ENGINEERING INNOVATION CHALLENGE 2021
AUGUST WORKSHOP

Product Development and Prototyping

A WORKSHOP BY

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SINGAPORE POLYTECHNIC (SP)

JOINTLY ORGANISED BY:

NUS National University of Singapore | Singapore Nuclear Research & Safety Initiative | Science Centre Singapore | The Institution of Engineers Singapore

SUPPORTED BY:

Ministry of Education Singapore | National Research Foundation Prime Minister's Office Singapore

PARTNERS:

Singapore Polytechnic SP

Product Development & Prototyping
Traditional & Modern Techniques

What is Digital Fabrication?

- Simplified definition:

> "Digital fabrication is a type of manufacturing process where the **machine** used is **controlled** by a **computer**. The machines can **reliably** be **programmed** to make **consistent** products from **digital designs**."
>
> Opendesk

- 3 main types of digital fabrication
  - 3D printing
  - CNC machining
  - Laser cutting

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Differences (from Traditional Methods)

- Traditional
  - Requires skilled craftsman
  - Slow, labour intensive
  - Not easily scalable
  - Changes requires rebuild
- Digital fabrication
  - Fast, convenient prototypes
  - Lowers barriers to product development
  - Easily scalable
  - Production ready prototypes
  - Easy path from prototype to production

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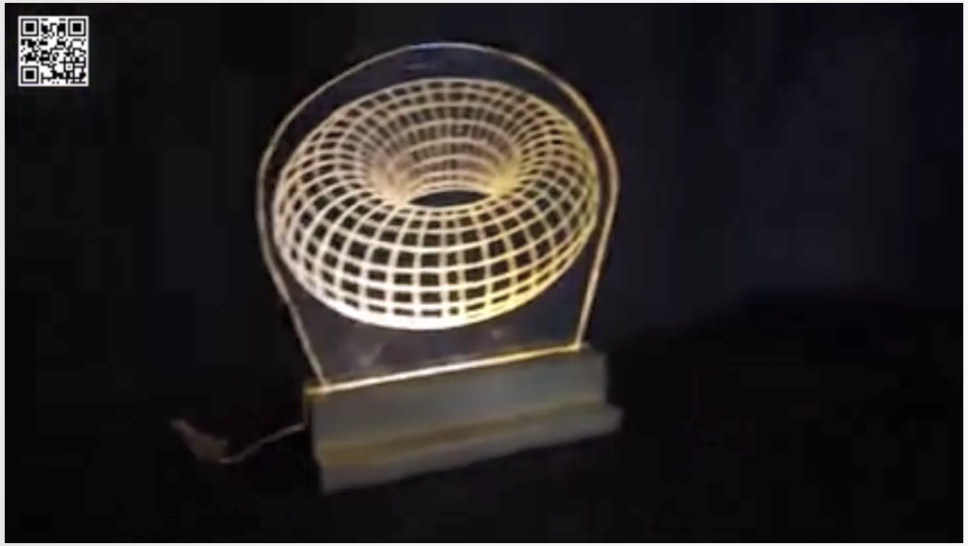
Comparing Techniques

Traditional



Digital Fabrication

Benefits of Digital Fabrication

- Pros
  - Computer assisted, saving time
  - Repeatability
  - Changes are easy
  - Personalized product
  - Localized production
  - Less wastage
  - Complex products don’t cost more
  - Faster than regular manufacturing methods
- Cons
  - No economies of scale, first product costs as much as 1,000th
  - Not beneficial for mass production
  - 3D printing takes longer
  - Machines require maintenance & consume power
  - Initial equipment cost

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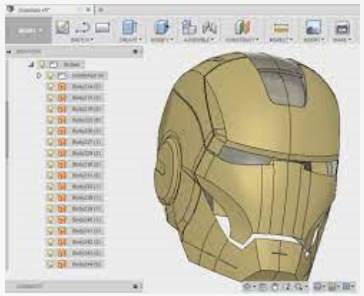
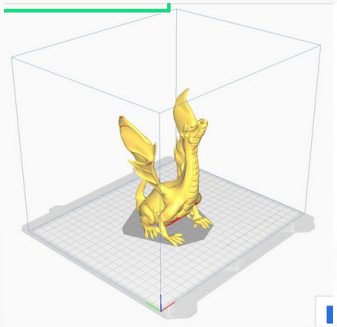
Tools, Technologies & Equipment

- Software (Mechanical):
  - 2D/3D CAD
  - CAM
  - Slicers
- 3D printers
- Laser Cutters
- CNC:
  - Large format routers
  - Precision CNC
- Composite workbench





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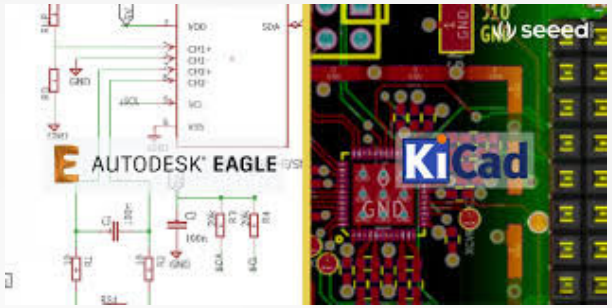
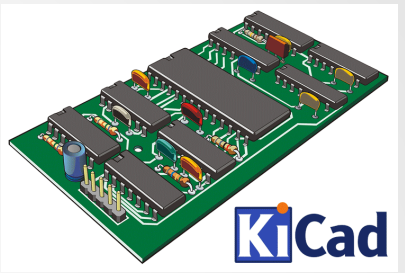
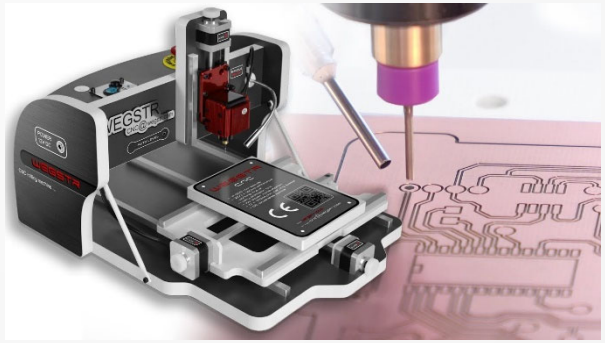
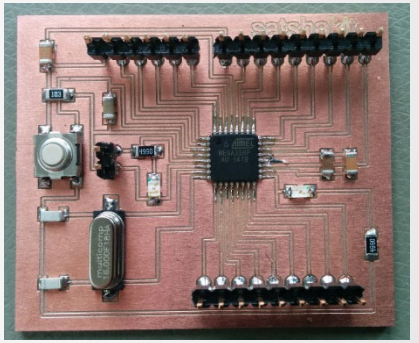
Tools, Technologies & Equipment

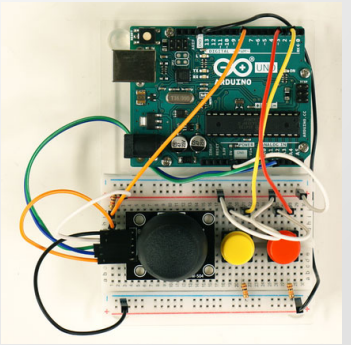
- Software (Electronics):
  - EDA
  - Programming tools
- Electronics workbench
- PCB fabrication process











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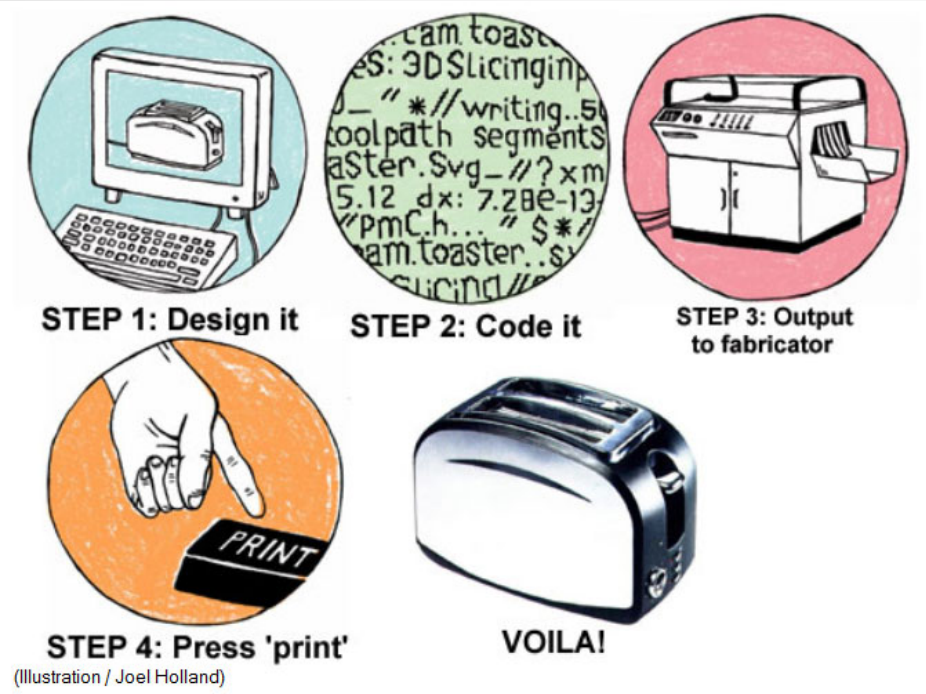
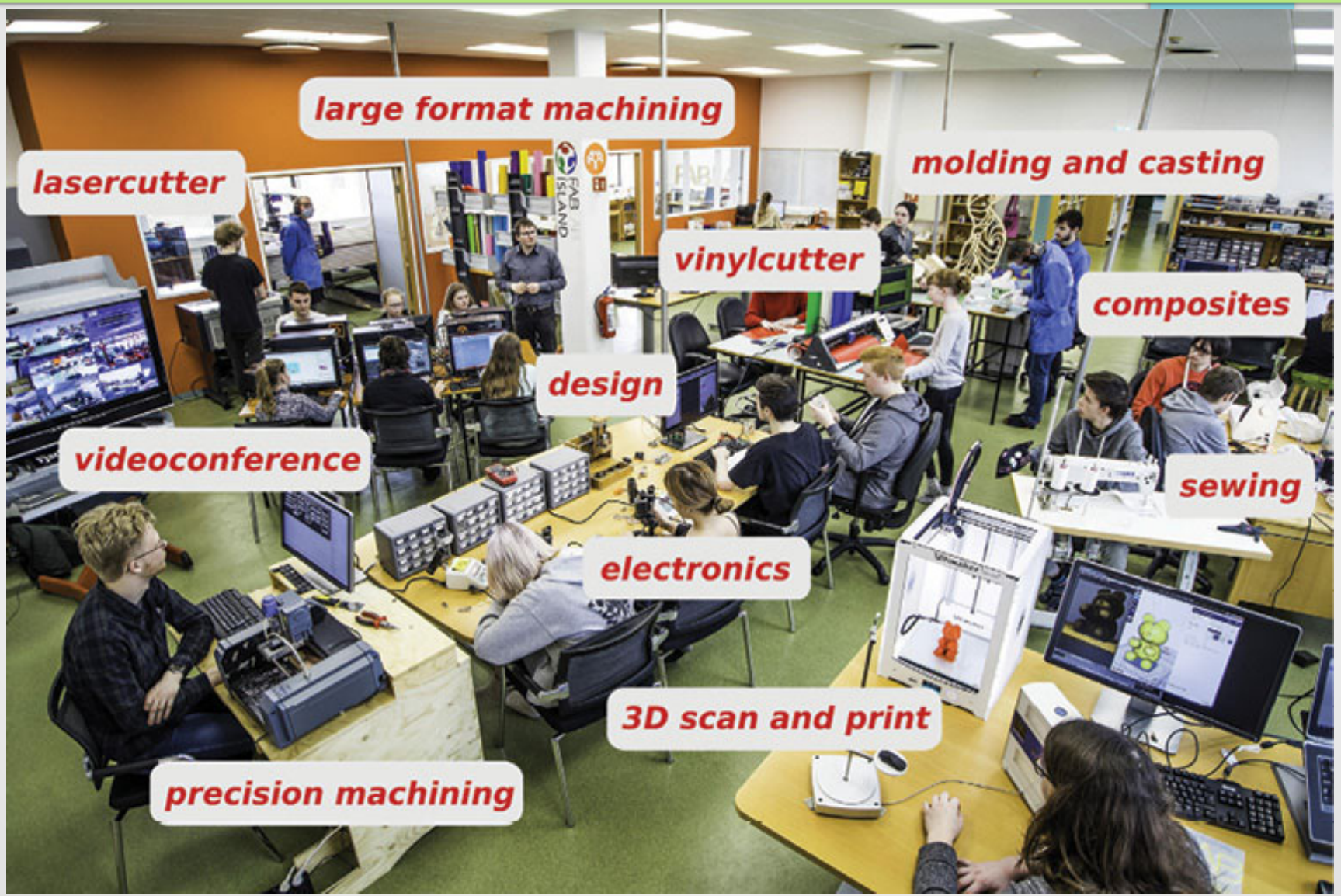
Digital Fabrication Workflow (Idealized)



Boston Globe

Typical Fablab Setup



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Case Study

FAB ACADEMY 2020

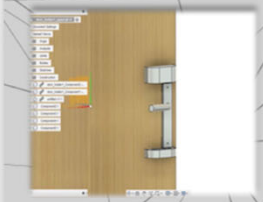
Door Handle Sanitizer

FabLab UAE فاب لاب الإمارات

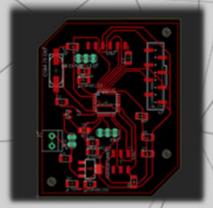
By: Waleed Alhamdi

A self sterilized door handle.

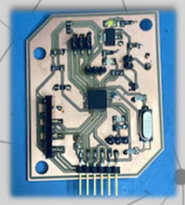
Once the door is opened or closed , UV lights will operate to clean and kill the germs on the handle.



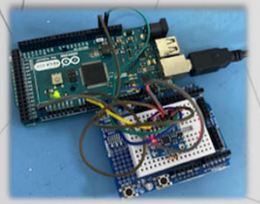
CAD design



Electronics design



Electronics production



Programming

3D printing

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Case Study – Door Handle Sanitizer

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By: Waleed Alhamdi

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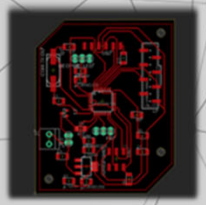
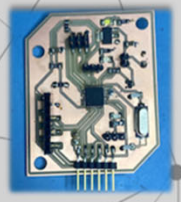
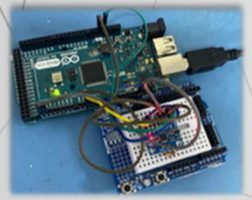
CAD design



Electronics design



Electronics production



Programming

3D printing

Case Study

TW

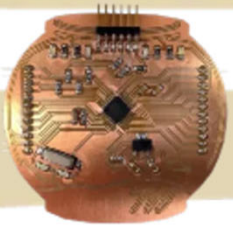
CHARLOTTE LATIN FAB LAB

ASSISTIVE AQUAPONICS

FISH TANK

BY TEDDY WARNER

A MONITORED AQUAPONICS ECOSYSTEM, EXPANDING THE ACCESSIBILITY OF SUCCESSFUL & THRIVING AQUAPONICS ECOSYSTEMS



Electronics

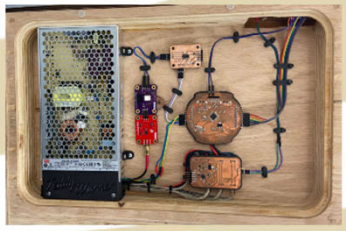
-ATMega 328
-Temp/Humidity Sensor
-pH Probe
-LCD
-ATTiny 412 + Grow Lights

Laser Cutting

-Acrylic Fish Tank
-Electronics Compartment Cover
-Tank Front Plate

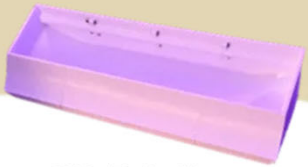
CNC Milling

-Plywood Tank Structure



System Integration

-Planned Electronics Mounting & Housing



3D Printing

-Grow Box
-Press-Fit Board Mounts
-Wire Management

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Case Study – Assistive Aquaponics

TW

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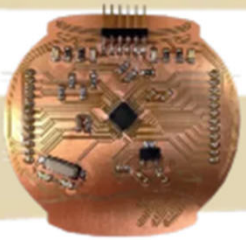
ASSISTIVE AQUAPONICS

FISH TANK

BY TEDDY WARNER

A MONITORED AQUAPONICS ECOSYSTEM, EXPANDING THE ACCESSIBILITY OF SUCCESSFUL & THRIVING AQUAPONICS ECOSYSTEMS



Electronics
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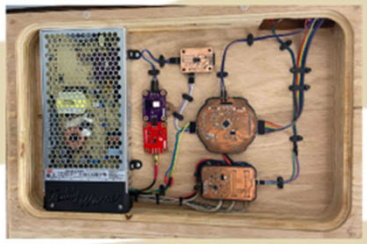
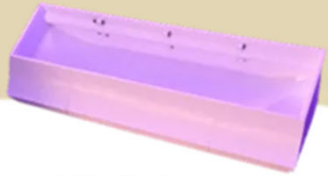


System Integration
-Planned Electronics Mounting & Housing



3D Printing
-Grow Box
-Press-Fit Board Mounts
-Wire Management

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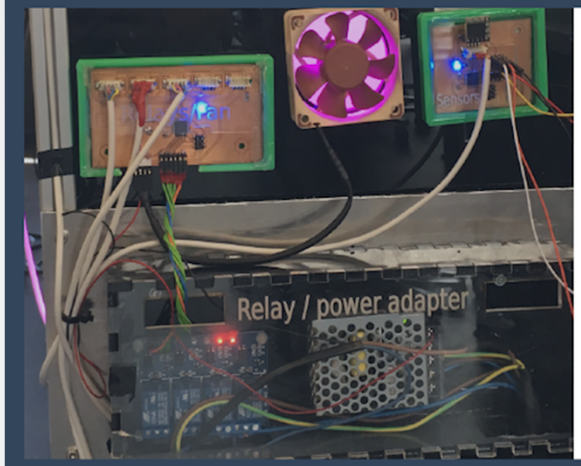
Case Study

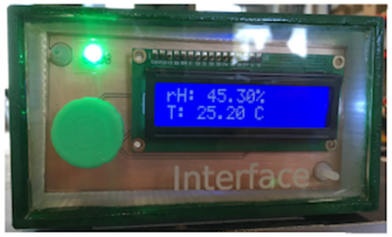
Open Hydroponic Growsystem

A multifunctional and extensional open source growbox

Marcel Kellner
Fabacademy 2017

HRW



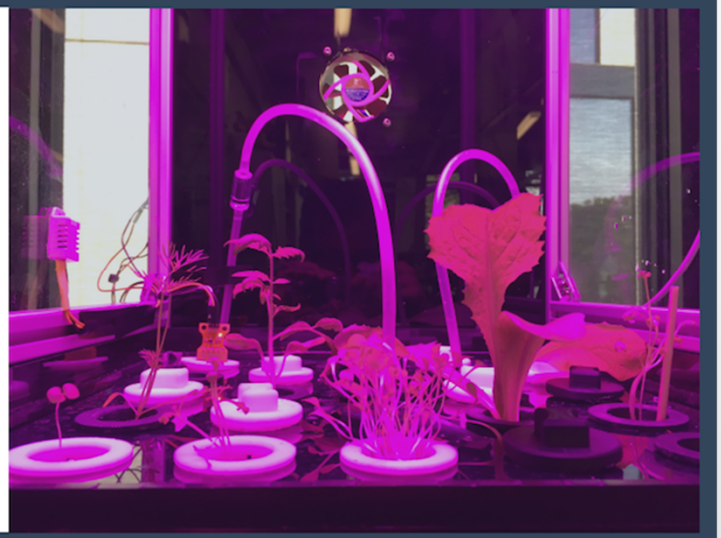


Features

LCD-Module
Relay Control
Rotary Encoder
Real Time Clock
Temperature and humidity sensor
I2C-Bus with extensional possibility
Water Level Sensor Module with RGB LED

Used skills

Electronics design/production
3d-printing
CAD
Computer controlled cutting
Embedded programming
Input/output devices
Networking & communications
Mechanical design



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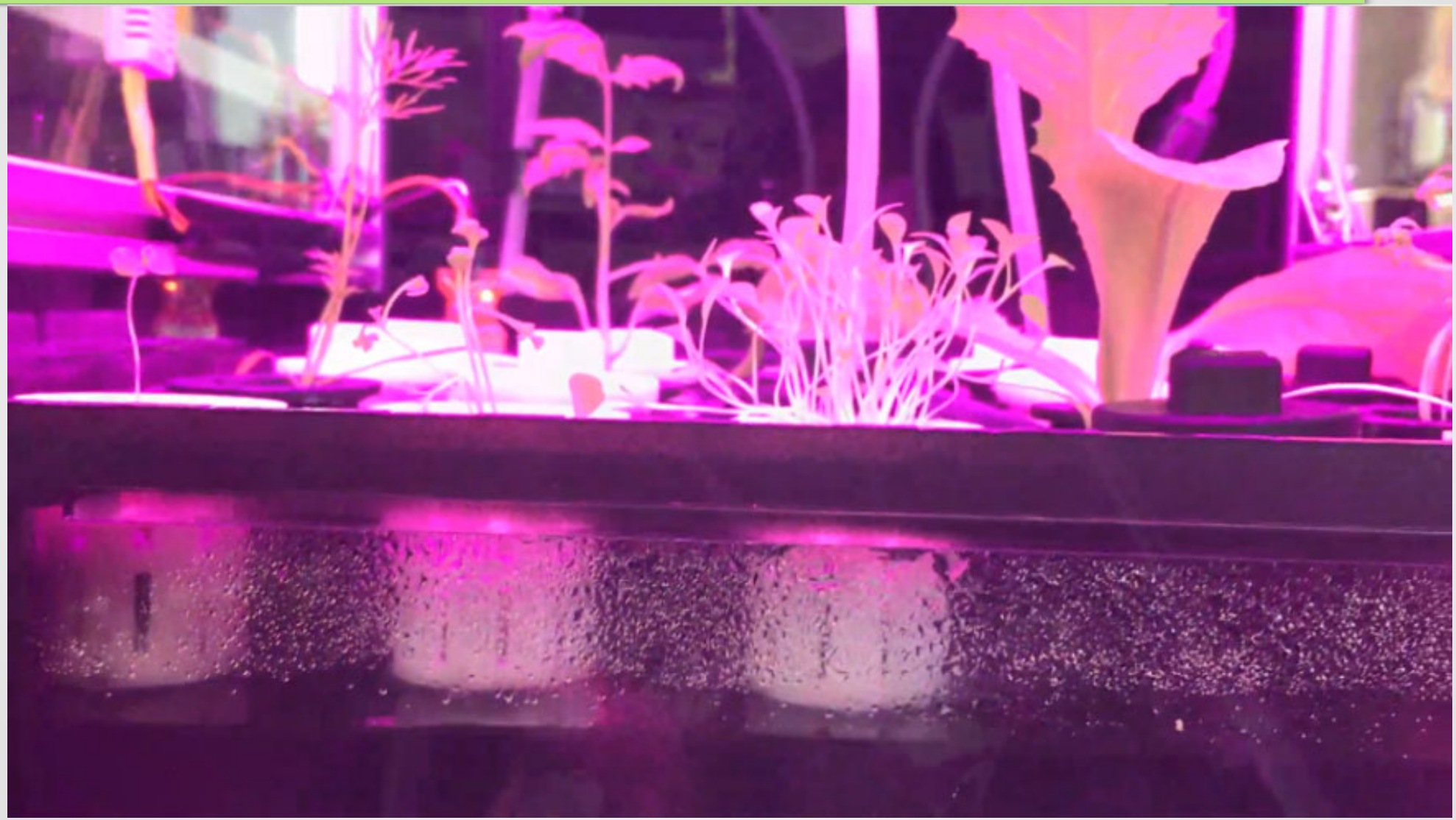
Case Study – Open Hydroponics



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What Do You Want to Build?

Towards a sustainable future

- One 40’ container can grow crops equivalent to 2.5 acres of land
- Fully automated environment monitoring & control
- Direct from farm to table

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How Can I Get Started (w/ Digital Fabrication)?

- Check with your school/ IHL for workshops or training
- Many IHLs conduct CET training on digital fabrication
- Digital Fabrication Space (DFS) at SSC runs workshops & courses for the public
- Look for courses/workshops offered by commercial Makerspaces
- Sign up as a member of a local Fablab or makerspace to get training & access to equipment

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Computer Aided Design & Digital Fabrication

Science Centre Singapore

- Infinity Mirror
- Vertigo!
- Paper Packaging Techniques (1)
- Fast Prototyping with 2D CAD (2)
- Impeller Pumps
- Paper Packaging Techniques (2)
- Micro:pet
- Smart Devices With Grove Kit (1)
- Smart Devices With Grove Kit (2)
- Microcontrollers 101
- Light Box Camp
- Robotic Arm Camp

SkillsCraft

Community Innovation Makerspace

As a university of applied learning, Singapore Institute of Technology (SIT) is working closely with the Punggol Grassroots to establish a Community Innovation Makerspace.

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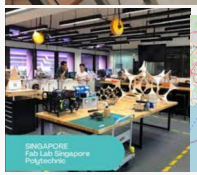
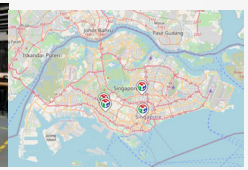
Access to Digital Fabrication Equipment

- School/IHL

- Makers' Studio@Fuhua Primary
- MakerSpace@Westwood Primary
- Community Lab@UWCSEA
- Home-Fix XPC
- IdeasHub UWCSEA Dover
- Design Space@Commonwealth Secondary School
- Prototyping Lab@National Design Centre
- Nanyang Polytechnic Makerspace
- Orchard Library Makerspace
- Sustainable Living Kampung

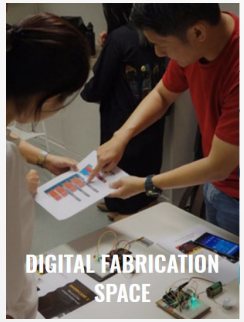
- Fablabs





- FabLab Singapore Polytechnic
  Singapore, Singapore, Singapore
- FABLAB FREEFORM
  Singapore, Singapore, Singapore
- Nexus International School (Singapore) Makerspace and Fab Lab
  Singapore, SINGAPORE
- Fablab OMG | Makerspace@NDC Singapore
  Singapore, Singapore, Singapore

- SSC - DFS



- Community Makerspaces

SkillsCraft

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