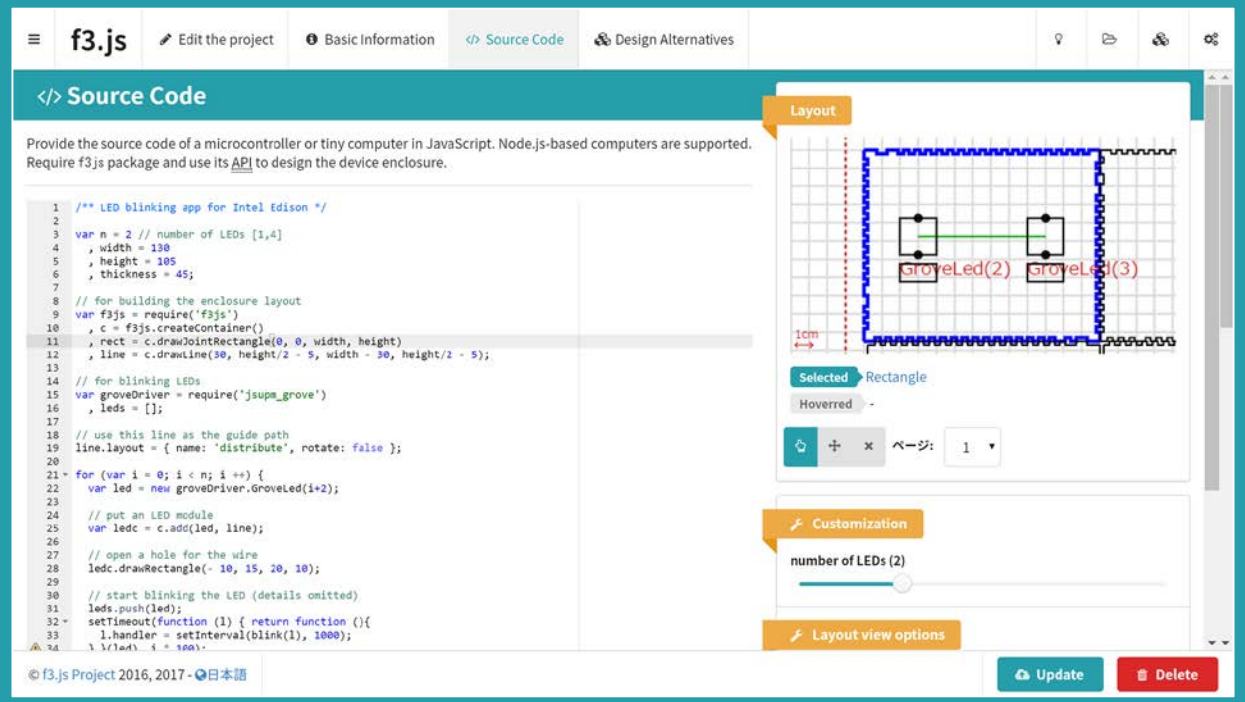
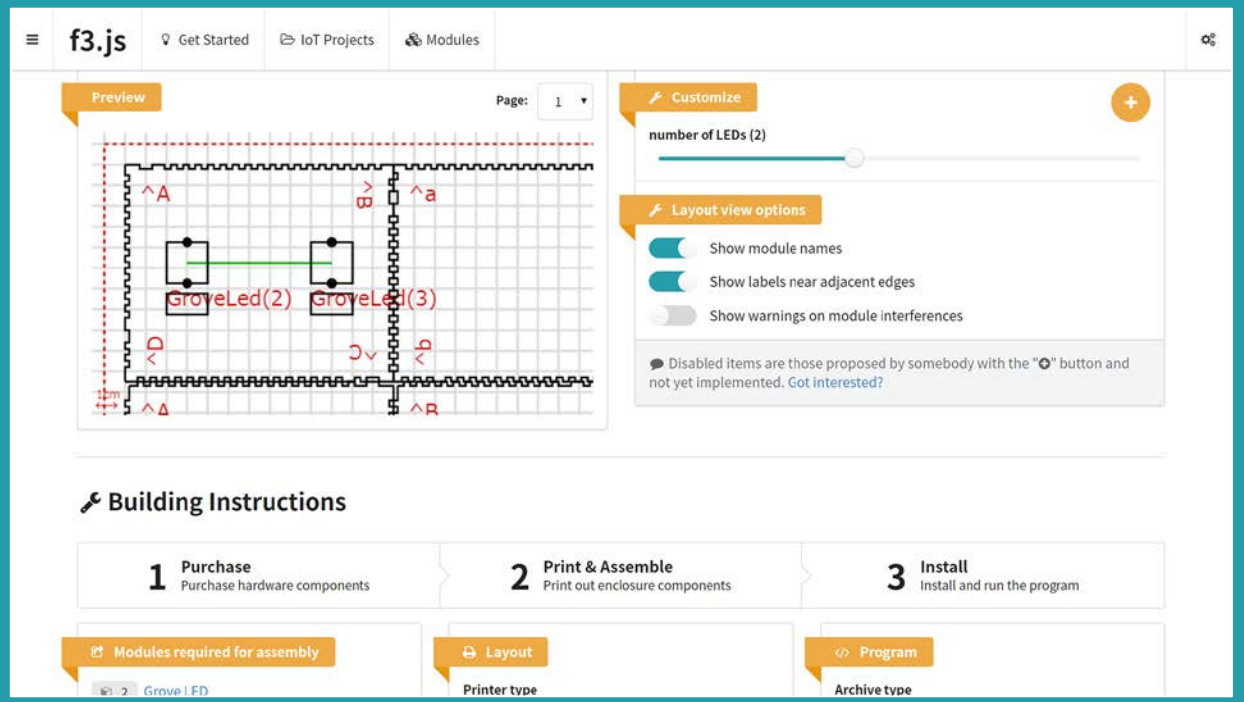
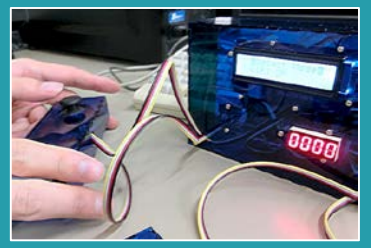
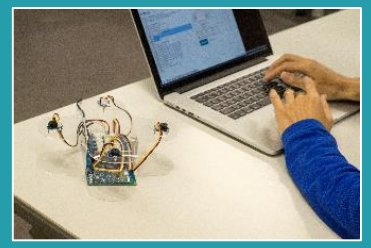
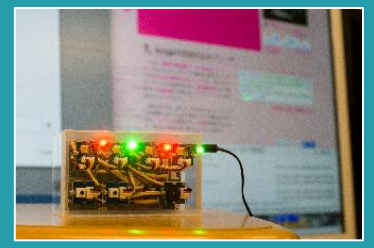
f3.js: A Parametric Design Tool for Physical Computing Devices for Both Interaction Designers and End-users











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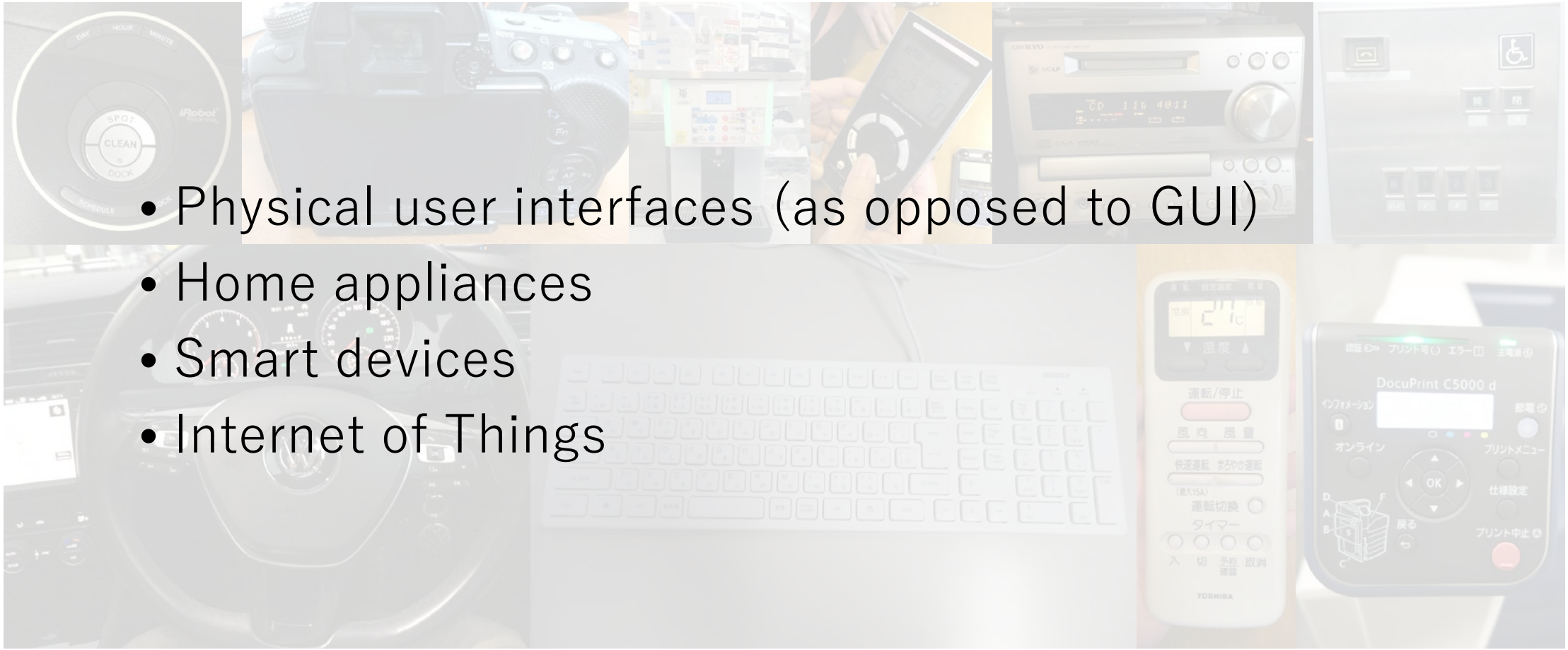
The presented system is publicly available at

http://f3js.org

Physical computing devices, everywhere

Physical computing devices, everywhere



- Physical user interfaces (as opposed to GUI)
- Home appliances
- Smart devices
- Internet of Things

Personal fabrication made easy

3D print in “Maker” venues

Photo taken by Atsushi Tadokoro (CC BY 2.0)
https://www.flickr.com/photos/tadokoro/5138646645

Soldering with parents

Photo taken by Mitch Altman (CC BY-SA 2.0)
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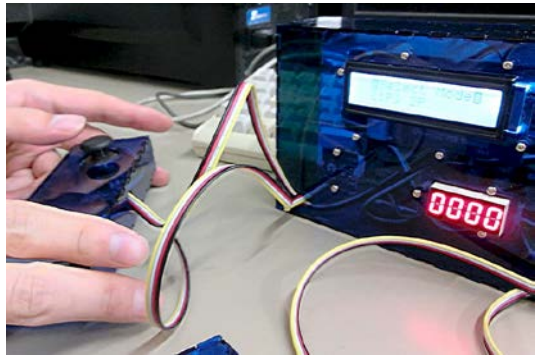
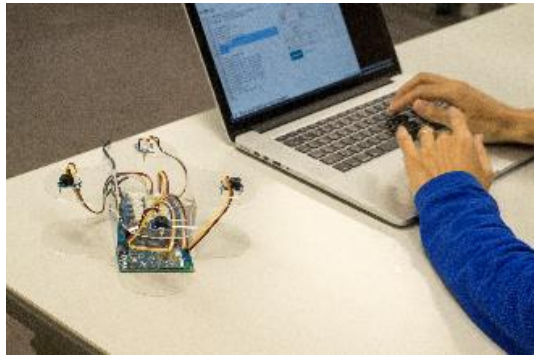
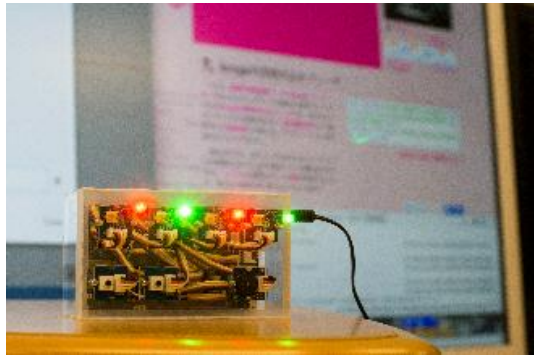
Working prototypes

How about device programming & assembly?

Research questions
regarding physical computing devices

For interaction designers

- How can we support prototyping of the devices?

For end users

- How can we support personal customization of the devices?

Preliminary observations:
photos of 200 devices and informal interviews


Last minute additions


エレベータ (4)


オーディオ機器 (28)


カメラ (4)


キーボード (6)


ゲーム機 (2)


コーヒーマシン (5)


プリンタ・プロッタ (11)


リモコン (28)


業務用機材 (18)


空調・照明 (22)


自動車 (3)


洗濯機・洗浄器 (7)


調理器具 (21)


電話機・キオスク (13)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20160811_145540111_iOS.jpg


20160904_165210408_iOS.jpg


20160919_054853044_iOS.jpg


20160923_040313503_iOS.jpg


WP_20160918_00_57_19_Pro.jpg

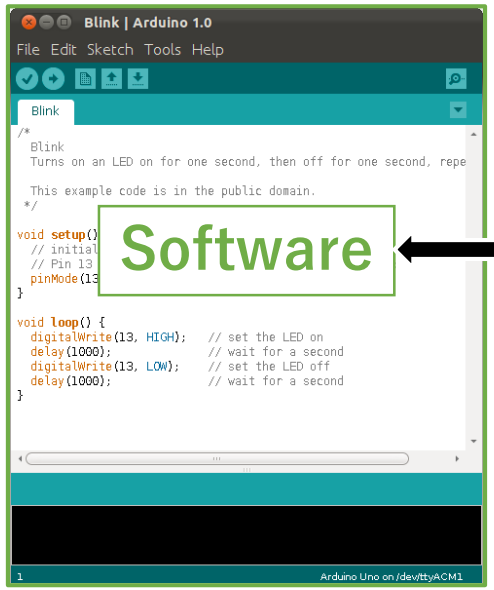
Design patterns in Physical User Interfaces

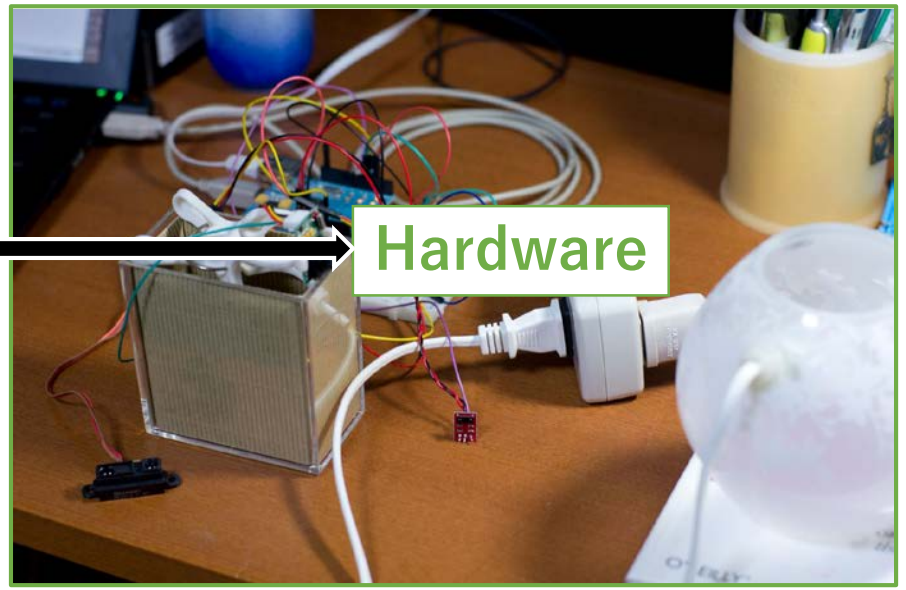
Line layout

Circle layout

- 187 devices have physical user interfaces on **planar surfaces**
- 139 devices have modules placed along **straight lines**
- 51 devices have modules placed on **circular paths**

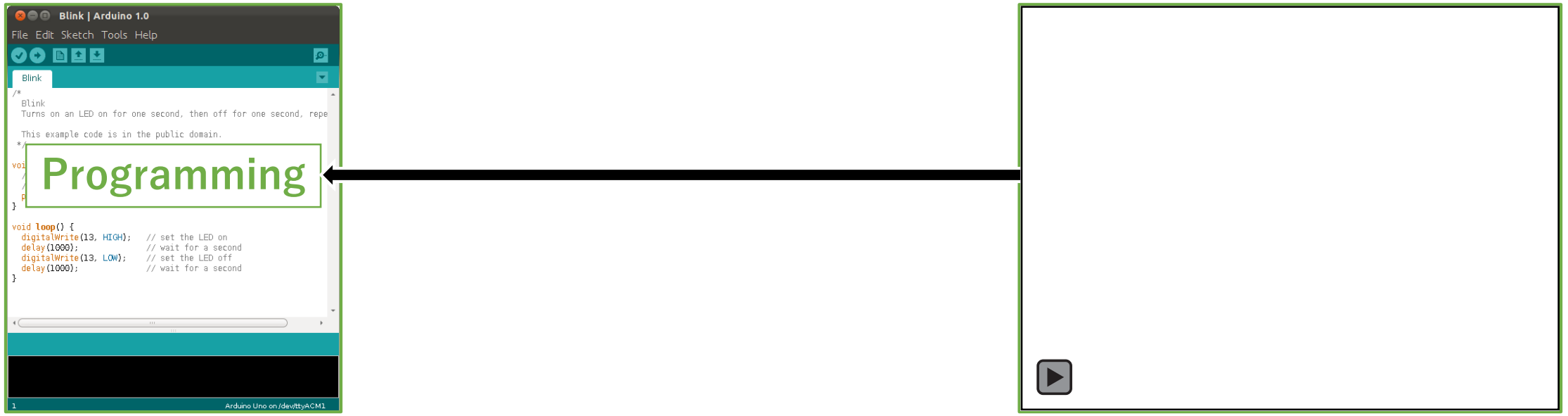
Mental gap between software & hardware





- Designers need to imagine hardware while writing code
- “`new Button()`” does not infer any hardware layout

Difficulties in exploring design alternatives



- **Expensive switching** cost between two activities in two tools
- Prior efforts in either one of these (software **or** hardware)

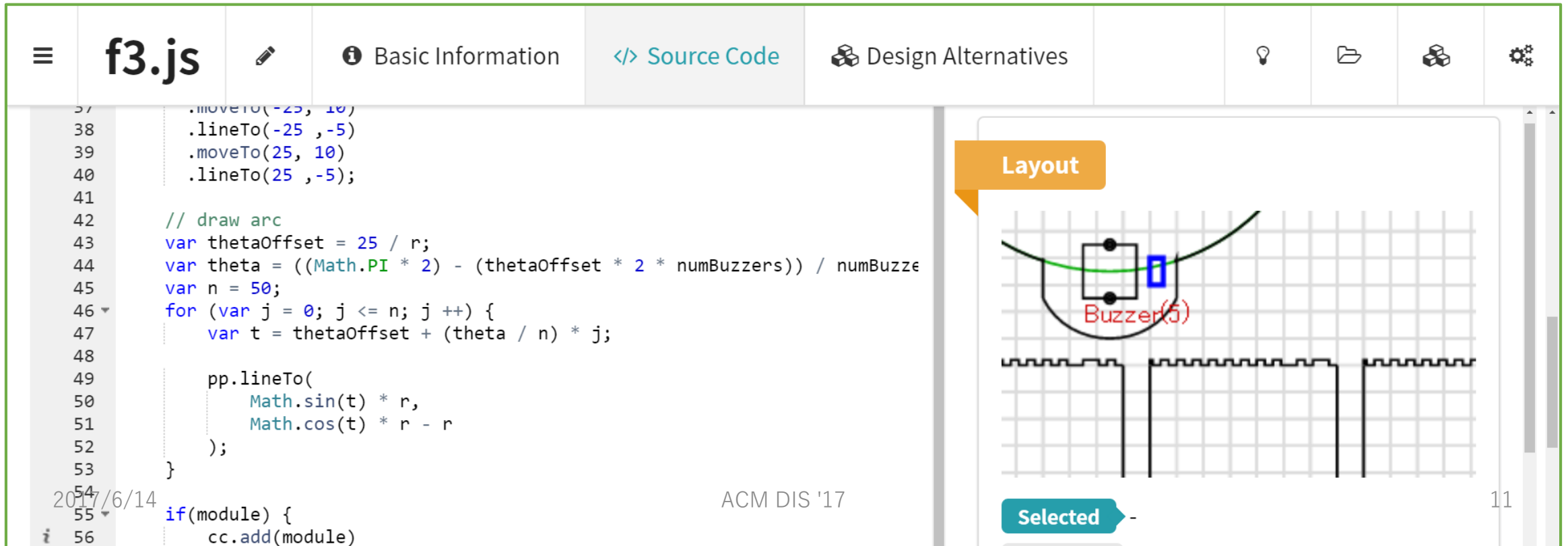
Preliminary observations (summary)

- Typical **design patterns** should have tool support
- **Mental gap** between software & hardware exists
- **Comparing alternatives** is crucial for good design

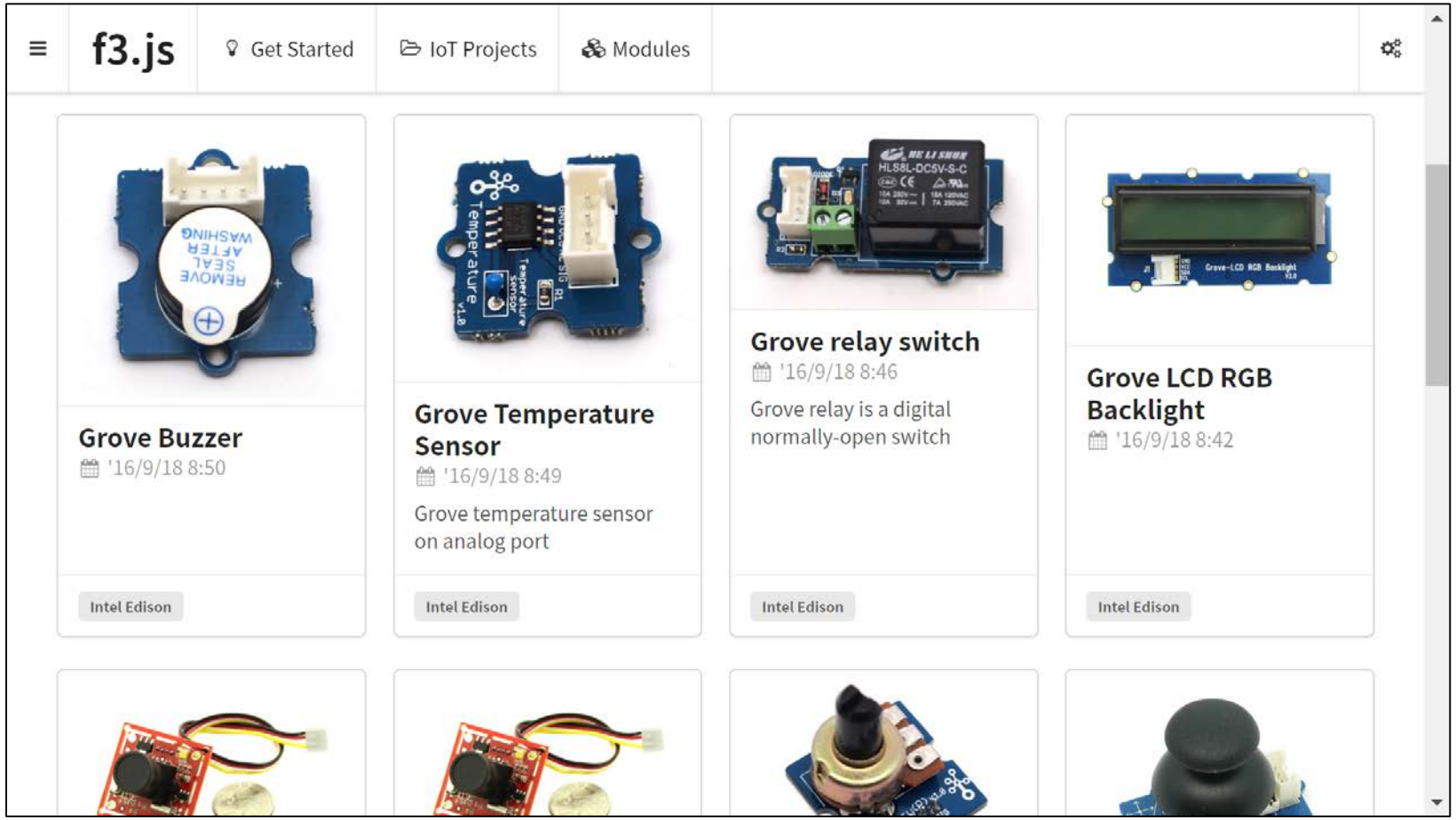
DEMO

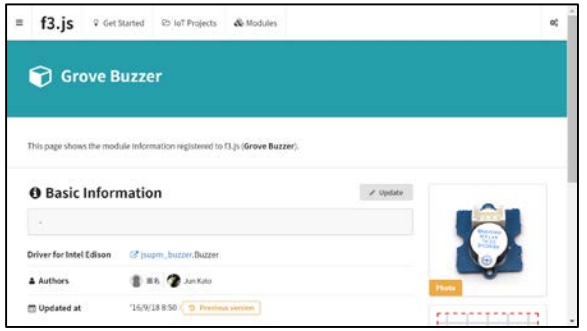
f3.js: integrated support for programmers

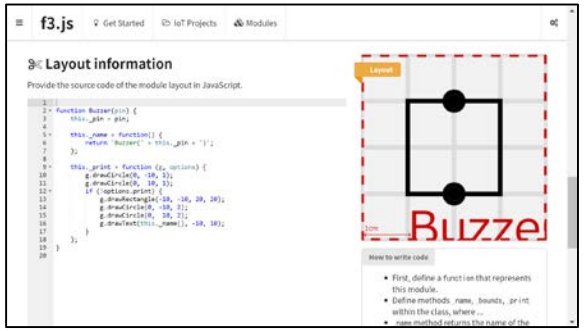
- **Live Programming with intuitive APIs** of features & layout
- Interactive development of IoT devices in **one environment**



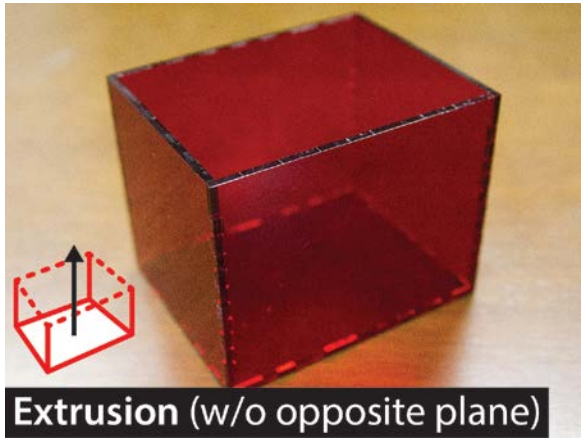
Module repository for hardware metrics



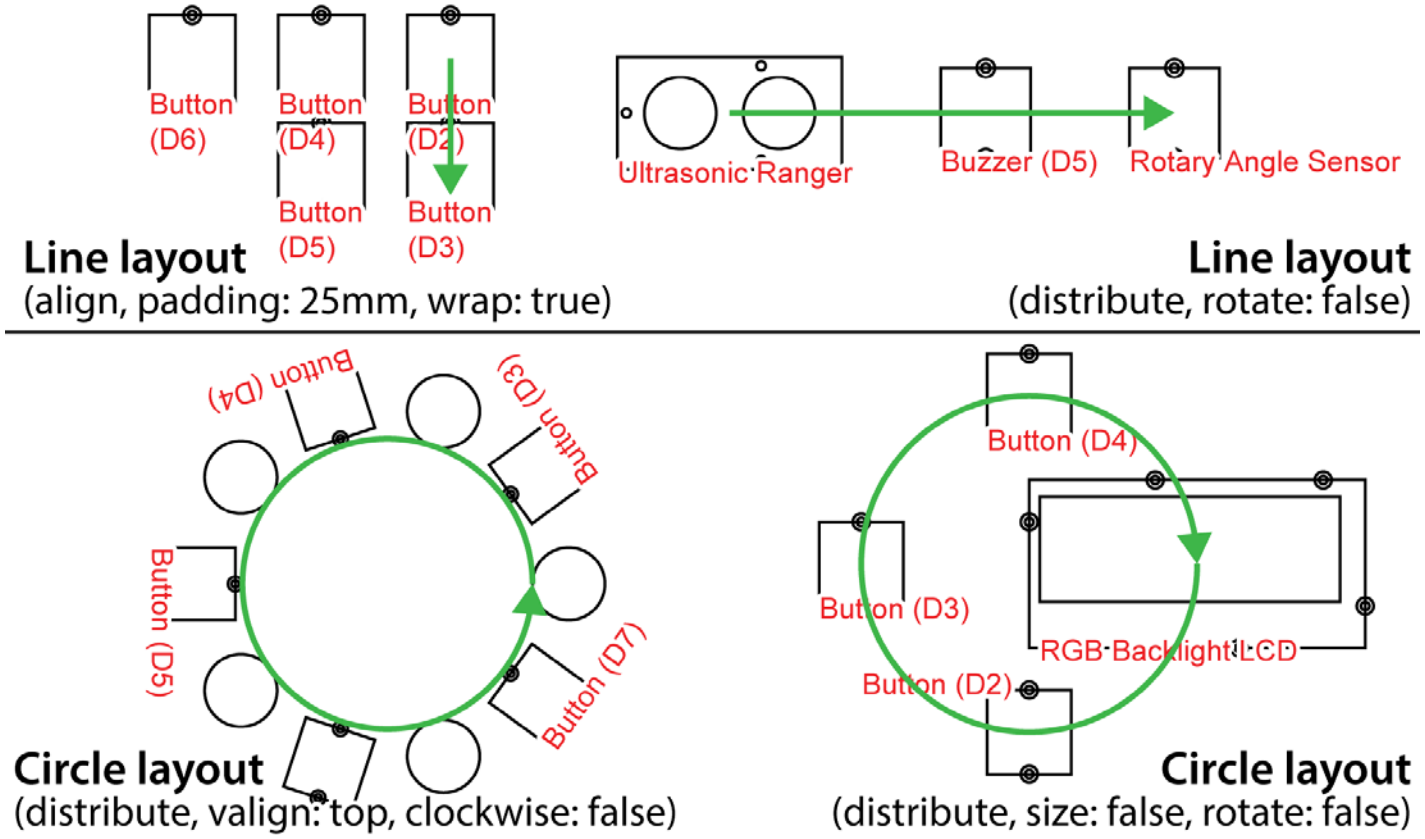




APIs for 3D extrusion and 2D layout



3D extrusion



2D layout

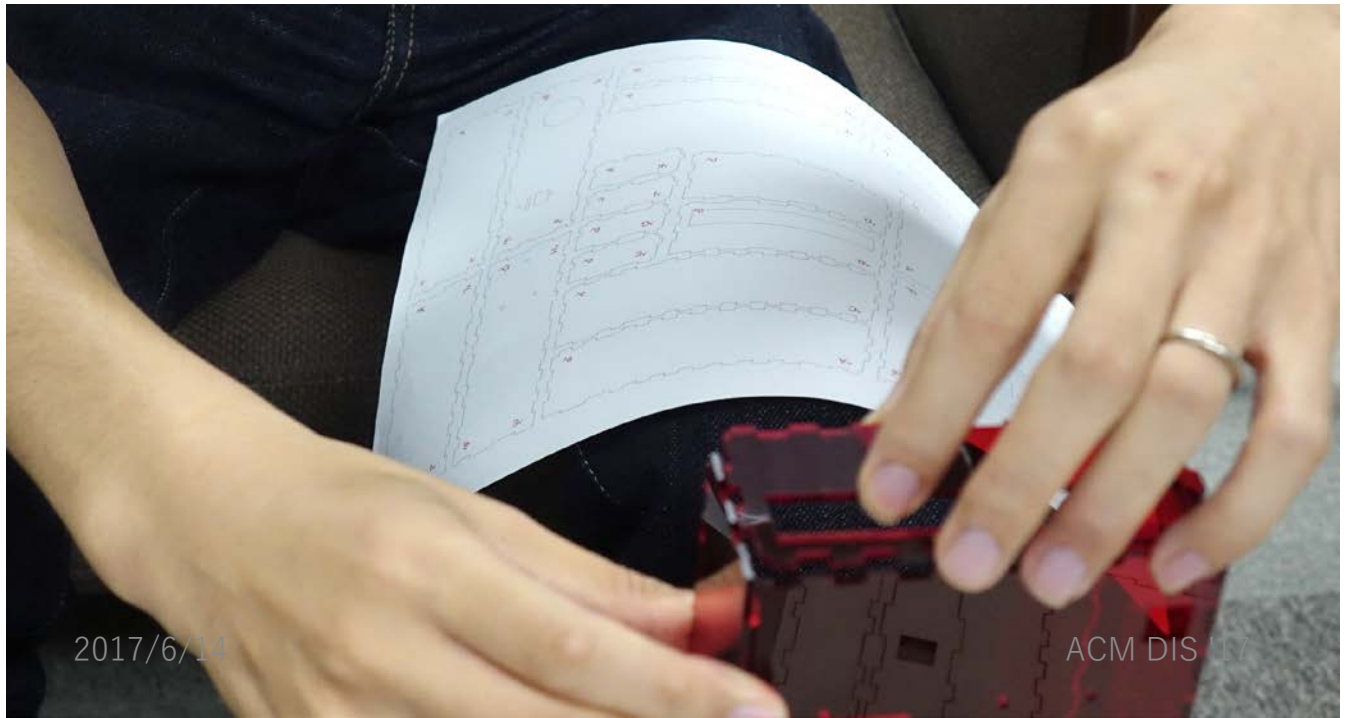
f3.js for parametric design of physical computing devices

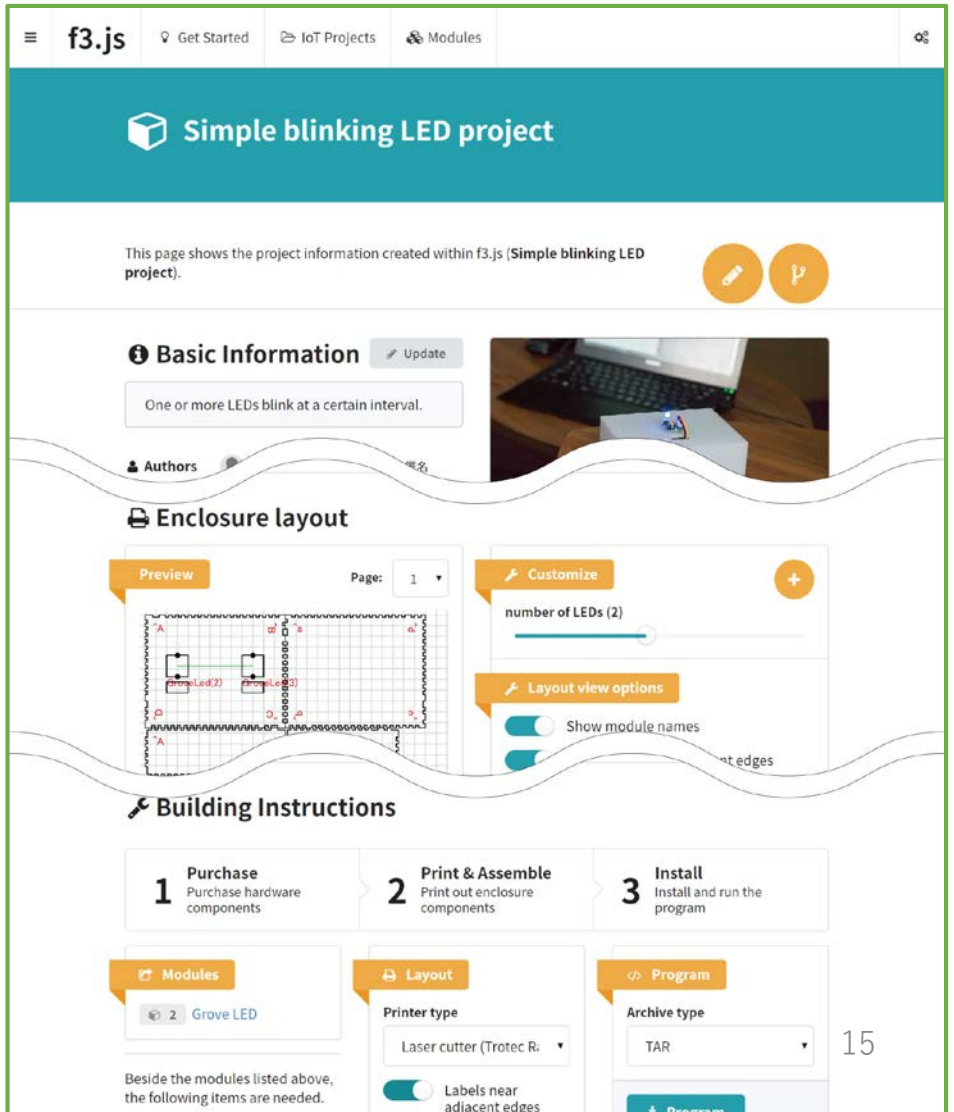
- Typical **design patterns** should have tool support ☑ supported
- **Mental gap** between software & hardware exists ☑ addressed
- **Comparing alternatives** is crucial for good design ☑ supported

DEMO

f3.js: customizing support for end-users

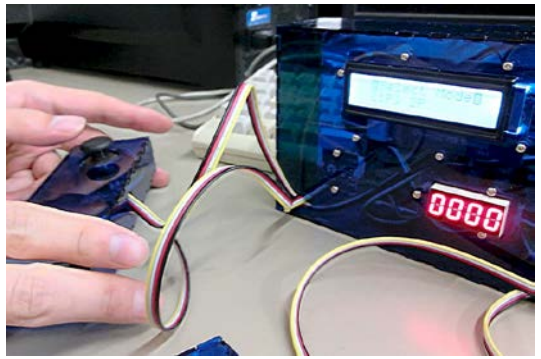
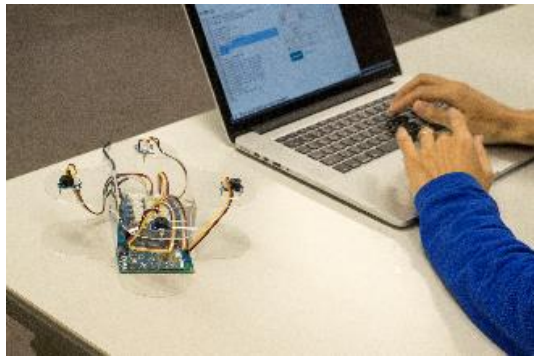
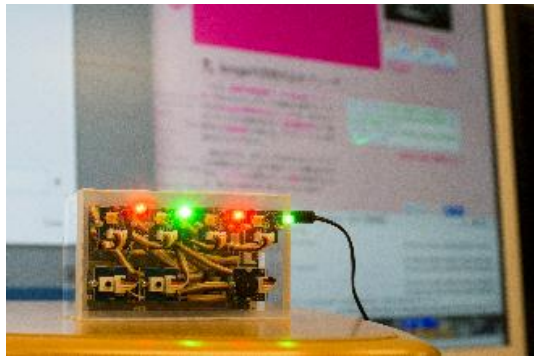
- **Interactive UIs** for customization
- Automatic generation of **device building instructions**





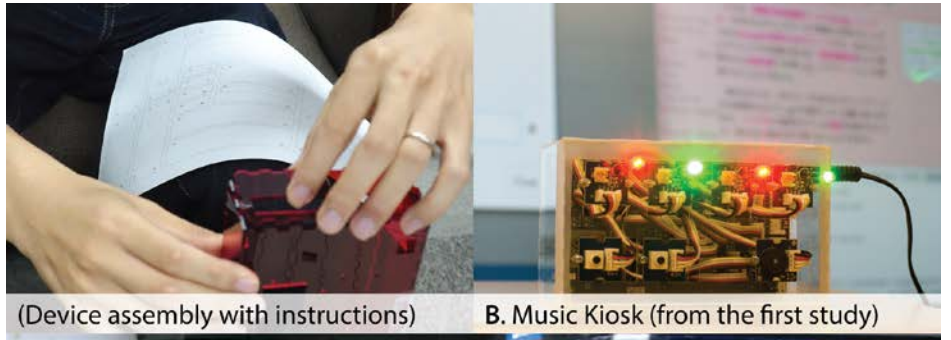
User studies

- 14 teams to create physical computing devices with f3.js
  - 5 interaction designers and 16 university students
  - Intel Edison and Grove modules, acrylic panels and screws provided
- 3 interaction designers and 3 end-users with revised f3.js
  - 3 interaction designers asked to create parametric designs
  - 3 end-users asked to customize and assemble devices

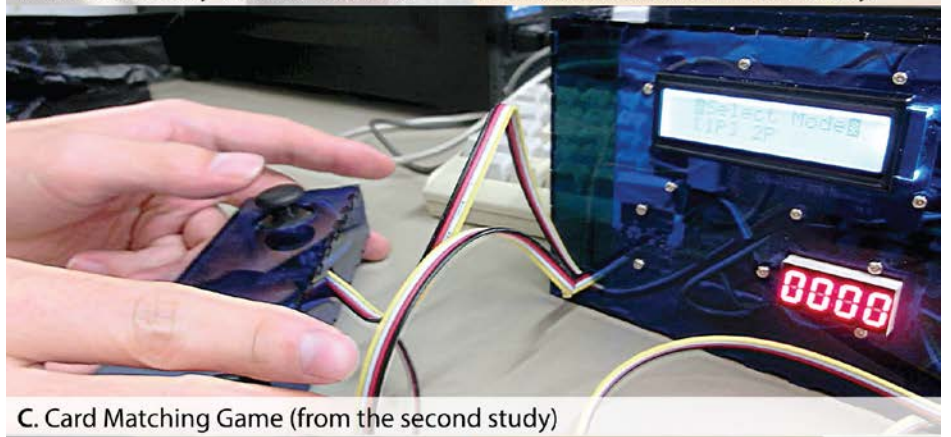





User studies:
results & discussions

- Creativity support environments, not tools
- 3D vs 2D layout managers
- Interface builders are important
- Code-centric tool complements to 3D modeling tools
- Domain-specific language support (like HTML)

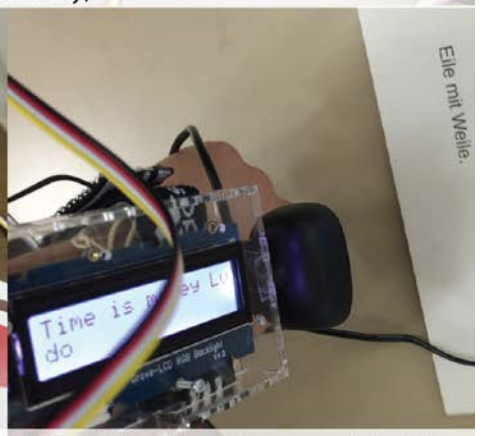

(Device assembly with instructions)

B. Music Kiosk (from the first study)



C. Card Matching Game (from the second study)

D. Rhythm Game (from the third study)



D. Translator (from the second study)

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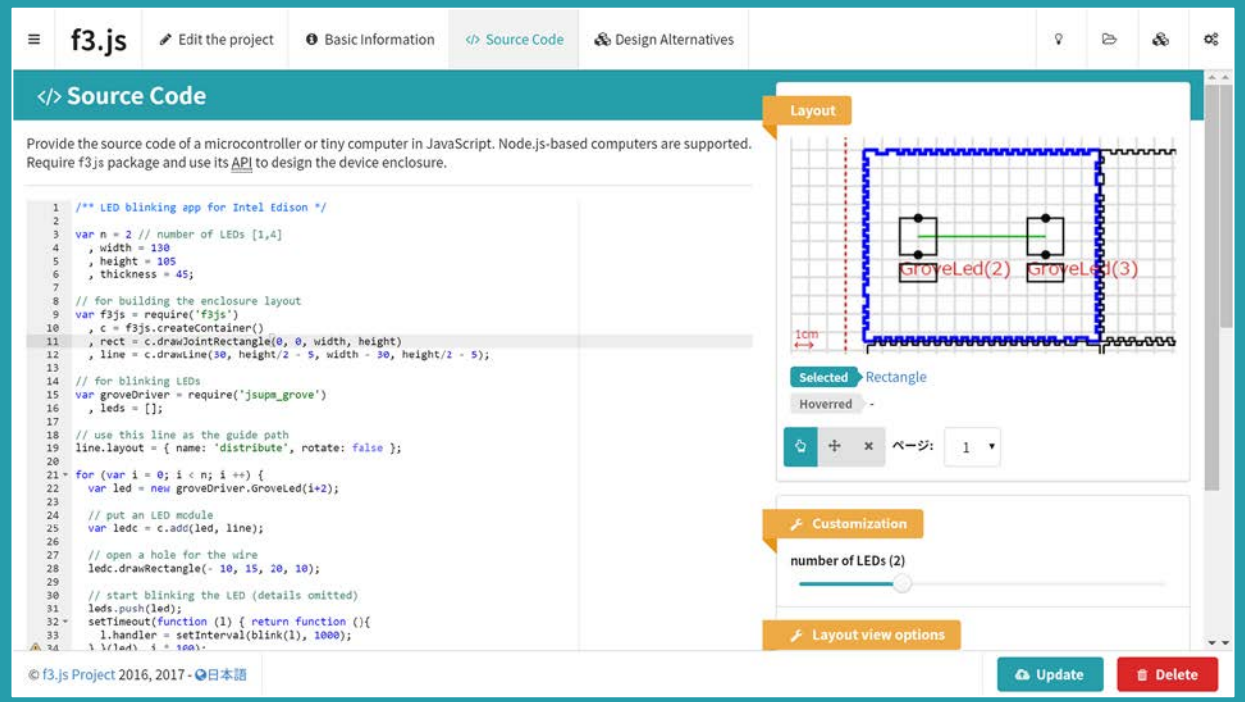

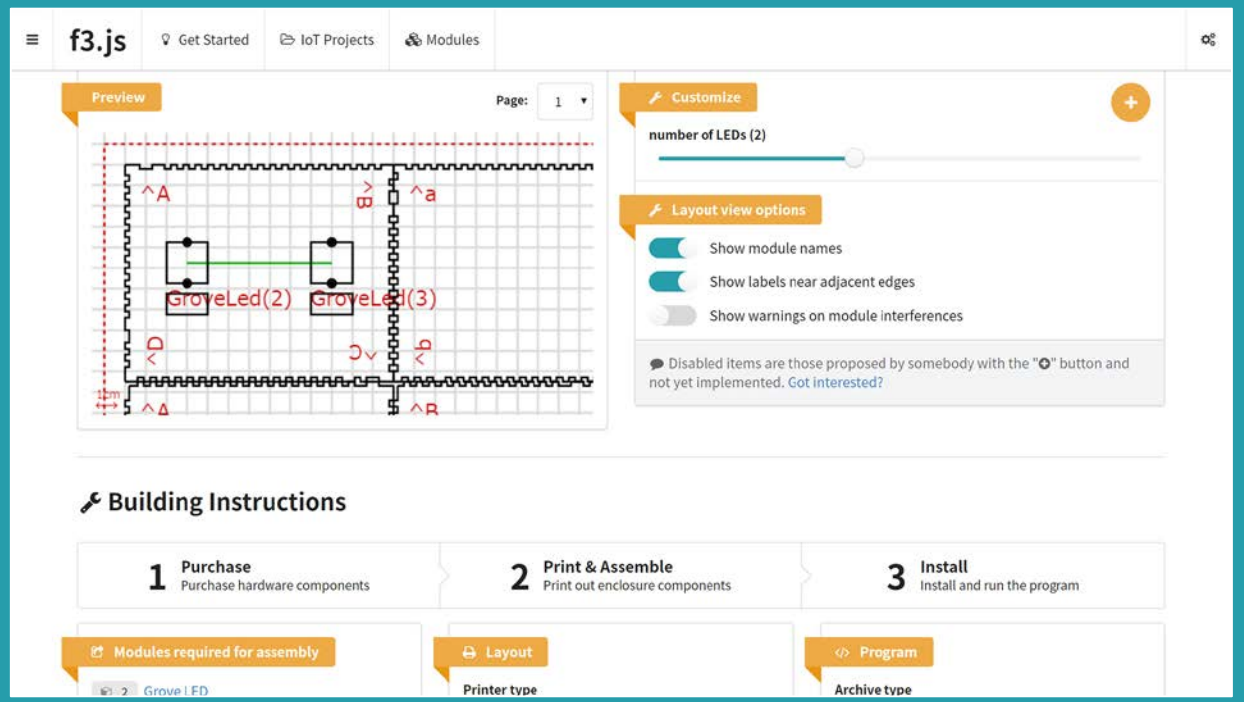

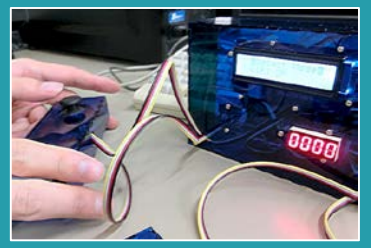

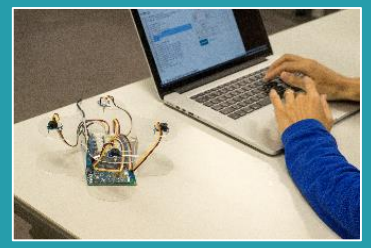

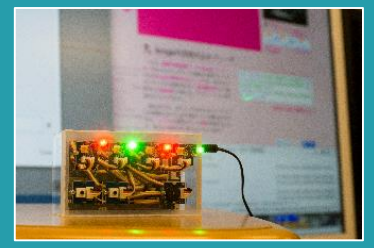

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