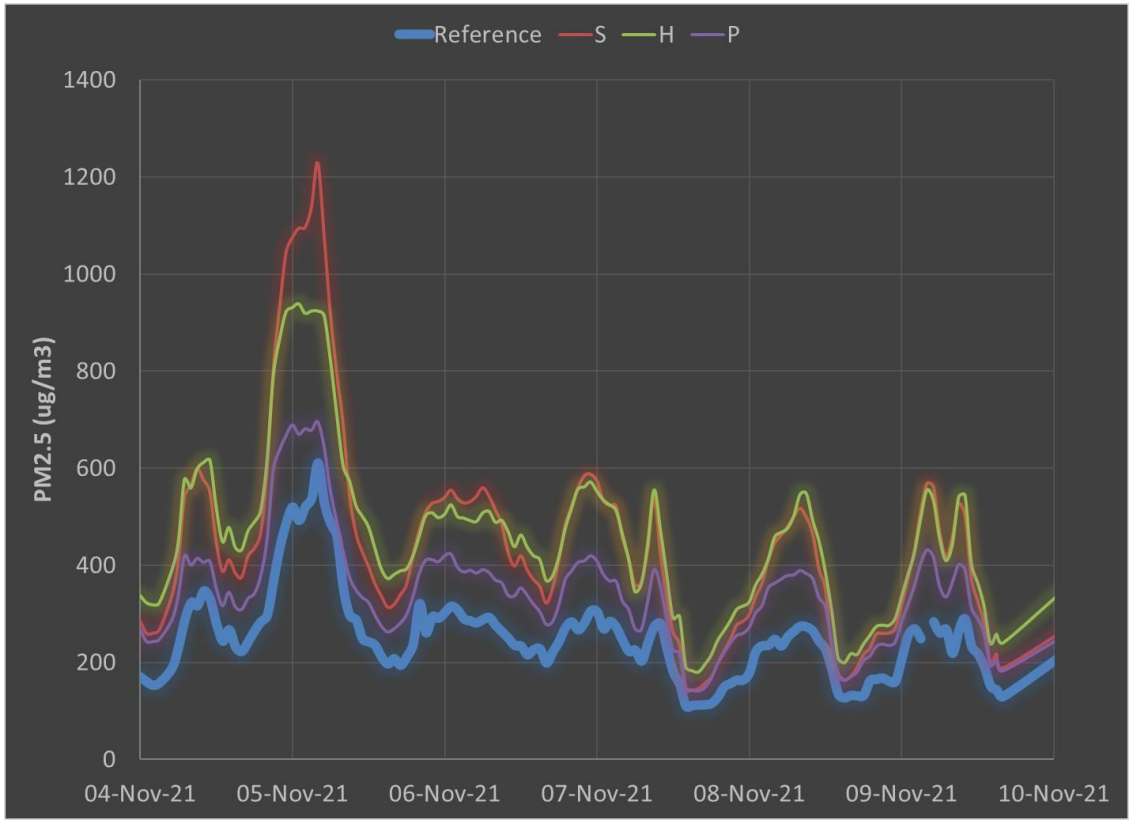


Solidworks model of V1



Prototype V2

Field testing of Low Cost PM sensors



- Field testing at IIT Delhi
- Present R^2 > 85% with low cost sensors
- Next steps: wireless sensor network, indigenous PM sensor, IAQ monitoring

Summary

1. • Design Thinking
   • Sustainability
2. • Digital, Electro-mechanical Prototyping
   • Digital Fabrication
3. • Learning by doing
   • Makerspaces
4. • Case study 1: Change.Makers boot camp
   • Case study 2: Air pollution monitoring