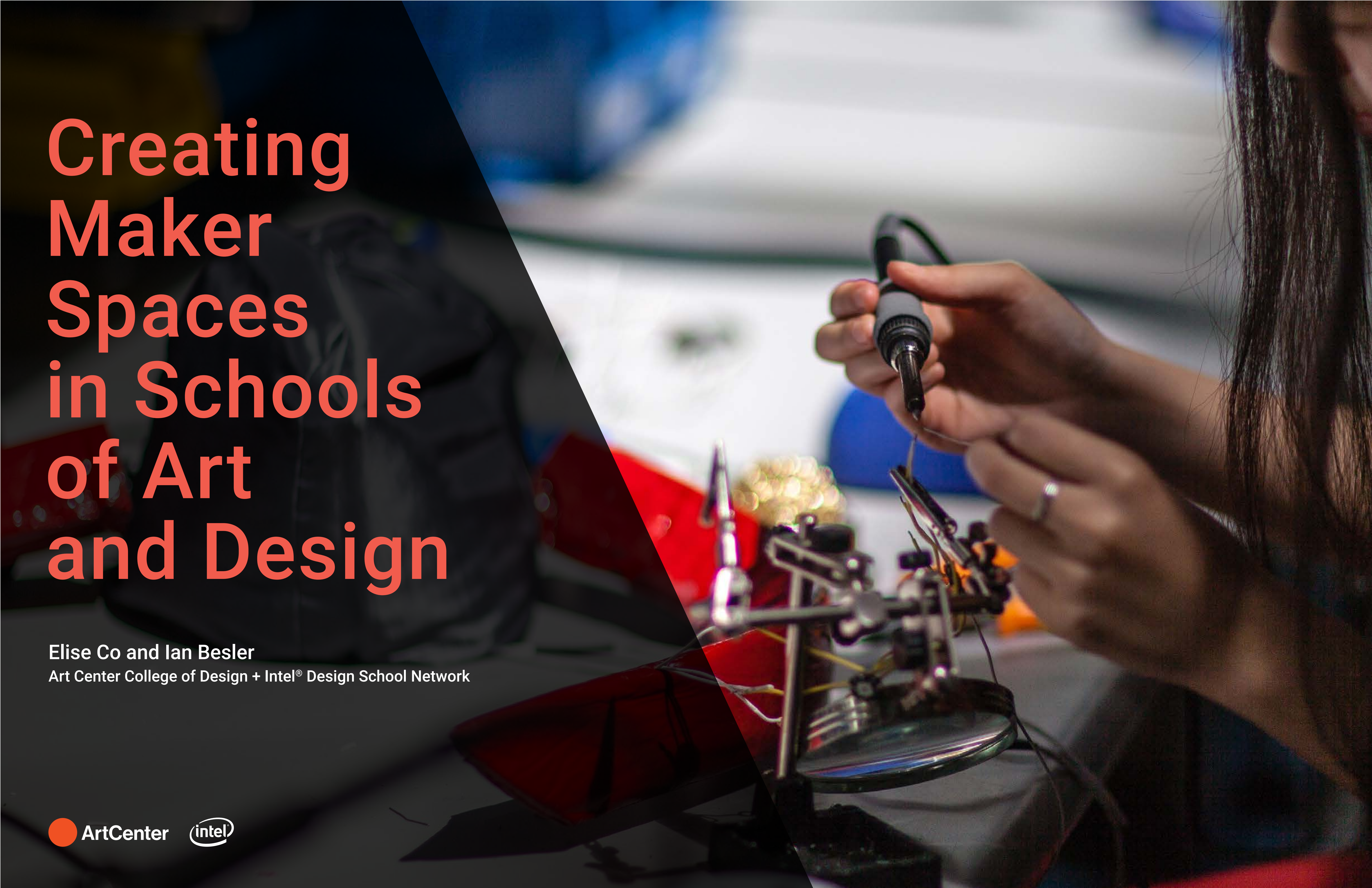
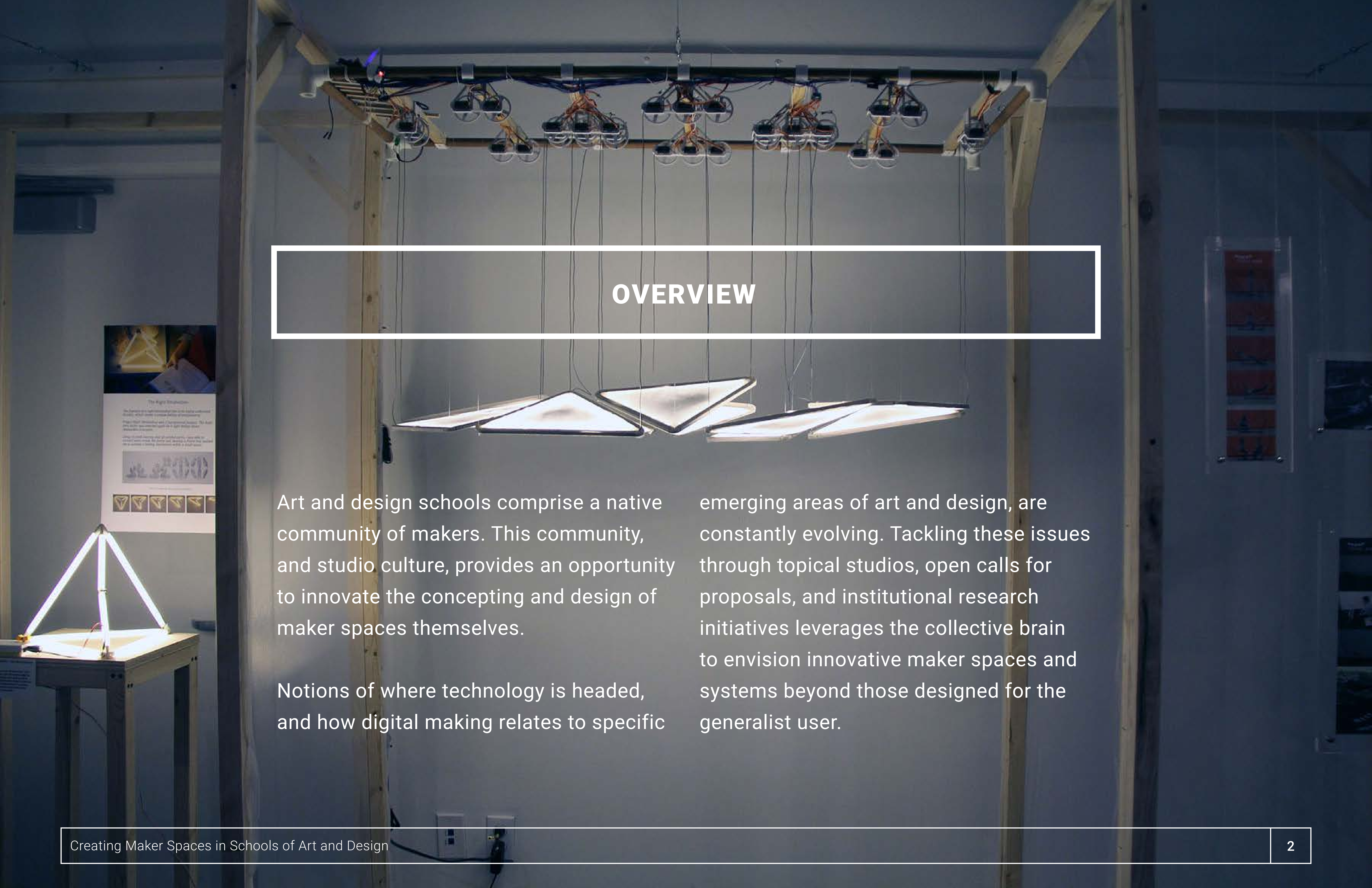


Creating Maker Spaces in Schools of Art and Design

Elise Co and Ian Besler
Art Center College of Design + Intel® Design School Network

ArtCenter intel



OVERVIEW

Art and design schools comprise a native community of makers. This community, and studio culture, provides an opportunity to innovate the concepting and design of maker spaces themselves.

Notions of where technology is headed, and how digital making relates to specific emerging areas of art and design, are constantly evolving. Tackling these issues through topical studios, open calls for proposals, and institutional research initiatives leverages the collective brain to envision innovative maker spaces and systems beyond those designed for the generalist user.

Art and Design schools are already centers for making which presents unique challenges and opportunities for the integration of digital making.

The maker space, forged out of DIY and engineering cultures is built upon different traditions.

Unique challenges

- Individual disciplines have their own workflows, skillsets, and approaches to making.
- The craft and making traditions of each discipline may contradict the processes and attitudes of digital making.
- Resources for making may be siloed by discipline.

Unique opportunities

- Digital making can be embedded within multiple media, making practices, and processes.
- The maker space itself can be designed by its own community of users.

Maker Spaces can make technology accessible to non-experts - allowing artists and designers to work in new ways.

Training and peer-to-peer learning are a major part of a maker space's function, even outside an academic context. Maker spaces are designed for a range of users from the novice to the expert.

Hi-Tech

- State-of-the-art, cutting edge, exclusive
- Commercial-grade, expensive
- Requires safety protocols, lock-outs, protective gear

Low Tech

- Accessible
- Consumer-grade, affordable
- Easy to learn, STEM/STEAM-oriented

Digital making can play a role within a range of art and design making practices.

Production

Highlights refinement of formal design, fidelity, and quality of form and finish. Often informed by industry standards. Requires explicit training, learning, and time.

Prototyping

Making as an intermediary step in the iterative design process; meant to be evaluated, revised, and redone. Focus is on testing or demonstrating particular aspects of use.

May range from low to high fidelity Requires persistent setup and storage to enable iteration. Deployment spaces, areas set-aside for testing.

Experimentation

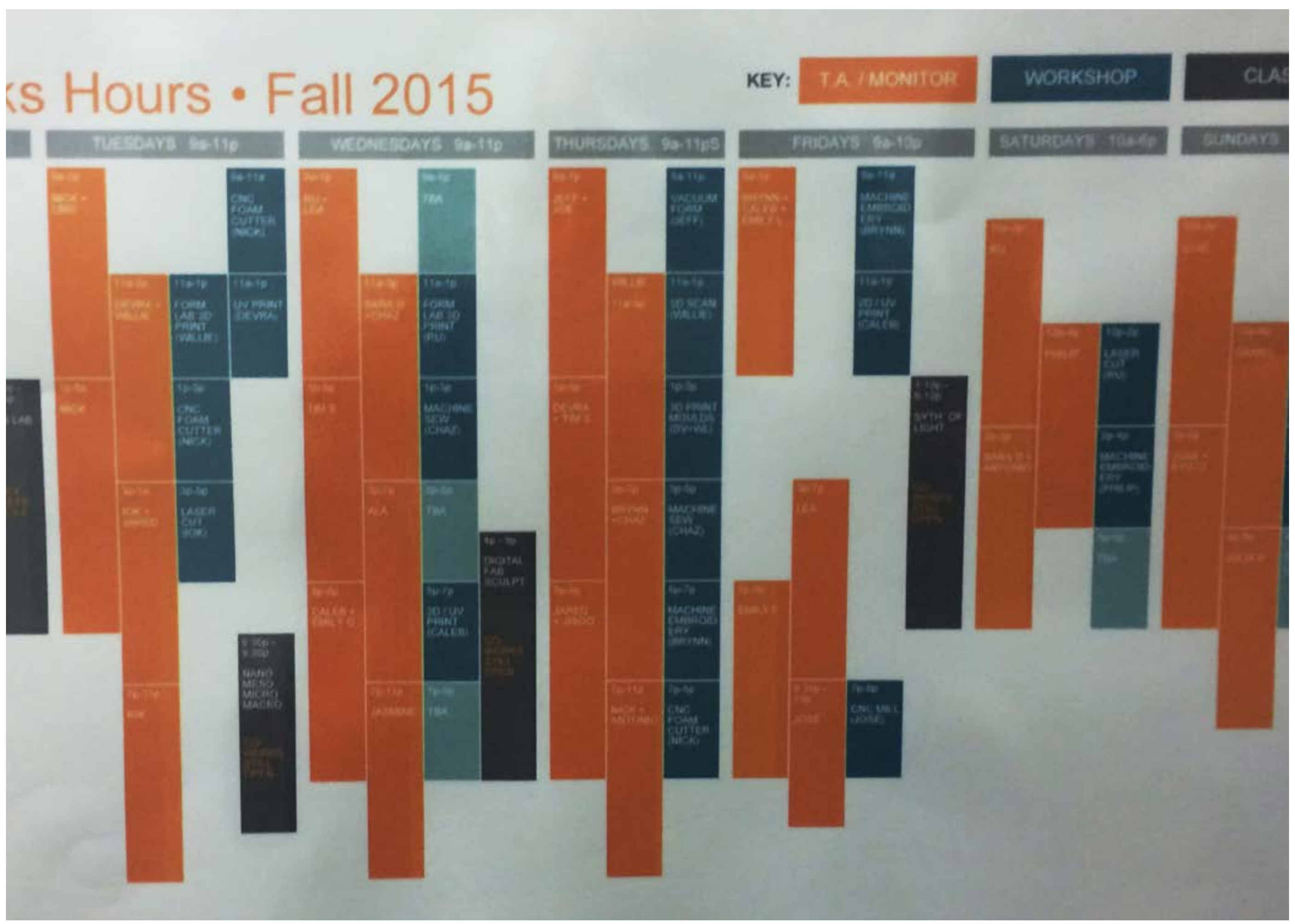
"Playing around" without a particular endpoint in mind, to "see what happens." Includes testing and developing techniques and processes.

Proximity or co-location of different types of making/materials. Possibility of being wet, messy, hazardous, etc.

Working Knowledge

Engaging in a making process enough to be able to work, appreciate, and communicate knowledgeably with future collaborators in the area.

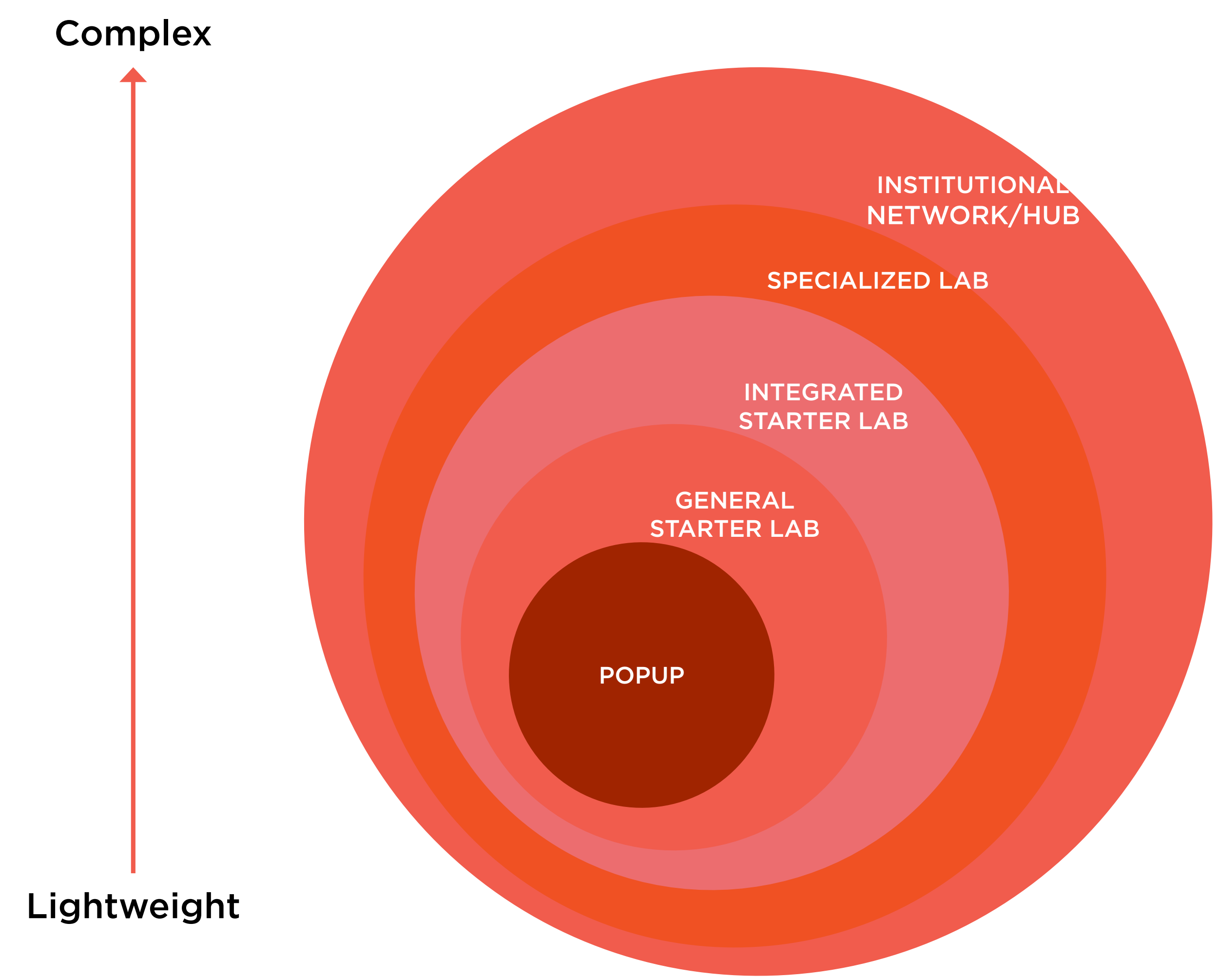
Maker Spaces are ecosystems that depend as much on community, staffing and programming as technology and equipment.



Integrating a maker space into the making culture of an art and design school is best done iteratively, allowing it to grow organically in response to evolving community needs. For maker spaces at all scales, the patterns of use – from bottlenecks to improvised workflows – are data for continuously innovating program and process.

Maker spaces can work at a variety of scales, from a single cart to an institution-wide network.

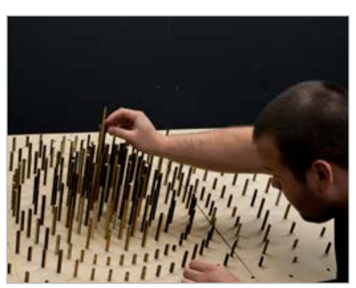
The most successful ecosystems develop organically over time, not through top-down design. Therefore, this report encourages working from the bottom-up by putting the pieces in place for a space to grow, and looking for the moments of inflection that indicate a space/initiative that is ready to transition to another scale.



At Art and Design Schools, maker spaces are great design projects.

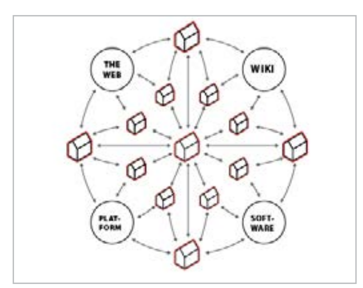
Graduate Transportation UX Studio
Art Center College of Design

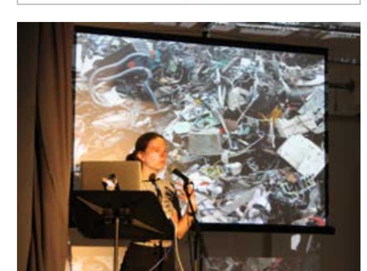
- Brief: Development of concepts and designs for vehicular interior "simulator" / prototyping platforms
- Redefinition of the established notion of a "simulator," moving from quantitative data collection to qualitative (but rigorous) observation and experience
- Research and analysis including proposal for industry partnerships and system models for implementation and use
- Positing the simulator not as a means of end-testing design, but as the site for the design process itself, with prototyping as a fundamental component
- Maker space results: modular systems of UX simulations including screens, projection, physical user interface inputs and outputs, and enclosed vehicular interior



Future Makerspaces
Royal College of Art

- Visioning for future makespaces and their role in distributed manufacturing
- 2-year research initiative
- Includes all stakeholders in the value chain: equipment suppliers to product manufacturers, end-users, and the broader community
- Symposia, workshops, and funded feasibility projects
- Maker space results: Circular Makespaces address issues of materiality, reuse, and repair (link)
- Maker space results: Deals with maker spaces as individual entities; local networks; digitally connected networks; and national/international phenomena





Beyond the "starter" maker space, which is fast becoming a fundamental need, there is a real design challenge and opportunity to define next-level maker spaces, including: systems and networks of multiple spaces and labs for highly specialized types or modes of making.

About this Report

In 2015 Intel® funded a study into the unique challenges of maker spaces in art and design schools, environments that see themselves as the natural home of "making" of all kinds.

Research began at Art Center College of Design as a home base and primary in-depth case study. At Art Center, departments have strong identities and well-established methodologies, practices and approaches, many of which are strongly informed by industry. Various levels of technological making exists among departments, from very defined workflow to open-ended/experimental. The school is entering an era of expansion with an ambitious Master Plan, and aiming for more cross-departmental resources and cross-pollination through the establishment of a network of maker spaces.

Maker spaces outside of the educational context were also surveyed, with a particular focus on exploring different models of programming, membership, and funding. What each space had in common was the use of making as a design TOOL (not product), and a preoccupation with how to be self-sustaining: financially, and in the cultivation of a strong enough user base to support and justify the maker space's existence.

Training and education was a large part of each space's function, although not all were in an academic context. Most aimed, as an explicit component of their mission, to make technology accessible – not just physically, but functionally.

More than the particulars of physical space and equipment, we found that the most essential element of a successful maker space was its community and the ecosystem of users (both learners and leaders), programming, and curriculum.

Integrating digital making into the established making traditions of art and design can lead to exciting hybrids and interdisciplinary collaborations. What follows are guidelines to help others determine the right scale, model, equipment, and philosophy to build a maker space unique to their home institution.

Contents of this report

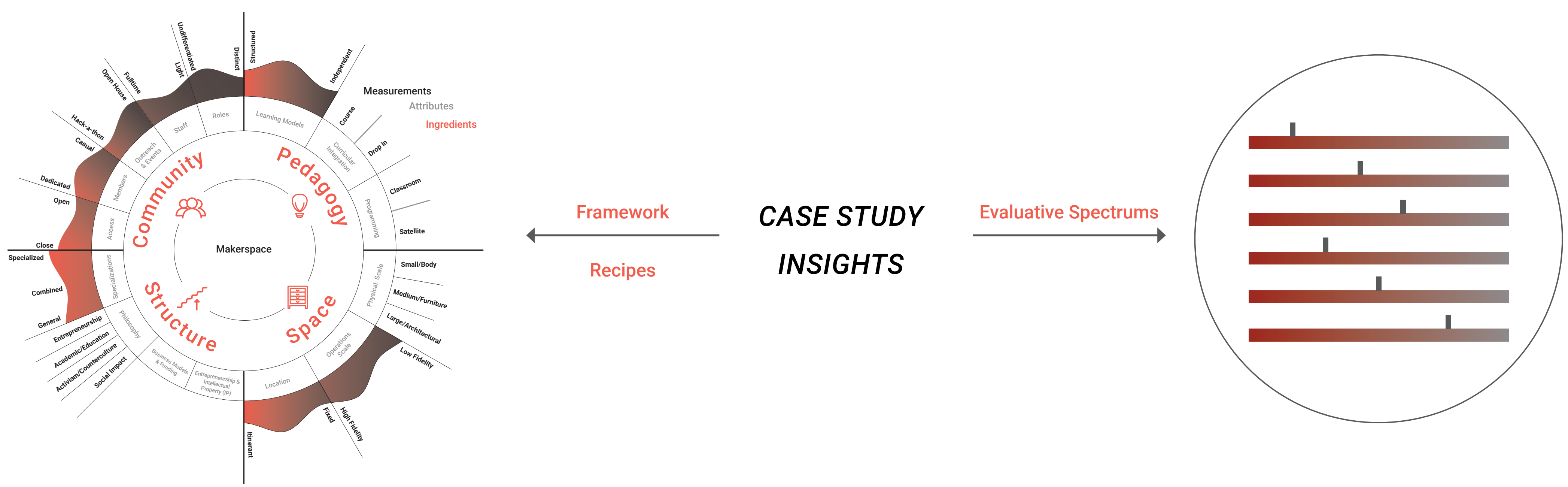
How to use this report

We have organized this report around what we see as the primary "ingredients" that go into a maker space: community, structure, space, and equipment. Pedagogy is also a primary ingredient that is specific to maker spaces in the art and design school context. We break each ingredient down further into key attributes.

There is no generic "optimal" setting for each factor; how a space fulfills a certain factor is highly context-specific. Our Case Studies hint at how particular combinations of factors result in spaces with very specific characteristics.

Our Recipes formalize some of the patterns and mechanisms we saw across multiple case studies; configurations of design factors that allow a certain activity to be performed, or a need to be met.

In general, but for a design school in particular, there is a progression from ad-hoc making to more established, dedicated, and staffed spaces. Depending on the existing level of interest and established maker space we offer several models: The Pop-Up; the Starter Lab; the Integrated Lab; and the Institutional Network.



CASE STUDIES

Makerspace	Noisebridge	Techshop	Autodesk Pier 9
	2007, San Francisco	*2006, San Francisco*	*2013, San Francisco*
	http://www.noisebridge.net	*http://www.techshop.ws/*	*http://www.autodesk.com/pier-9*
Summary	• Truly open access, includes set procedure for anyone present in the space to buzz people (anyone) in and orient newcomers • Stated orientation is "do-ocracy" and single rule is "be excellent to each other" • Actively used space at all hours, with diverse users. • Doctoral student in botany had built growing (plant) systems, was learning electronics from another member through collaborating on an automated living wall • Collective project to build a pic-n-place machine, acts as collaborative effort and also will be major equipment addition • Supports a tor server for access by journalists in censored countries	• Makerspace as commercial-level production facility/factory • Explicit entrepreneurial agenda • 24-hour staffed access • Leading for-profit makerspace, with robust membership, but explores multiple business models beyond membership • Equipment included extremely high-tech MagPrinter, for printing superstrong (and very technical and abstract) Polymagnets. The printer was provided by the manufacturer as a way to see what potential applications might be. • Open workspace area had lots of natural light and was very actively used	• Makerspace as interface between makers/artists and software company • Artist-in-residence program • Staff includes public programs manager • Most high-tech and well-equipped space surveyed • Artists in residence work on their own projects at Pier 9 and are required to post any work on instructables (owned by autodesk) • Pier 9 acts as a testing area for autodesk software • Autodesk employees also use Pier 9 for in-house product prototyping and personal making
Access:	Open	Open (fee-based)	Closed (invitation only)
Membership	Free/donation suggested	Fee-based	Artists-in-residence, staff
Involvement:	Dedicated	Dedicated	Dedicated
Roles:	Hybrid	Fixed	Hybrid
Staff:	Hybrid, volunteer	Fixed	Fixed
Support:	Unstructured	Structured, mandatory safety/equipment training	Structured, mandatory safety/equipment training
Outreach/Events:	Informal, unprogrammed, community TOR (anonymity network)	Programmed, open houses	Programmed (lectures, gallery exhibitions)
Specialization:	Hacking, electronics, hybrid/combined, member-driven	Machine tools, woodshop, digital fabrication	Hybrid/combined, member-driven
Philosophy:	Anarchist, hacker, collectivist, "Do-ocracy"	Commercial, entrepreneurial, maker culture	Maker culture, art practice, user-centered software development
Business Model:	Donations	Membership fees, corporate partnerships	Corporate funding (Autodesk)
Entrepreneurship/IP:	N/A	Support for small businesses	N/A
Curriculum Integration:	N/A	N/A	N/A
Learning Models:	Peer-topper, ustructured	Fixed, orientation classes	Peer-to-peer, unstructured
Programming	Informal, ask-for-help	Formal	Formal, orientation sessions
Scale of work:	Medium/desktop scale	Medium/desktop scale	Small/body scale, medium/desktop scale
Size:	3,000 sq. ft.	8,000 sq. ft.	12,000 sq. ft.
Permanence:	Fixed	Fixed	Fixed
Library:	Books, scrap electronics,	N/A (bookstore)	Books, materials
Virtual Space:	board games	Website, calendar	Website, Instructables
Lighting:	Website, Wiki	Ceiling lights, natural lights	Natural, ceiling lights
Storage:	Natural, ceiling lights, floor lamps	Lockers	Offices
Layout:	Small lockers, workspace, open plan	Workshop, workspace, open plan	Sectioned (shops, workspaces, offices)
Equipment:	• Woodshop (tablesaw, miter saw, drill, sander) • Three (3) 3D Printers • Garden area • Four (4) sewing machines • Scrap electronics area • SMT pick-and-place machine • Media production workstation • Library, board games • Tabletops, workstations, desktop computers, printers	• Manual mills, CNC mills, routers, metal lathe • MIG, TIG, gas, arc and spot welders • CNC plasma cutter • Oscilloscopes • Laser cutters / engravers • 3D printers • Industrial and consumer-grade sewing machines • Cutting table, work tables, desktop computers, large-format printers • Material shop (plywood, lumber, etc.)	• CNC machines • Waterjet • 5-axis router • 3D printers • Metal and wood shops • Electronics lab • Consumer-grade sewing machines • Work tables, desks, large format printers, desktop computers • Autodesk software • Kitchen

Makerspace

Noisebridge

2007, San Francisco

http://www.noisebridge.net



Techshop

2006, San Francisco

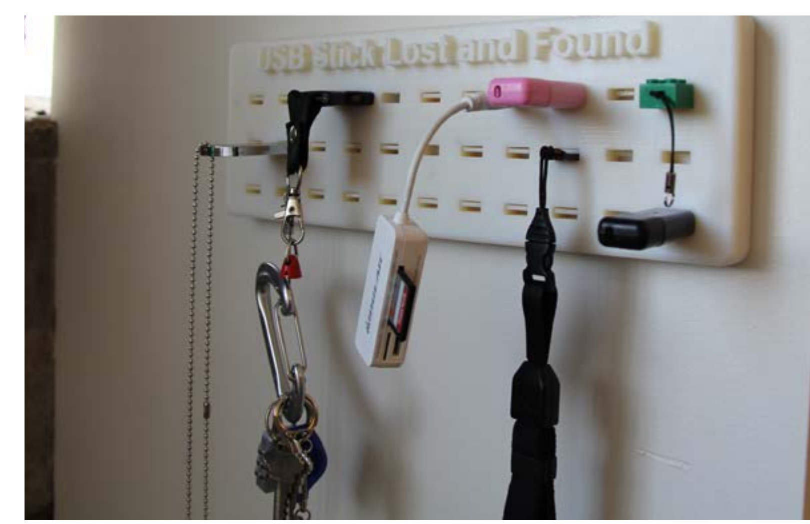
http://www.techshop.ws/


Autodesk Pier 9

2013, San Francisco

http://www.autodesk.com/pier-9





CASE STUDIES

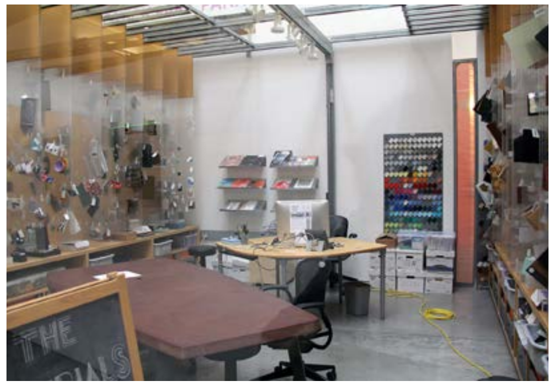
Makerspace	Hybrid Lab at CCA	The LAB (LA Biohackers)	Maker City LA
	2012, San Francisco https://www.cca.edu/about/administration/studio-resources/hybrid	*2010, Los Angeles* http://www.thel4b.com/	*2010, Los Angeles* http://makercityla.com/
Summary	• Multidisciplinary in academic context • Workspace/social space for students • Many of the most meaningful/high-impact decisions contributing to success of the space were in spatial details such as: table height; casters; light quality (higher brightness than usual) • Lab manager's (Andrew) open attitude and personality deemed a key factor in the success of the space and its community • Andrew also an active user of the space, building his own projects and posting tutorials on their development	• Makerspace as interface between general public and scientists • Platform for incorporating science into everyday life	• Makerspace as post-graduate resource for nearby schools (fidm, usc, etc.) • Neighboring communities such as usc and fidm (fashion institute) provide much of their user base • Different levels of membership: tenant, workspace memberships at varying access levels, single-day passes • Makerspaces (the sound and stage recording rooms, the sewing atelier) are a draw for the fixed tenants • Many staffing and tech support / consulting roles are filled by tenants • Will be the site of techshop la, in large part because of centrality and visibility of building in downtown LA
Access:	Closed (academic)	Open	Open (fee-based)
Membership	Students, faculty, staff	Free/donation suggested	Fee-based
Involvement:	Dedicated	Dedicated	Dedicated
Roles:	Fixed	Hybrid	Hybrid
Staff:	Fixed	Volunteer	Fixed, members
Support:	Unstructured, drop-in advisement sessions	Structured, ask-for-help	Structured
Outreach/Events:	Informal, unprogrammed	Programmed, meetups	Programmed, meetups, networking events
Specialization:	Hybrid/combined, member-driven	Biology, chemistry, member-driven	Hybrid/combined, member-driven
Philosophy:	Maker culture, electronics prototyping	Citizen science, D.I.Y. biohacking	Maker culture, entrepreneurship
Business Model:	N/A (academic)	Donations	Fee-based
Entrepreneurship/IP:	N/A	N/A	Support for small businesses, co-working spaces
Curriculum Integration:	Classes, extracurricular research, project development	N/A	N/A (General Assemblyeducation space on site)
Learning Models:	Traditional, peer-to-peer	Traditional, tutors, community liaisons	Unstructured, peer-to-peer
Programming	Informal, ask-for-help	Formal	Informal, ask-for-help
Scale of work:	Small/body scale, medium/desktop scale	Small/body scale, medium/desktop scale	Small/body scale, medium/desktop scale, large/architectural scale
Size:	1,000 sq. ft.	2,000 sq. ft.	500 - 2,000 sq. ft. (depending on office space)
Permanence:	Fixed	Fixed	Fixed
Library:	Electronics, manuals	N/A	N/A
Virtual Space:	Website, Instructables	Website	N/A
Lighting:	Natural, ceiling lights	Ceiling lights, desk lamps	Natural, ceiling lights
Storage:	Shelves	Shelves, plastic bins	Offices, lockers
Layout:	Workspace, open	Workspace, open	Offices
Equipment:	• Arduinos & shields • 3D printer • PCB mill • Multimeters, oscilloscopes • Power supplies • Soldering stations • Various electronic components (resistors, capacitors, LEDs, ICs, wire, etc.) • Tablets (iOS & Android) • Webcams • Microsoft Kinect	• Microscopes • Centrifuge • Electrophoresis gel box • Electrophysiology station • Gel documentation system • Electrophoresis power supply • Heating stir plate • Ventilation hoods • LED grow light panels	Media Lab • Podcasting studio • Green screen stage • Edit bays • Lighting, camera, audio equipment for rent The Atelier textile studio, display area • Sewing machines • Cutting tables • Forms • Spray booths TechShop workshop on-site (coming 2016)

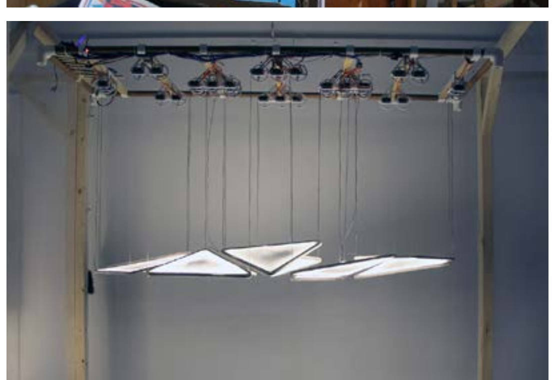
Makerspace

Hybrid Lab at CCA

2012, San Francisco

https://www.cca.edu/about/administration/studio-resources/hybrid





The LAB (LA Biohackers)

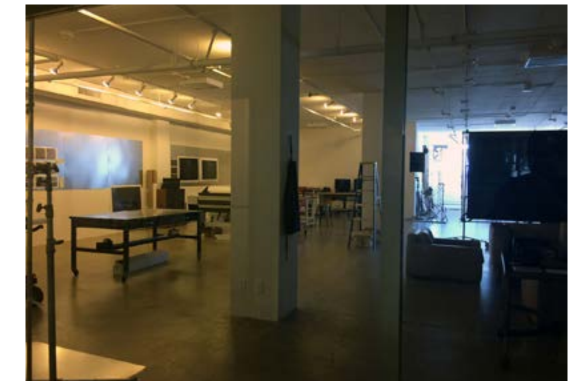
2010, Los Angeles

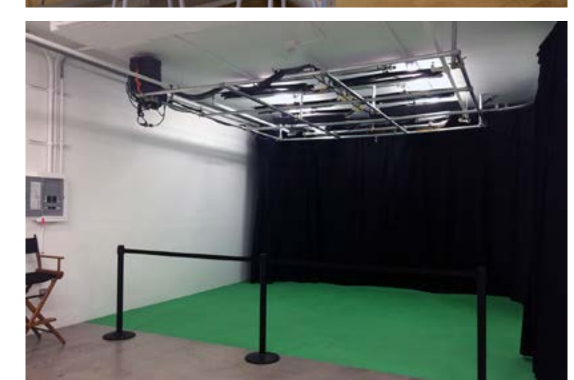
http://www.thel4b.com/

Maker City LA

2010, Los Angeles

http://makercityla.com/





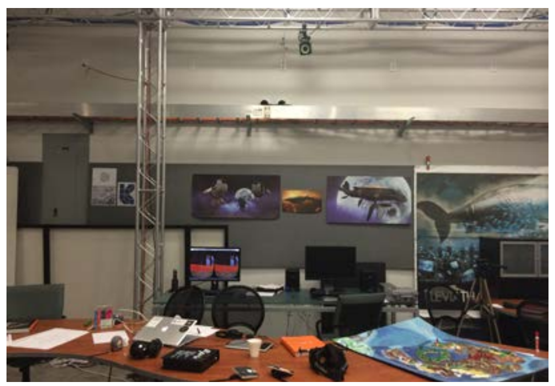
Makerspace	World Building Lab at USC *2014, Los Angeles* http://worldbuilding.usc.edu/	LA Makerspace *2012, Pico Public Library, Los Angeles* http://www.lamakerspace.com/	MDP Making Lab *2014, Pasadena* http://mediadesignpractices.net/
Summary	• Virtual reality stage • Making and fabrication in the context of cinema and filmmaking • World building a combination of film-related processes such as production design and narrative to inform experiential and systems design • More traditional "academic research lab" feel • desire for (but to date does not include) 3D fabrication resources for prop design etc • Highly specialized sub-spaces: stop-motion animation production "cube" with controllable lighting; and large-are interactive tracking + VR space	• Pop-up/nomadic makerspace • STEAM educational partnership with Los Angeles Public Library system • Scratch Squad programming team • Minecraft workshops	• Multidisciplinary in academic context • Workspace/social space for students
Access:	Closed (academic)	Open	Closed (academic)
Membership	Students, faculty, staff	Free	Students, faculty, staff
Involvement:	Dedicated	Casual	Dedicated
Roles:	Fixed	Hybrid	Fixed
Staff:	Fixed	Volunteer	Fixed
Support:	Structured	Structured	Unstructured, drop-in advisement sessions, workshops, etc.
Outreach/Events:	N/A	Workshops, classes, meetups	N/A
Specialization:	Media/game design	Computer programming (Scratch, Minecraft, etc.)	Hybrid/combined, student-driven
Philosophy:	Media production	STEAM (Science, Technology, Engineering, Arts, Mathematics)	Critical design, interaction design, electronics prototyping
Business Model:	Corporate partnerships	Donations	N/A (academic)
Entrepreneurship/IP:	N/A	N/A	N/A
Curriculum Integration:	Classroom and production space	N/A	Class workshops, extracurricular research, project development
Learning Models:	Traditional, structured	Traditional, structured	Unstructured, peer-to-peer
Programming	Curriculum, research	Curriculum, research	Informal, ask-for-help
Scale of work:	Medium/desktop scale, large/architectural scale	Medium/desktop scale	Small/body scale, medium/desktop scale
Size:	4,000 sq. ft.	N/A	1,000 sq. ft.
Permanence:	Fixed	Pop-up, nomadic	Fixed
Library:	N/A	N/A	Manuals, etc.
Virtual Space:	Website, virtual reality space	Website	Wiki
Lighting:	Ceiling lights, gantry lights	Ceiling lights	Worklights
Storage:	N/A	N/A	Tabletops
Layout:	Open, stage	N/A	Open
Equipment:	• Virtual reality stage • Media production workstation • Stop-motion photography space • Desktop workstations	• Laser cutter • 3D printers • Electronics (Arduino, etc.) • PC laptops • Arts and crafts supplies • Filmmaking studios	• Laser cutter • 3D printers • 3D scanner • Electronic components (Arduino, sensors, shields, resistors, capacitors, LEDs, ICs, wire, etc.) • Oscilloscope • Soldering stations • Machine tools • Power tools (cordless drills, sander, jigsaw) • Computers, displays, speakers, etc.

Makerspace

World Building Lab at USC

2014, Los Angeles

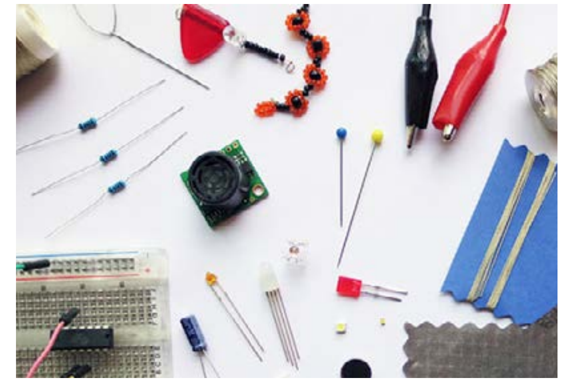
http://worldbuilding.usc.edu/



LA Makerspace

2012, Pico Public Library, Los Angeles

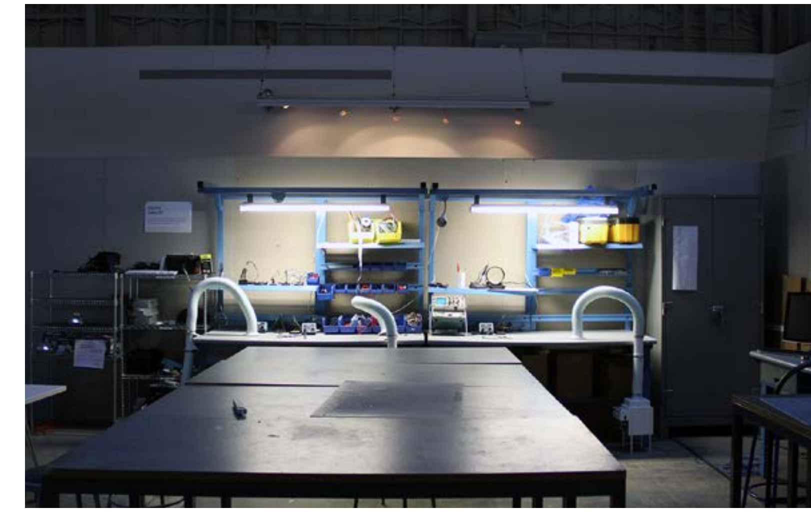
http://www.lamakerspace.com/

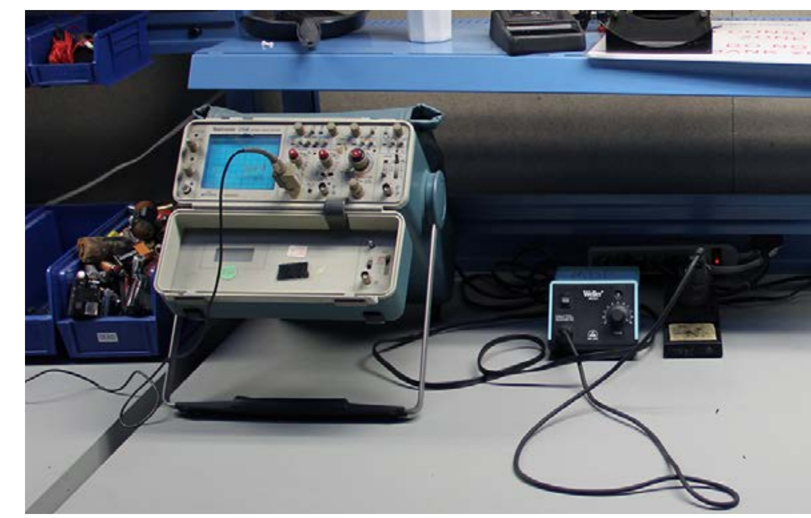


MDP Making Lab

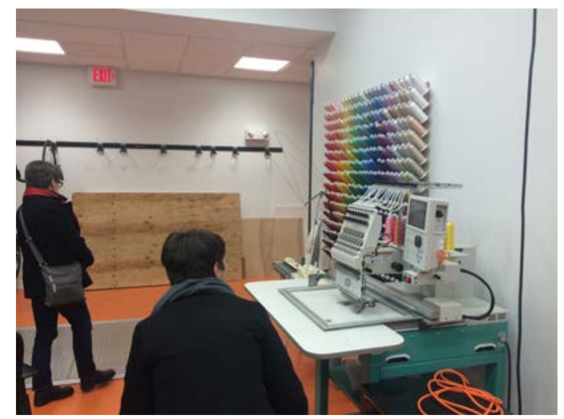
2014, Pasadena

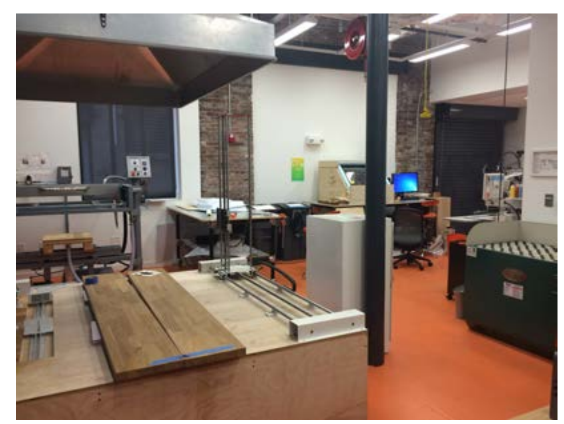
http://mediadesignpractices.net/

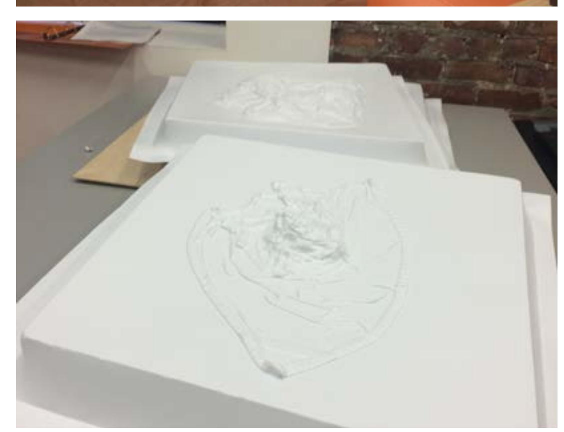




Makerspace	**Co-Works Lab at RISD** *Rhode Island* http://info.risd.edu/co-works/ http://academicaffairs.risd.edu/faculty-teaching/teach/technology/risd-co-works/ http://academicaffairs.risd.edu/2015/01/co-works-2015-projects/
Summary	• Interdisciplinary fabrication lab explicitly for fostering and hosting cross-departmental collaboration • Programming and access to lab done through open calls for proposals • Workshops, research and collaborative projects • Equipment includes 3D printing, 3D scanning, a range of CNC equipment, laser cutting, vacuum forming, machine embroidery and knitting, industrial sewing, foam cutting, UV and large format printing
Access:	Closed (academic)
Membership	Students, faculty, staff
Involvement:	Dedicated
Roles:	Hybrid
Staff:	Dedicated, semi-fixed (adjunct faculty, grad students, as needed)
Support:	Structured
Outreach/Events:	Open calls (to academic community) for project, workshop, and course proposals
Specialization:	General
Philosophy:	Cross-departmental collaboration
Business Model:	N/A
Entrepreneurship/IP:	N/A
Curriculum Integration: Learning Models: Programming	Structured but hybrid, open via calls for proposals
Scale of work:	Body, tabletop, furniture
Size:	N/A
Permanence:	Fixed
Library:	N/A
Virtual Space:	N/A
Lighting:	Ceiling lights
Storage:	N/A
Layout:	Open
Equipment:	• Embroidery machine • Knitting machine • Industrial sewing machines • UV and larg-format printer • 3D scanner and printer • CNC equipment • Laser cutter







GUIDELINES

Makerspace Ingredients

Community

The core community of a makerspace is its members and users. In some cases, staff or instructors provide guidance and support, either in fixed or flexible roles. In all cases, collaboration and peer-to-peer learning, networking, and outreach are key.

Structure

Philosophy, membership model, business model, and specializations.

Pedagogy

Makerspaces provide not just physical access, but also training and instruction on tools and technologies - either through formal instruction, demos, and workshops, or through collaboration among members.

Space

Choices about spatial layouts and arrangements and other environmental factors.

Equipment

Makerspaces provide access to tools and technology that would otherwise be outside the reach of the community.

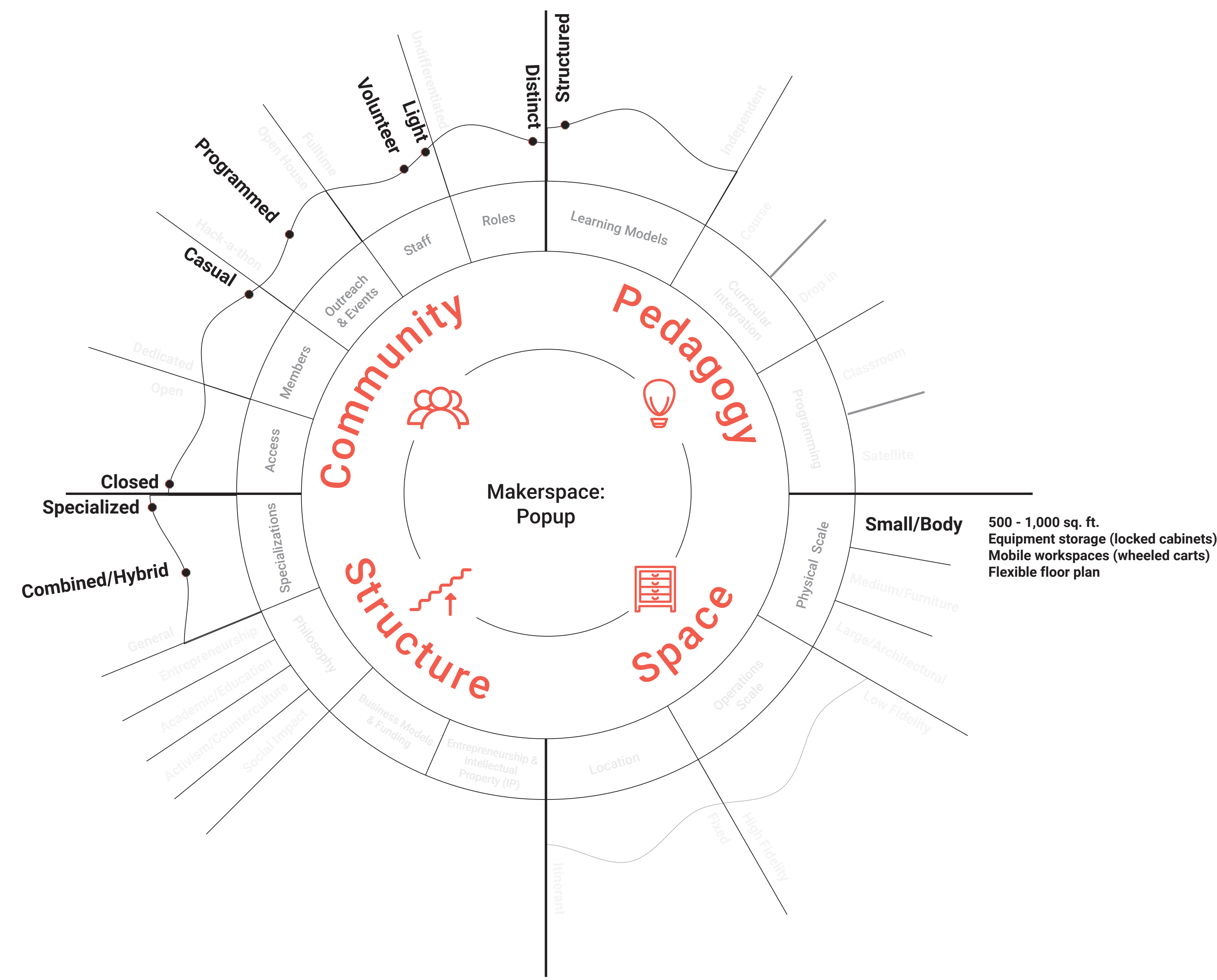
Popup

Small-scale, iterative/itinerant makerspaces, best for demonstrating that a community interest exists and for identifying the types of specializations, access models, and resources that would best serve that community.

Examples:

Bruce Hubbard's Electronics Lab, The Annex, Hillside Campus

Sewing Lab, 950 Building, South Campus

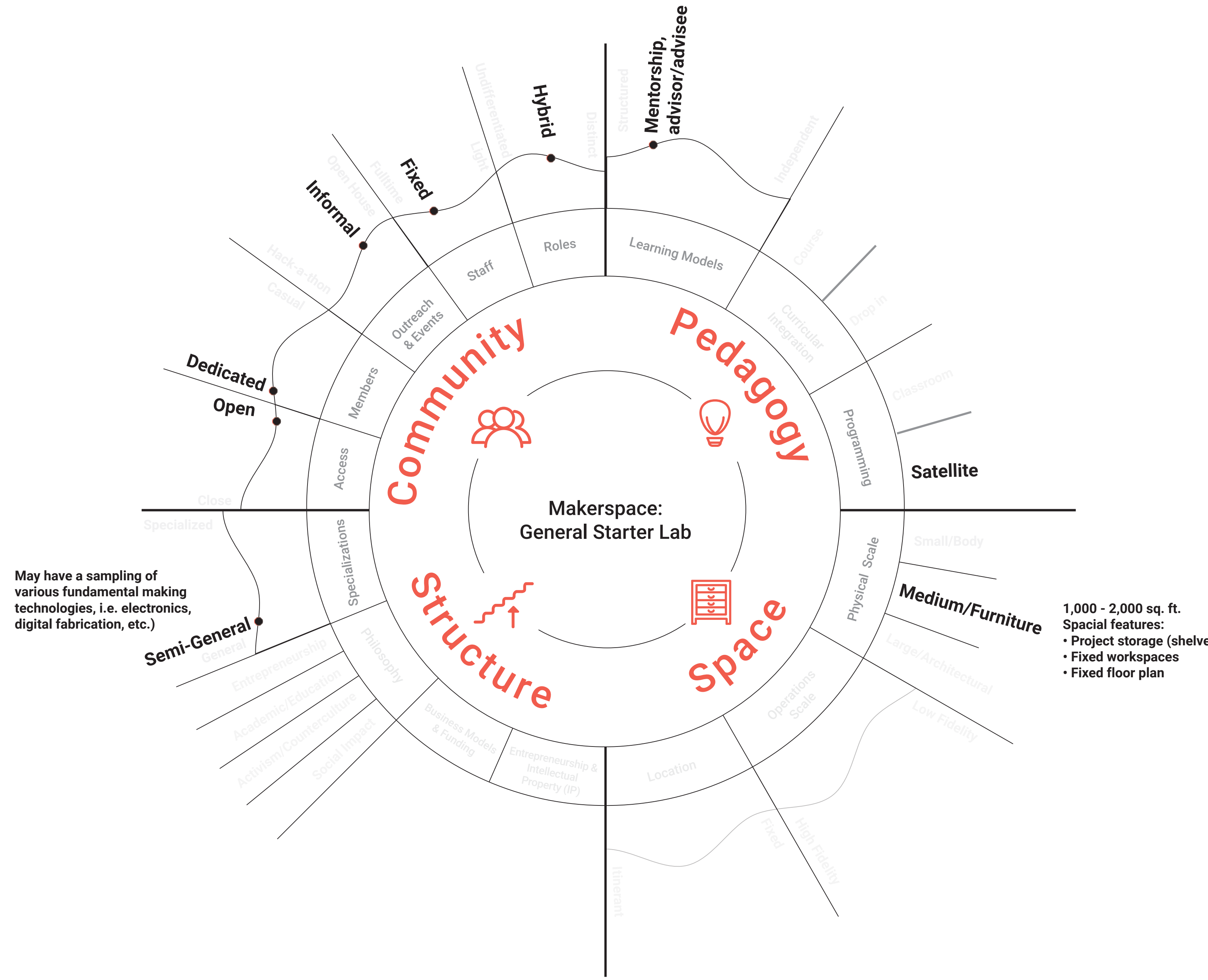


General Starter Lab

Transitioning from pop-up and single-person-driven resources to a fixed and more self-sustaining iteration of the makerspace. Often serves an existing while also creating the potential for growth in interest and outreach.

Examples:

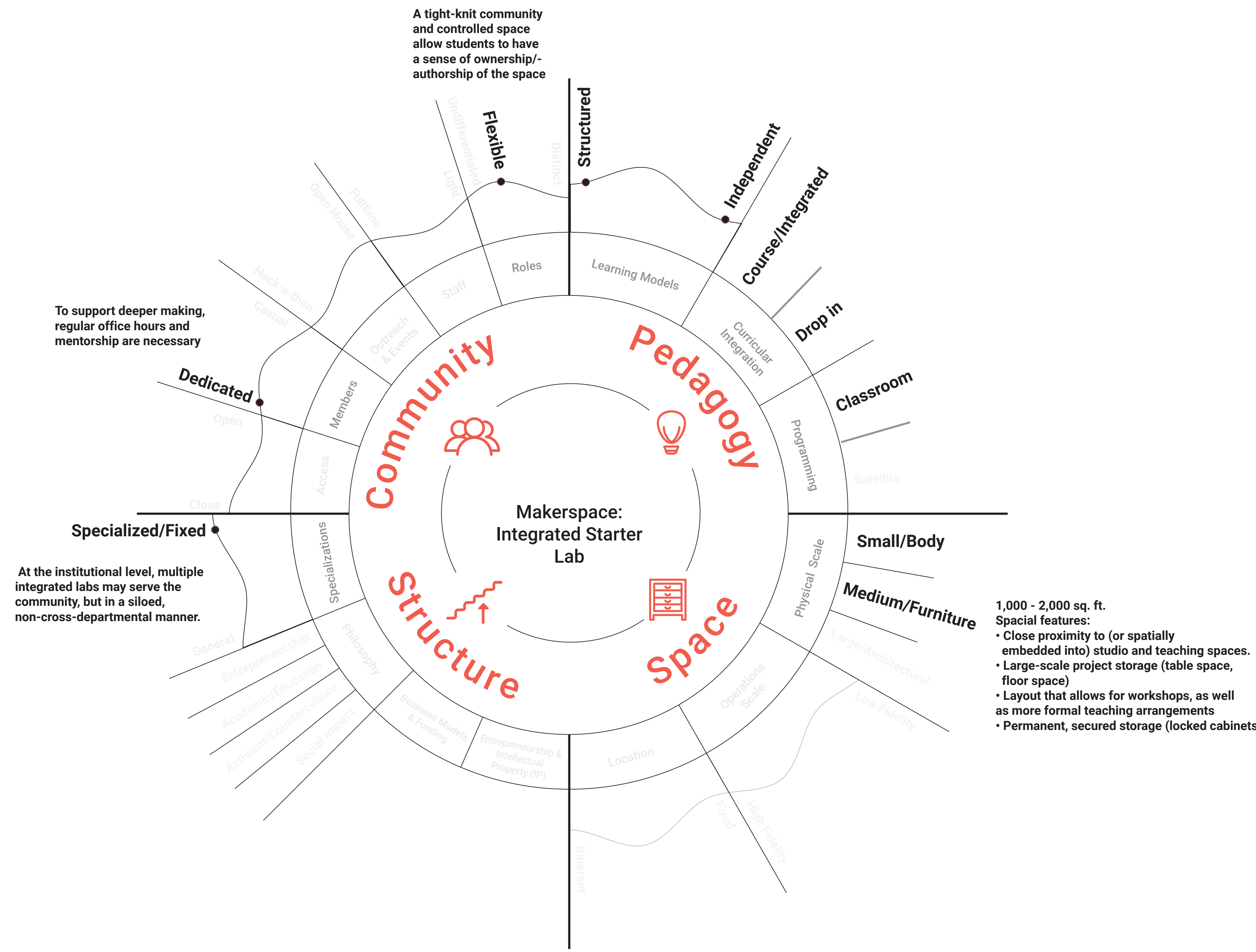
CCA Hybrid Lab, California College of the Arts, San Francisco



Integrated Starter Lab

A tightly integrated maker space is one that plays an explicit role in most of a program's curriculum, through a combination of direct curricular integration and drop-in project support.

Integration of makerspace in curriculum demands more fixed resources (Permanence–Fixed) and full-time staff (Staff–Dedicated).

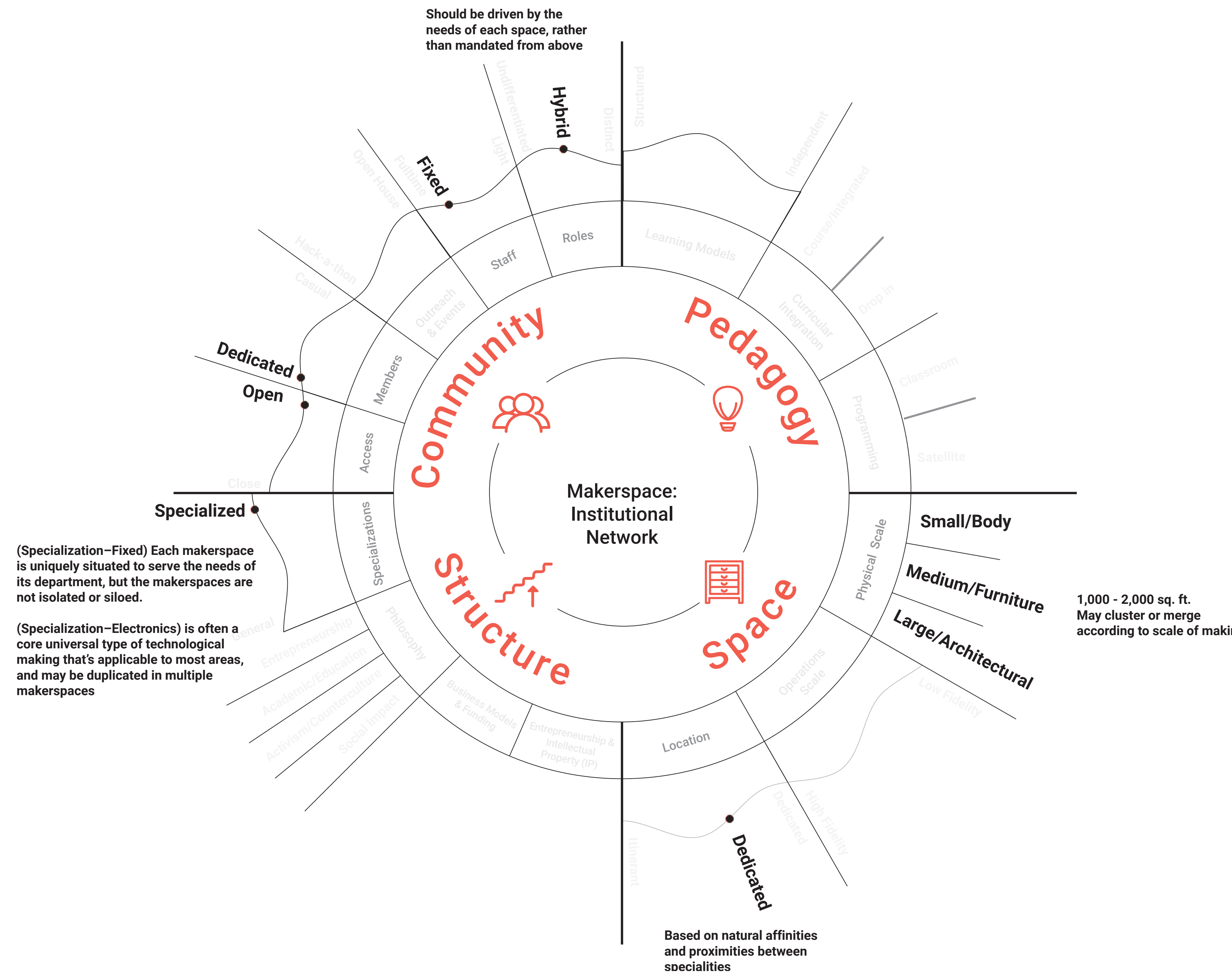


Examples:

MDP Making Lab,
Art Center College of Design

Institutional Network

Multiple makerspaces across a larger institution, each with its own specializations, but with each still serving the entire community. The redistribution of resources may result in each individual makerspace embodying characteristics of the “Pop-Up Lab” or “Starter Lab”.



Community

What is a Makerspace community?

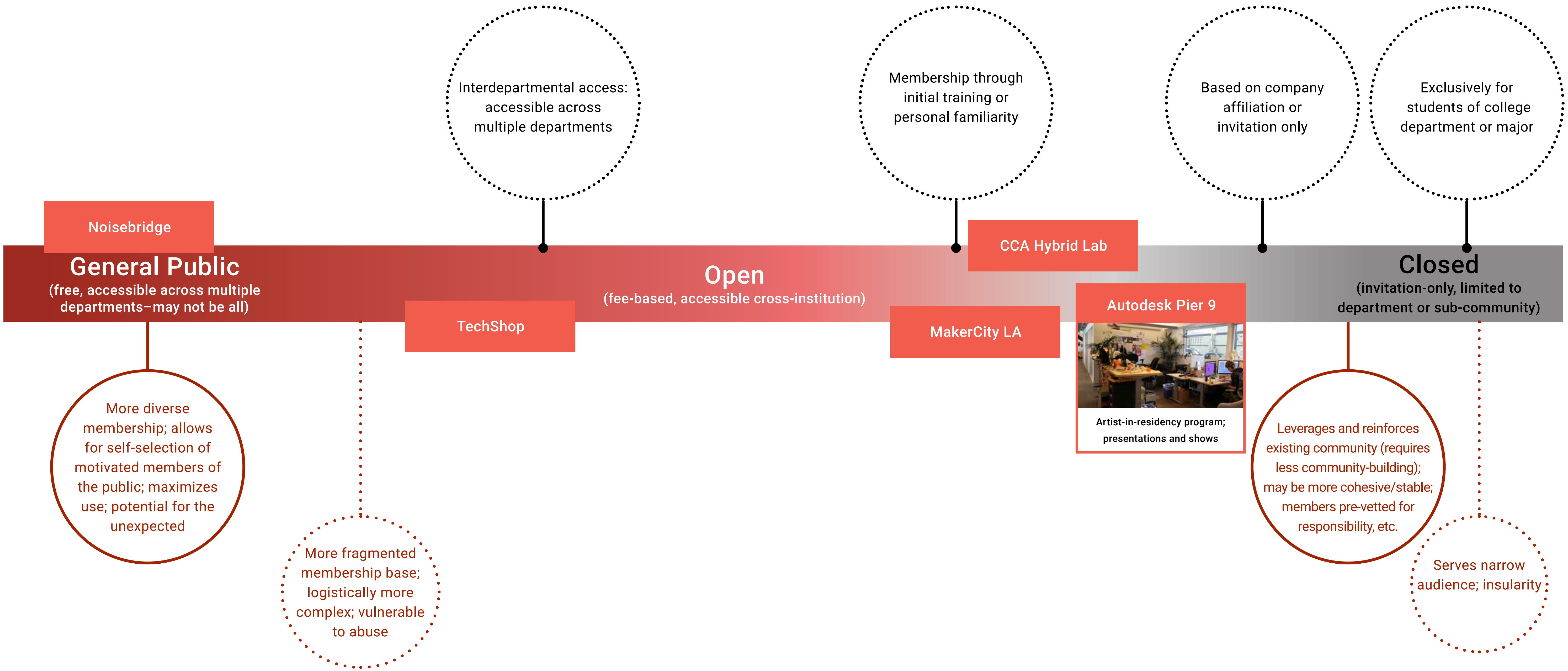
Creation and cultivation of community is the most important ingredient for any self-sustaining makerspace. The members, users, staff, and supporters of a makerspace facilitate peer-to-peer learning, encourage participation, and provide an incentive for others to be in, and actively use, the space. Strong community is also a prerequisite for any model of distributed or shared maintenance or management.

Attributes of a community:

Access, Members, Events , Staff, Roles

COMMUNITY → Access

How the community (whether members, potential members, or casual followers) interfaces and interacts with the space has repercussions on its potential for growth, the type of work that it enables, and the overall impression of how it serves those around it.



COMMUNITY → Members

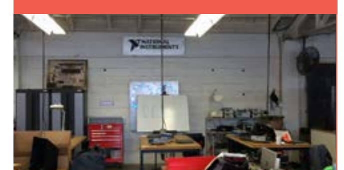
The most robust and sustainable communities have members across the full spectrum of involvement, from casual to "ownership." Establishing that variety, especially on the dedicated end, requires various strategies.

Casual users provide the flow for new membership intake, and act as audience for makerspace activities and events.

Machine Project

hosts one-time installations, lectures, performances, screenings, tours, workshops, etc. Constantly changing teachers and topics encourages a shifting audience and user group

Techshop



Each piece of equipment requires specific training before use, encouraging a consistent and dedicated user group

Advocates for the space, helps drive vision and growth.

Casual

Passerby, single event attendance, audience, light exposure to tech.

Novice

Beginning to learn about tech

Novice and project-specific interests often provide fresh take on emerging areas

Dilettante

Comes in for specific project support

Expert

Feels a sense of ownership of space; takes on maintenance roles

BlowThingsUp Lab
(Colorado University Boulder)

membership is by application, including the question: "What will you give back to the BTU Lab?"

Investor

Has a financial/professional/ vocational stake in space

Mentor

Imparts knowledge to peers; explores independently; has "expertise"

Dedicated

Active, visible, ambassadorial

COMMUNITY → Events

Autodesk Pier 9

Artist-in-residency program; presentations and shows

Open Houses

All visitors are welcome, informational, introduction to the space, what it offers, who are the members.

Workshops

A meeting at which a group of people engage in intensive discussion and activity on a particular subject or project

Meetups

Members find and join groups unified by a common interest

Engagement with general community as audience, participant, and potential user/ member

Classes

Meeting regularly to study a subject under the guidance of a teacher or someone with expertise

Hack-A-Thons

A large number of people meet to engage in collaborative making

Thank You for Coming

Operates as a restaurant that is open to the public

COMMUNITY → Staff

Whereas academia traditionally reinforces distinctions between staff and faculty, makerspaces often leverage a fluidity between roles to serve the community best across a variety of scales and needs.

Staff embody maker attitude, and model hacker ethos and process for members. "let's figure this out together" vs master-apprentice

general maintenance and programming;

in addition to maintenance, provides project support and tech consultation to students (and faculty)

develops and leads workshops and demos; is fully dedicated to space and community

Light

Fulltime

may run workshops; role may be taken on by faculty with other responsibilities

Makerspaces aim to create their own communities but often find stability supporting existing communities (i.e. students at nearby institutions).

Makerspace community members often take on hybrid roles, moving between user and provider, or client and administrator/employee.

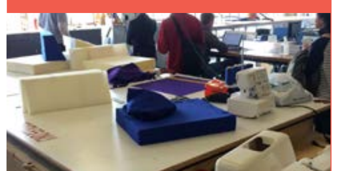
Staff personality is key to whether students feel the space and resources are accessible, and how open they are to experimentation, unconventional use, and productive failure.

COMMUNITY → Roles

Workshops, fab labs, and other spaces of production often rely on mentor-mentee or agency-client models for both pedagogical and logistical reasons. How the space allows for fluidity across roles will impact how members invest in and engage with the space.

Distinct

Techshop



Arizona State University partnership fills need for fabrication equipment and staffing, while built-in student membership provides automatic user base

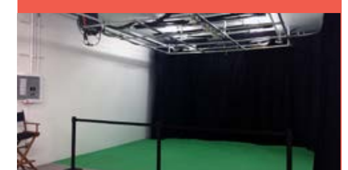
Clear understanding of "place" within system, clear scope of responsibilities

Predefined roles can limit vision and discourage feeling of ownership

Hybrid Lab

fills specific curricular need in Interaction Design department, but also draws students from all departments

Maker City LA



Tenants also fill positions as stage managers and sound production consultant

Noisebridge

Hackerspace is totally ad-hoc with no required participation, but community members' exposure to each other results in collaboration (botanist working with engineer on living wall project)

total fluidity, encourages collaboration, self-motivated learning, and potentially new models of collaboration/learning

requires self-motivation and responsibility. maintenance very difficult to sustain without some feeling of ownership

Undifferentiated

Structure

How are Makerspaces Structured?

A successful makerspace responds to specific needs and demands from a community. Therefore, these spaces reflect a specialization of purpose and productive means. Some makerspaces are oriented more towards industrial fabrication, some toward automotive maintenance, some toward film making and set-building. A single makerspace may not be able to satisfy the demands of every single user, so rather than trying to fit every resource into one space (generalization), it may be more effective to implement a network of smaller, more flexible spaces.

Attributes of a Structure:

Specializations, Philosophy, Business Model and Funding, Entrepreneurship and Intellectual Property (IP)

STRUCTURE → Specialization

Choices about equipment, spatial configuration, and even the name of the space are important in how they influence perceived intent and use of the space for community members.

Required where departments have very different funding structures/sources. Works when there is not a lot of cross-departmental activity

Specialized

Different media and processes have their own dedicated spaces. Allows proximity to most relevant departments. Allows for more specialized and narrower-focus processes and expertise.

World Building Media Lab

stop-motion animation "cube" space and open motion-tracking VR space

Combined

Natural affinities between specializations can lead to innovative cross-departmental spaces.

These affinities might include:
shared scale of making
overlap of equipment or processes
pedagogical overlaps and connections

Wearables Lab

technology + sewing

Works for small institutions/communities, may be necessary as a first-incarnation makerspace. Generally includes 3D fabrication/ rapid prototyping and some electronics.

General

Strategic combinations of 2 or 3 specializations with natural overlaps can be used for each media separately, or in combination potential for cross-pollination.

STRUCTURE → Philosophy

Entrepreneurship

Incubation

Business networking

Rapid prototyping towards

Minimum Viable Product

Academic/Education

Youth K-12

STEM/STEAM

Computational literacy

Activism/Counterculture

DIY as reaction to consumer

culture and global industrial

production

Sewing as antidote to
fast fashion

Upcycling, repair,

and repurposing

Anarchist

Hacktivism

Feminism

Social Impact

Community engagment

Resourcefulness/low tech

Sustainability and
eco-consciousness

(Ex. MDP Field track,

ArtCenter Design Matters,

TheLab/LA Biohackers)


Techshop


LA Makerspace


Noisebridge


LA Biohackers

STRUCTURE → Business Model & Funding

Membership Fees

TechShop

Class Fees

Machine Project

Subsidized by other business advantages

PR and community outreach
Overlap with business fabrication needs (Autodesk, DeezMaker)
User testing (Autodesk)

Retail Production

Thank You for Coming sells meals, monthly "CSA subscription"

Proprietary Process/ Curriculum

TechShop sells training curriculum and access model to Autodesk

Educational Partnership

TechShop partnership with Arizona State University (AZ)

Cross-promotion

Loew's Home Improvement Store (TX) with TechShop adjacent
TechShop hosting partner technologies (HP Sprout, magnet printer) for promotion and testing

Innovation Partnership business advantages

SpaceX and Hyperloop educational partnerships/competitions
Corporate-sponsored Research project model (USC)

STRUCTURE → Entrepreneurship / IP

- Can the space directly address and support entrepreneurship?
  - Documentation - shooting areas, equipment (kickstarter videos)
  - User testing/observation areas
- Larger-scope/scale projects that are continuously contributed to by members of the community

Pedagogy

How is Pedagogy Integrated into Makerspaces?

In an academic context, it is sometimes difficult to classify makerspaces and how they can best be integrated into existing pedagogical practices — whether as classrooms, labs, workshops, or studios. Community makerspaces have traditionally embraced educational models that privilege self-initiated investigation over structured learning. As such, there are a number of approaches that different spaces use to integrate pedagogy.

Attributes of a Pedagogy:

Curricular Integration, Learning Models, Programming & Scheduling

PEDAGOGY → Curricular Integration

Curricula can integrate “making” into courses in one of several ways:

as shop
as software training
as material experimentation
as sketching/process
as production

	COURSE		DROP-IN		
PEDAGOGY	Via Direct Integration	Via Workshop	Via Workshop	Supported	Independent
	Class time includes demos/ training in space, led by course faculty Class held either in the makerspace, or in a classroom with satellite equipment	Required workshops and demos held in makerspace (and not run by course faculty; run by staff or other) workshops may be customized to course content	Support for drop-in usage may range from simply being available/ open, to explicit “office hours” for helping students with project implementation	No explicit course requirement to use the space or its equipment, but students utilize the space and resources on their own in order to complete projects.	Students practice skills and work on projects on their own or in a peer sharing /collaborative manner

Makerspaces become a resource for learning, via workshops/demos and also because they act to consolidate knowledge in a known location. Students can “drop in” for support on more advanced projects/making (even outside of a particular class).

Unique to maker spaces situated in design schools, **pedagogy** is a primary factor in usage. Makerspaces can support, externalize, and extend curriculum.

PEDAGOGY → Learning Models

Expectations regarding demonstrable learning outcomes and methods will influence the programming and use of makerspaces in academic institutions. Makerspaces situated in academic institutions tend to rely on structured learning models more than independent and community-based spaces.

Electronics Cabinets - Art Center Annex

Product at Art Center

Structured → Classes → Events/Projects → Peer-to-Peer

Classes:
- Equipment Training
- Foundational
- Advanced Topical

Events/Projects:
- Hackathons
- Competitions
- Open houses

Justine Parish Sewing Lab

PEDAGOGY → Programming & Scheduling

In a design school context, how is the maker space itself programmed/scheduled to address both structured and unstructured use?

Makerspace as Classroom

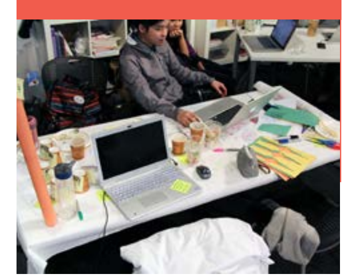
- Requires space
- Flex layout or dedicated class/demo area for appropriate table configuration
- Specific presentation/demo equipment: projection or large monitor
- Camera for view of hands-on allows immersion in maker space
- Is another type of space programming while class is in session
- Limits access to non-class users

Satellite / Mobile Making

- Equipment checked out of maker space for use in a separate (remote) classroom
- Allows maker space to remain accessible to others
- Only works with portable/ small-scale equipment
- Specially designed mobile carts or pods

Examples:

CMTEL Material carts



CCA Electronics carts

Space

Spatial Qualities of Makerspaces

The location and physical layout of a makerspace guides its usage. Characteristics such as working surfaces, lighting, acoustics, storage space, visibility, and accessibility are fundamental to the community's reception and adoption of a space and the type of work that it will support.

Attributes of Space:

Physical Scale, Operation Scale, Location

SPACE → Physical Scale

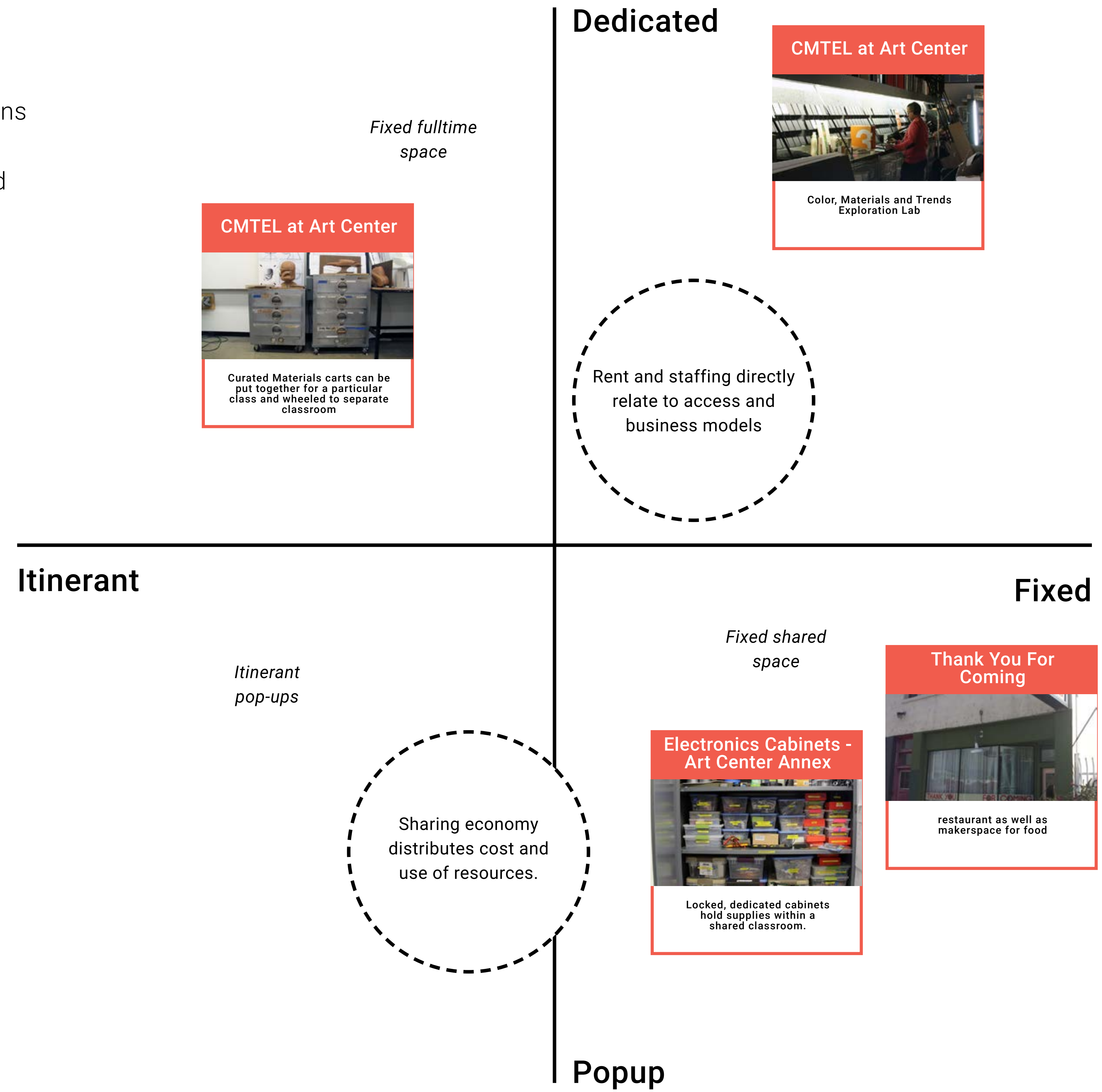
Small/Body	Medium/Furniture	Large/Architectural
• electronics	• furniture	• wall and facade-scale media
• wearables	• desk	• reactive spaces
• sewing/soft-goods:	• kiosk	• building fabrication processes
• accessories and clothing	• vehicular interior	• landscape
• consumer electronics / devices		

SPACE → Operation Scale

Whereas production spaces in academic institutions (like workshops and model shops) have traditionally stressed craft, finish, and material qualities, contemporary makerspaces often enable experimentation and iterative prototyping, especially in technology and digital fabrication.

SPACE → Location

The visibility of the space, its resources, and the work that happens within it are important for how the community is made aware of the space, and how it evenutally serves a role in both a social and productive capacity.



Spatial Qualities

The fluid activities and open technology-centric mindset of a maker space are a natural fit with web-based platforms for information, documentation, and administration.

- Lab wiki
- Remote webcam or space monitoring (nullspace “Open” sign on webpage)
- Online scheduling (TechShop)
- Signage, quick how-tos, equipment guides and troubleshooting within space
- FAQs
- Online tutorials and demos

Makerspace as hangout space:

- Generally open studio-style
- Large tables, without barriers or dividers
- Line of sight throughout workspace
- Can hang out without any specific thing to work on
- Exposure to other people, other projects

Design of these spaces include:

- Good lighting
- Table heights
- Flexible furniture layout
- Openness (visibility, open door)
- Formal and informal
- Access (key, card)
- Staffing

Equipment

Capabilities and Capacities that Makerspaces Enable

Makerspaces have emerged in conjunction with significant shifts in material production. While the integration of digital fabrication technologies (i.e. 3D printers and laser cutters) have become characteristic of these spaces, the types of equipment available for users should be informed and driven by the work that the space aspires to enable. The use of the equipment will be driven by other factors, such as community and accessibility.

EQUIPMENT → Electronics/Physical Computing

Processes

Structural fabrication

Surface finishing

Enclosure fabrication

Form making

Equipment

- ☐ Wood and metal shop manual tools (band saw, table saw, etc.)
- ☐ 3D printers
- ☐ Laser cutters
- ☐ CNC router
- ☐ Water jet cutter
- ☐ Paint and spray booth
- ☐ Sandblaster
- ☐ Powder-coating enamel oven
- ☐ Fumigation hood

Supplies/Materials

- ☐ Plywood sheet
- ☐ Metal sheet
- ☐ Acrylic sheet
- ☐ Bits, blades
- ☐ Hardware (screws, nails, etc)

EQUIPMENT → Electronics / Physical Computing

Processes

Circuit building and testing

Hardware hacking (disassembly, testing, reverse engineering)

Firmware programming and testing

Equipment

- ☐ Microcontrollers
- ☐ Discrete electronic components
- ☐ Soldering iron
- ☐ Fume extraction or ventilation
- ☐ Pick-n-place machine (automated component placement)
- ☐ PCB fabrication (milling or etching)
- ☐ Hackable/repurposable electronics
- ☐ Power supplies
- ☐ Signal generators
- ☐ Oscilloscopes
- ☐ Multimeters
- ☐ Breadboards

Supplies/Materials

- ☐ Discrete electronic components
- ☐ Solder
- ☐ Wire

EQUIPMENT → Game Design

Processes

VR development

User testing

Digital game development

Game paper-prototyping and play testing

Equipment

- [ ] Console developer kits
- [ ] Virtual reality technologies (Oculus Rift)
- [ ] Sensors and game controllers
- [ ] Screen-based software development (Unity, Unreal)

EQUIPMENT → Sewing / Textile

Processes

Sewing

Pattern making

Draping

Cutting

Textile manipulation

Textile surface design: dyeing, printing

Felting

Equipment

- ☐ Sewing machines (industrial, hobby)
- ☐ Embroidery machines (computerized)
- ☐ Overlock machine
- ☐ Cutting tables
- ☐ Dress forms
- ☐ Steamer and iron
- ☐ Silkscreening frames
- ☐ Textile printer
- ☐ Large sink / water
- ☐ Loom
- ☐ Knitting machine

Supplies/Materials

- ☐ Fabric
- ☐ Fibers
- ☐ Coated fabric (textile printer-specific)
- ☐ Thread
- ☐ Pins

EQUIPMENT → World Building

Processes

VR development

Animation

Set design

Model making

Ideation

System design

Equipment

- ☐ Camera tracking (motion-capture) rigged space
- ☐ VR technologies
- ☐ Stop-motion animation “black box”
- ☐ Model-building
- ☐ 3D printing
- ☐ Set and prop fabrication
- ☐ Whiteboard
- ☐ Projector and projection area

EQUIPMENT → Food

Processes

Gardening/Farming

indoor

outdoor

compost

hybridization

Cooking

Baking

Equipment

- ☐ Sink
- ☐ Refrigerator
- ☐ Toaster Oven
- ☐ Oven
- ☐ Hot Plate
- ☐ Stove
- ☐ Blender
- ☐ Cutlery+Utensils
- ☐ Dehydrator
- ☐ Sous-vide
- ☐ Industrial Kitchen

Supplies/Materials

- ☐ Ingredients
- ☐ Seeds
- ☐ Plants
- ☐ Soil

EQUIPMENT → Biohacking

Processes

Gene sequencing

DNA amplification

Genetic engineering (splicing)

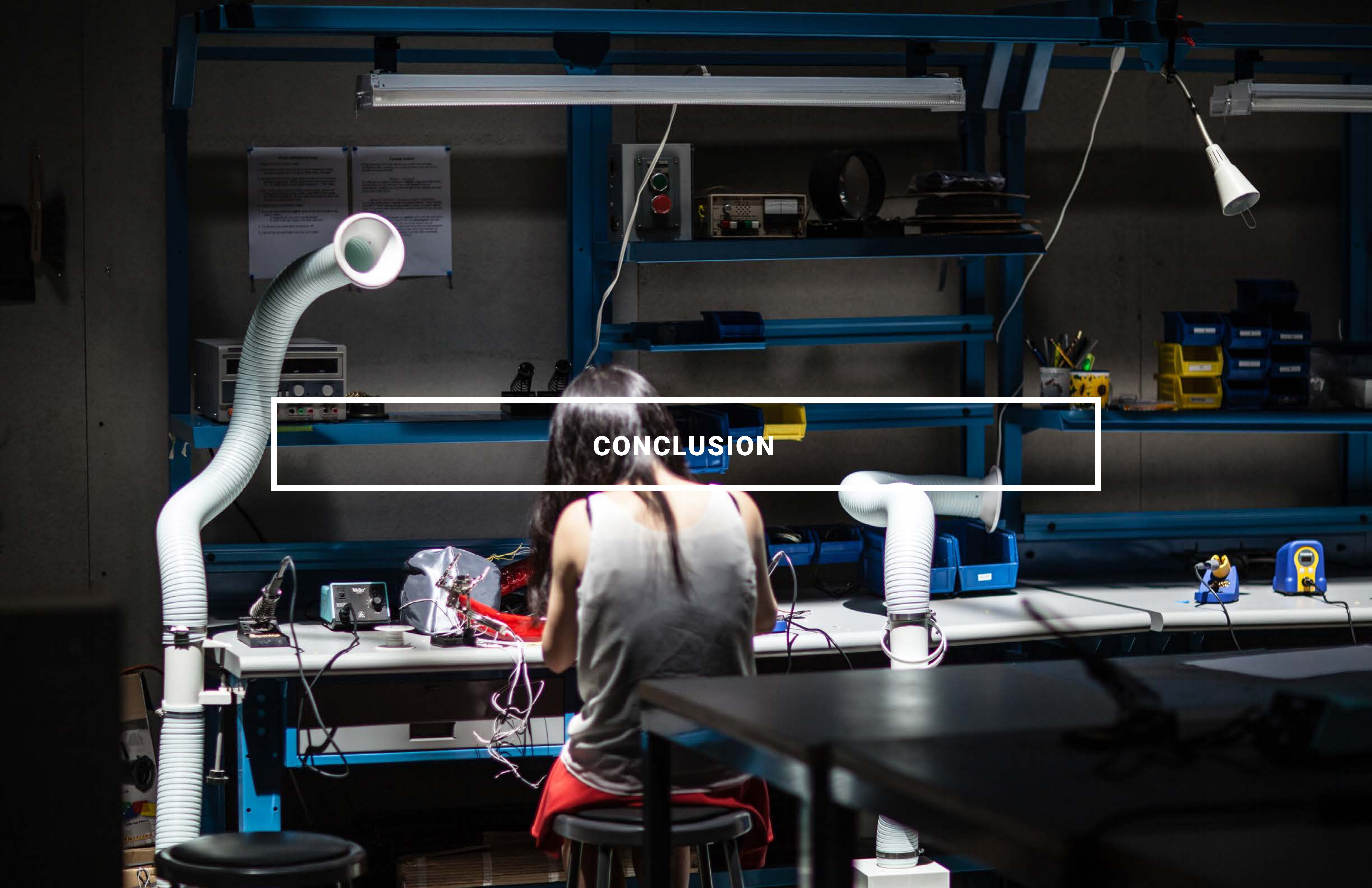
Synthetic biology

Equipment

- [ ] Centrifuge
- [ ] Electrophoresis gel box
- [ ] Electrophysiology station
- [ ] Gel documentation system
- [ ] Electrophoresis power supply
- [ ] Heating stir plate
- [ ] Fumigation hood
- [ ] Thermocycler

Supplies/Materials

- [ ] Petri dish
- [ ] Test tube
- [ ] Agar gel



CONCLUSION

Guidelines for schools interested in starting a maker space

- Art and Design schools are already centers for making which presents unique challenges and opportunities for the integration of digital making.
- Maker Spaces can make technology accessible to non-experts - allowing artists and designers to work in new ways.
- Digital making can play a role within a range of art and design making practices.
- Maker Spaces are ecosystems that depend as much on community, staffing and programming as technology and equipment.
- Maker spaces can work at a variety of scales, from a single cart to an institution- wide network.
- At Art and Design Schools, maker spaces are great design projects.

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https://designschoolnetwork.intel.com/

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