MAKER DAY TOOLKIT

a place of mind
THE UNIVERSITY OF BRITISH COLUMBIA
Faculty of Education
Okanagan Campus

Acknowledgements

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This toolkit is available in multiple formats.
EPublication and PDF: itabc.ca/youth-trades/maker-day
Editable word files: blogs.ubc.ca/centre/2013/11/18/maker-day-tool-kit

Maker Day Toolkit

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What is a Maker Day?

Celebrating The Best Gifts of Humanity: The Ability to Think Wisely and Tinker Creatively and Share Generously

A Maker Day, as conceptualized and supported by this resource, is an immersive professional development event. It is a facilitated event that requires participants to thoughtfully and fully engage in design thinking and creative problem finding. At the heart of the day is the Maker ethos which "values learning through direct experience and the intellectual and social benefits that accrue from creating something shareable" (Martinez & Stager, 2013). We know that it is hard to share meaningfully things that we have experienced deeply. If educators, or others, are to share the Maker movement with their students or friends, we believe a full day Maker Day experience is an essential first step.

The purpose of a Maker Day is to introduce participants to the Maker Movement, focusing on four distinct yet related elements:

- Design thinking
- Design challenge
- Collaborative prototyping of a design solution
- Group reflection

A Maker Day is **NOT** the same thing as a Maker Faire, which is a celebration of the "arts, crafts, engineering, science projects and the Do-It-Yourself (DIY) mindset" (wikipedia). Nor is it a Maker or hacker space that is a "community-operated workspace where people with common interests, often in computers, technology, science, digital art or electronic art, can meet, socialize and/or collaborate" (wikipedia). The goal of a Maker Day is to encourage participants to experience making and tinkering through design thinking and hands-on activities. As part of the day's agenda, participants are introduced to Design Thinking, Inquiry, Making and Experiential Learning through small group engagement with a pre-designed kit of tools and materials, supplemented by a pantry of extra materials.

This resource is provided to help you host your own Maker Day. The materials were developed by the Innovative Learning Centre (ILC) at the Faculty of Education, University of British Columbia Okanagan Campus. They were initially tested at Maker Day 2013 where 80 educators gathered to experience Making. The day would not have been possible without the generous and helpful support for Industry Training Authority (ITA) and the Women In Trades Program at Okanagan College.

We welcome all feedback and suggestions for improvement. Please let us know how your Maker event goes and whether other resources are needed.

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Making a Case for Making

We have a need to make. It stems from our curiosity with the world and our basic human desire to make things and then make those things better. The Do-It-Yourself movement is evidence of this—from cooking channels to home improvement shows, we have been knitting, tinkering with cars, renovating our homes, and making gifts for friends for ages.

Now, we are reclaiming this need and formalizing it into a movement. We are creating shareable workshops (maker spaces), providing hours of instructional videos (You Tube, Instructables, etc.), and offering workshops (e.g. Home Depot – How to Sessions), reclaiming the model building kits from our recent past and adding 3-D printers and robotics. And, educators have a role to play.

Background

North America is in an interesting place. We currently have three generations in our work force. Fifty per cent of the content we access is cloud based. Approximately 95% of 12 – 17 year olds are regularly online, 76% of them use social networks, and 77% have cell phones. Globally, there are over one billion smart phones, and the sum of human knowledge, in the form of Wikipedia, is available offline in a downloadable format. We appear to haveat least few problems accessing information or finding opportunities connect.

Basically, we are in a time where digital fluency is an essential skill and we have the potential learn, formally and informally, at any time, place or in format we need. Learning opportunities have probably never been more ubiquitous and flexible.

All levels of education are calling for knowledge skills situated in learning environments that are:

- Learner-centred: highly focused on learning but not as an alternative to the key role for teachers
- Structured and well-designed: needs careful design and high professionalism alongside inquiry & autonomous learning
- Profoundly personalised: acutely sensitive to individual and group differences and offering tailored feedback
- Inclusive: such sensitivity to individual and group differences means they are fundamentally inclusive
- Social: learning is effective in group settings, when learners collaborate, and when there is a connection to community (OECD, 2011).

These learning environments are consistent with what Pink (2005) calls our current Conceptual Age—a time where logical and linear thinking is valued, especially when it is coupled with creativity and innovation. Exploration, visual aesthetics, problem find and problem solving have been identified as essential skills in this age.

Hatch (2014), author of the *Maker Manifesto*, suggests that as part of this Conceptual Age, we are actually entering a new industrial revolution. If the first revolution was fuelled by factories powered by steam and the second by electricity, our new age is to powered by unlimited access to information, the development of increasingly reasonably price, powerful tools, and the ability to obtain a range globally sourced materials and resources with which to make things. Hatch suggests the Maker Movement is actually an Internet of Physical Things claiming it is actually bigger because it consists of physical objects connected via sensors to the Internet.

Running parallel with this new age and Internet of Things is "the largest untapped human resource on the planet ... the space time, creativity, and disposal income of the 'creative class' " (Hatch, p. 52). This group was identified by Richard Florida in *The Rise of the Creative Class.* Florida suggests this class is an "amalgamation of engineers, artists, lawyers, programmers, designers, and other who have the educational or professional propensity to 'create' " (Hatch, p. 52). He suggests this class is fostering the majority of contemporary innovation and is moving into advanced manufacturing which in turn is supporting an economic recovery, new employment options, and the rapid growth of the Maker Movement. In 2010, in the United States alone, it was estimated there at 40 million Americans in the creative class—50% of the employed workforce, controlling $474 billion in disposable income. This income is increasingly being directed to creative and imaginative work, often using Maker Spaces for prototyping and networking.

Oddly, at the same time, we are questioning where all the skilled workers are in Canada? (Mason, Oct. 18, 2013). Mason states:

> Once upon a time, shop class was mandatory in most high schools. There was a belief that even if a student wasn't intent on becoming a mechanic or carpenter, having some basic life skills in these areas wasn't a bad thing.
>
> Over time, however, shop began to look dated and irrelevant and was given less status. Somewhere along the way, it was drilled into students that the only way to get ahead in life was to go to university and earn a degree.

The complete Mason article is reprinted with his permission in section four of this toolkit.

Taking Making Into Class

The Maker Movement and classrooms seem perfect partners. Inquiry-based learning, problem-base learning, constructivism, experiential learning, Reggio-inspired learning all cry out for hands-on approaches to making learning visible.

Sylvia Martinez and Gary Stager, in their highly lauded book Invent to Learn, explain making is an authentic way to bring STEMx (Science, Technology, Engineering, Mathematics and Design) into the classroom. Reading *Invent to Learn: Making, Tinkering, and Engineering in the Classroom* (2013) is a first step. Chapters include a background to the Maker Movement and the educational leaders who have embraced its principles; a link to current educational theories and practices (constructivism and constructionism), descriptions of good projects to Maker and how to design them, suggestions for classroom design, and suggestions for resources and references.

Making is a pedagogical orientation that integrates imagination and creativity with design thinking, problem solving, and even more importantly, problem finding. We have watched schools turn their libraries into Learning Commons, embracing more than print materials. We are now at the stage of actively adding Maker Spaces. Spaces that have simple hand tools, cardboard, robotics, and 3-D printers.

Also, refer to the links in this resource (Designing a Problem Sketch and Annotated Reference List) for ideas and support. Mark Hatch's *The Maker Movement Manifesto* is an excellent introduction to the Maker Movement and community based Maker Spaces.

Bringing making into the schools is not about adding another course or discipline to an already overcrowded curriculum. Rather, it is an intentional way of integrating STEMx and supporting personalized constructionist learning across the curriculum. It is also a way to encourage all students to explore Trades and Technology as a course of study, reclaiming "Shop" as a valuable place to turn theory into practice, ideas into design, design in prototype. Making in the schools could just begin to answer the question of where the skilled workers are ... they are probably right there in our classes just wanting an opportunity to explore their creating and make something new and meaningful!

References

Hatch, M. (2014). *The Maker Movement Manifesto: Rules for Innovation in the New World of Crafters, Hackers, and Tinkerers*. NY: McGraw-Hill.

Mason. G. (Oct. 18, 2013). *Skilled workers: Where'd they go?* Retrieved from http://www.theglobeandmail.com/commentary/where-did-all-our-skilled-workers-go/article14909494/

Organization for economic co-operation and development (OECD). (May 2011). *Innovative learning environments – A leading OECD/CERI project.* Retrieved from http://www.innovations.sa.edu.au/files/links/ILEMay.pdf

Pink, D. (2005). *A whole new mind.* Retrieved from http://www.empathyed.org/index.

Suggested Use

This document adds background to design thinking. It might be helpful for those new to the approach.

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Background to Design Thinking

"Design thinking is generally considered the ability to combine empathy for the context of a problem, creativity in the generation of insights and solutions, and rationality to analyze and fit solutions to the context" (Wikipedia, n.d.).

Design thinking aligns nicely with the Maker Movement by helping makers consider what they would like to create and what might be needed. It allows makers to "creatively attack the world's greatest problems and meet people's most urgent needs" (Hatch, 2014, p. 10). As Walt Disney is attributed to have said, "It is kind of fun to do the impossible!"

The process of design is a series of decisions that inform the user experience. "Design doesn't just make things beautiful, it makes them work" (Dadich, 2013). In the 1980's, Dieter Rams, an architect and a designer for Braun, became concerned with the seemingly "impenetrable confusion of forms, colors and noises" in the world around him. To help sort out what might be considered as good design, he drafted 10 principles for good design (Vitsoe, 2013).

- **Good design is innovative**
- **Good design makes a product useful**
- **Good design is aesthetic**
- **Good design makes a product**
- **Good design is unobtrusive**
- **Good design is honest**
- **Good design is long-lasting**
- **Good design is thorough down to the last detail**
- **Good design is environmentally friendly**
- **Good design is as little design as possible**

Design thinking is a process for addressing problems and typically consists of seven steps: define, research, ideate, prototype, choose, implement, and learn.

Define

- Decide what issue you are trying to addresses.
- Agree on who the audience is.
- Prioritize this project in terms of urgency.
- Determine what will make this project successful.
- Establish a glossary of terms.

Research

- Review the history of the issue; remember any existing obstacles.
- Collect examples of other attempts to solve the same issue.
- Note the project supporters, investors, and critics.
- Talk to your end-users, that brings you the most fruitful ideas for later design.
- Take into account thought leaders' opinions.

Ideation

- Identify the needs and motivations of your end-users.
- Generate as many ideas as possible to serve these identified needs.
- Log your brainstorming session.
- Do not judge or debate ideas.
- During brainstorming, have one conversation at a time.

Prototype

- Combine, expand, and refine ideas.
- Create multiple drafts.
- Seek feedback from a diverse group of people, include your end users.
- Present a selection of ideas to the client.
- Reserve judgment and maintain neutrality.
- Create and present actual working prototype(s).

Choose

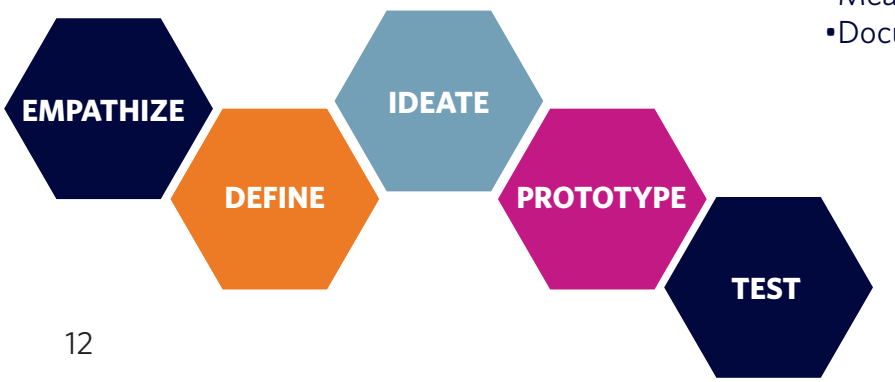
- Review the objective.
- Set aside emotion and ownership of ideas.
- Avoid consensus thinking.
- Remember: the most practical solution isn't always the best.
- Select the powerful ideas.

Implement

- Make task descriptions.
- Plan tasks.
- Determine resources.
- Assign tasks.
- Execute.
- Deliver.

Learn

- Gather feedback from the consumer.
- Determine if the solution met its goals.
- Discuss what could be improved.
- Measure success; collect data.
- Document.



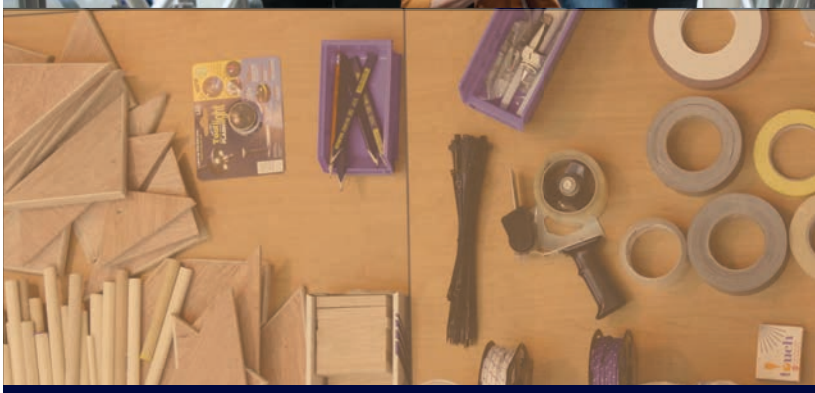
Although design is always subject to personal taste, design thinkers share a common set of values that drive innovation: these values are mainly creativity, ambidextrous thinking, teamwork, end-user focus, curiosity (Wikipedia, n.d.).

Stanford's d.School offers a great series of resources on design thinking. Please explore dschool.stanford.edu/dgift

Tie to Education

In some districts, educators are called upon to be designers of learning experiences. This is a shift from their previous roles as implementers or interpreters of curriculum. A good way to incorporate design thinking in the classroom is to use it to help students intentionally find linkages between authentic learning experiences as akin to curriculur enactment.

Because of its emphasis on empathy, design thinking invites students to think about things worth considering and to focus on human-centred design. It aligns nicely with STEMx projects grounded in improving the human experience. STEMx is an interdisciplinary way to engage in the study of Science, Technology, Engineering, Management, and Design. Mitch Resnick, director of Lifelong Kindergarten at MIT's Media Lab, suggests educators should incorporate the process of creative thinking—imagine, create, play, share, reflect (Resnick, 2007) in their practices as it "reflects the natural way that young children learn and play" (Martinez & Stager, 2013). Design thinking and creative thinking align quite nicely!



Suggested Use

This document adds background to design thinking. It might be helpful for those new to the approach.

Annotated Reference List

Videos to Watch

- **Apollo 13 – Clip from the movie – Square peg in a round hole**
- **The real story – Apollo 13**

Software to Explore

Autodesk 123D (123dapp.com)
Free 3D modeling software that is integrated with content and fabrication services. It also has links to projects, patterns, models.

Autodesk Inventor (autodesk.com/products/autodesk-inventor-family/overview)
The professional, commercial version of Autodesk 123D. Inventor 3-D CAD software offers an easy-to-use set of tools for 3-D mechanical design, documentation, and product simulation. Digital Prototyping with Inventor helps you design and validate your products before they are built to deliver better products, reduce development costs, and get to market faster.

Lego Building Software (techsupportalert.com/content/best-free-lego-building-program)

Logo Software (el.media.mit.edu/logo-foundation/products/software)

Maya (autodesk.com/products/autodesk-maya/overview). Maya 3-D animation software offers a comprehensive creative feature set for 3-D computer animation, modeling, simulation, rendering, and compositing on a highly extensible production platform. Maya now has next-generation display technology, accelerated modeling workflows, and new tools for handling complex data.

Scratch (scratch.mit.edu)
With Scratch, you can program your own interactive stories, games, and animations — and share your creations with others in the online community. Scratch helps young people learn to think creatively, reason systematically, and work collaboratively — essential skills for life in the 21st century. Scratch is a project of the Lifelong Kindergarten Group at the MIT Media Lab. It is provided free of charge.

Hardware to Explore

Arduino (arduino.cc)
Arduino is an open-source electronics prototyping platform based on flexible, easy-to-use hardware and software. It's intended for artists, designers, hobbyists and anyone interested in creating interactive objects or environments.

littleBits (littlebits.com)
littleBits is an opensource library of electronic modules that snap together with tiny magnets for prototyping, learning, and fun.

Leap Motion (leapmotion.com)
Leap Motion, Inc. is a company that manufactures and markets a computer hardware sensor device that supports hand and finger motions as input, analogous to a mouse, but requiring no hand contact or touching.

Lego Mindstorms (lego.com/enus/mindstorms)

McMaster (mcmaster.com)
Site for all types of fasteners

Sites to Check Out

Adafruit (adafruit.com)
Site for Adruino hardware and project ideas.

Suggested Use

These references are all valuable supports for your Maker Day. You may want to show the Apollo 13 videos as support for lateral thinking— thinking that prompts different approaches to problem solving.

Etsy (Etsy.com)
Shopping site for a range of arts and crafts and collectables from global entrepreneurs

Instructable (Instructables.com)
A site to share what you make with others. Instructables has directions for a range of projects.

Invent to Learn (inventtolearn.com)
Official site of the book, Invent to Learn. www.inventtolearn.com/resources lists a range of resources mentioned in the book

Khan Academy (khanacademy.org)
A site to learn—just for free. The library of content covers math, science topics such as biology, chemistry, physics, and the humanities with playlists on finance and history.

Kickstarter (kickstarter.com)
Kickstarter is the world's largest funding platform for creative projects.

Spark Fun (sparkfun.com)
Online retail store that sells the bits and pieces to make your electronics projects possible

Thinkgiverse (thingiverse.com)
Thingiverse is a website dedicated to the sharing of user-created digital design files. Providing primarily open source hardware designs licensed under the GNU General Public License or Creative Commons licenses, users choose the type of user license they wish to attach to the designs they share. 3-D printers, laser cutters, milling machines and many other technologies can be used to physically create the files shared by the users on Thingiverse.

Lynda (lynda.com)
Subscription fee to learn software skills.

Places to Go

MIT Center for Bits to Atoms (cba.mit.edu)
MIT's Center for Bits and Atoms is an interdisciplinary initiative exploring the boundary between computer science and physical science. CBA studies how to turn data into things, and things into data.

MIT Media Lab – Lifelong Kindergartner (llk.media.mit.edu)
The home of Scratch – Mitch Resnick and his team design tools and software to support design, creation and learning.

Stanford's Hasso Plattner Institute of Design – d.school (dschool.stanford.edu)
Home of design thinking ... The school was founded by Stanford mechanical engineering professor David Kelley in 2004. It is a joint project between the university and the Hasso Plattner Institute of University of Potsdam in Germany. Like some other design schools, it integrates business and management training into more traditional engineering and product design education.

Maker Space in the Faculty of English – Humanities
(maker.uvic.ca) The Maker Lab in the Humanities at the University of Victoria opened its doors in September 2012 under the direction of Jentery Sayers (Assistant Professor, English). With research priority areas in physical computing, desktop fabrication, versioning, and scholarly exhibits, it intersects cultural criticism, computation, and comparative media studies with tacit learning, multimodal communication, and experimental methods. As the Lab's name suggests, its design is anchored in blending a humanities research lab with a collaborative makerspace—a design that affords its team of graduate students and faculty opportunities to build projects through various modes of knowing by doing.

Annotated Reference List (cont.)

Toys to Play Use

Erector Sets (wikipedia.org/wiki/Erector_Set)
An Erector Set (the trademark has always been "ERECTOR") is a brand of metal toy construction sets, originally patented by Alfred Carlton Gilbert and first sold by his company, The Mysto Manufacturing Company of New Haven, Connecticut in 1913. In 1916, the company was reorganized as the A.C. Gilbert Company. Erector consists of various metal beams with regular holes for assembly using nuts and bolts. Other mechanical parts such as pulleys, gears, wheels, and small electric motors were also part of the system. What made Erector unique was the ability to build a model, then take it apart and build something else (over and over). Erector quickly became the most popular construction toy in the United States, most likely because it was the only construction set at the time to contain a motor. Erector was commonly referred to as an Erector Set, though erector set has become somewhat of a generic trademark denoting a variety of construction toys, irrespective of brand. The trademark for ERECTOR is owned and marketed by Meccano. It is still available at ToysRUs.

Goldie Blox (goldieblox.com)
Toys for future innovators.

Things to Read

Invent to Learn - Making, Tinkering, and Engineering in the Classroom (inventtolearn.com)
By Sylvia Libow Martinez & Gary Stager
Using technology to make, repair, or customize the things we need brings engineering, design, and computer science to the masses. Fortunately for educators, this maker movement overlaps with the natural inclinations of children and the power of learning by doing.

Make Magazine (makezine.com)
Designed after Popular Mechanics, *Make Magazine* is the go-to site for all things Maker— from ideas to tools.

Wired magazine (wired.com)
A subscription magazine (digital and print) that reports on emerging tools, technologies and trends. The recent issue has a feature on education and fostering the next Steve Jobs (http://www.wired.com/business/2013/10/free-thinkers).


Design Thinking
in the Classroom
Empathy is
Change. Incite Growth

Gary Mason, Globe and Mail

October 18, 2013

Once upon a time, shop class was mandatory in most high schools. There was a belief that even if a student wasn't intent on becoming a mechanic or carpenter, having some basic life skills in these areas wasn't a bad thing.

Over time, however, shop began =to look dated and irrelevant and was given less status. Somewhere along the way, it was drilled into students that the only way to get ahead in life was to go to university and earn a degree.

Occupations such as plumbers and pipefitters were looked down upon. They were the bedrock of blue-collar careers and commanded little respect. The people who made the big bucks wore white shirts and ties and owed their well-paying jobs to the swishy institutions of higher learning they attended. Kids and parents were told that in the future, most jobs would require a BA at minimum.

Today, Canada is dealing with the fallout from its ivory tower preoccupation. (We produce more university and college graduates, per capita, than most countries in the world.) We have an acute shortage of workers who actually build and fix things. It represents an alarming structural deficit that could cost the economy billions.

Let me say that this is not a diatribe against universities and colleges. While there are many university grads who've had trouble finding jobs in the past few years, statistics indicate that degrees generally hold their value. People who have them earn more than those who don't.

But in our single-minded obsession with academia, we forgot that the millions of people who literally built our economy would one day be retiring— and that there would be new industries sprouting up that would need skilled workers, too. Now, it's not an exaggeration to say we have a crisis on our hands.

Some of the numbers are sobering. According to the Canadian Manufacturers and Exporters, by 2016, Canada will have 1.3 million skilled labour jobs sitting vacant because there is no one to do them. In the construction industry alone, there will be 219,000 workers retiring between now and 2020 and not nearly enough people to take their positions. In the agriculture sector, 90,000 additional skilled workers were needed this year, according to the Canadian Chamber of Commerce.

Things are so bad that a coalition of construction companies is heading to Ireland —again— in the hopes of hiring 600 trained workers. Given the miserable state of the Irish economy, it shouldn't be a problem. In Ireland, construction-related jobs are still highly valued and not considered demeaning work.

While enrolment in trades schools in Canada has been increasing, the rise isn't fast enough to tackle the dangerous skills chasm that needs to be bridged. Also, completion rates sit at just 50 per cent. Many believe that education is at the root of our problem: Students need to be exposed to the benefits, financial and otherwise, of the trades. And it has to start at a much younger age.

WHERE DID ALL OUR SKILLED WORKERS GO?

B.C. Education Minister Peter Fassbender believes we need to be talking to students as early as Grade 5 about the value of being trained in a craft and about how technology has changed the nature of many of these jobs. (They aren't as dirty as they once were.) Eventually, students also need to know that demand has pushed wages into uncharted territory.

He might be on to something. Skilled workers remain an essential component of our economic well being. Without them, we're in trouble. In fact, we already are.

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He might be on to something. Skilled workers remain an essential component of our economic well being. Without them, we're in trouble. In fact, we already are.

http://www.theglobeandmail.com/globe-debate/where-did-all-our-skilled-workers-go/article14909494/

WITH PERMISSION

Checklist for Planning a Maker Day

This checklist helped to organize Maker Day 2013. While every effort has been made to make this checklist as complete as possible, due to the unique nature of such events, it may not cover every possible step required or answer every question. On the other hand, it may be too detailed for some events being planned. Generally, always prepare the most detailed plans necessary to suit the event being planned.

To begin:

Set your date and agenda for the day— start early.

Secure your venue as soon as possible— determine any services, permits and permissions required.

Develop a budget and monitor your spending.

Determine whether funding or sponsors for the event may be required – IF so, start proposal writing and connecting with potential sponsors as soon as possible.

Develop an agenda for the day with a work-back schedule for each key action on your agenda (i.e., set-up of venue, greeting/registering participants, opening the day, coffee breaks and food, capturing the day, grouping participants and facilitators, design thinking process, prototype building, reflecting on the day, clean-up of venue, debriefing/evaluating the day, etc.).

Develop a list of volunteers, facilitators, guest speaker(s), sponsors/funders, special guests, and participants.

Develop a communication plan from your work-back schedule and lists of people involved to set key pre-events, roles and responsibilities (i.e., marketing, volunteer meetings, facilitator trainings, guest speaker(s) topics/times,

Determine key milestones and set times to review whether 'the plan' is on track (i.e., adjustments need to be made (i.e, change in venue, participant numbers, guest speaker(s), problem sketch), steps need to be added, more/less feedback required, communication is happening, budget needs adjusting, more/less marketing, etc.)

Pre-event planning
Set-up of venue: sketch floor plan(s) for the day, list equipment required, chairs/tables, who will set-up, what time will set-up happen on the day, number of volunteers required, parking paid or free, other transportation required.

Greeting/Registering: any marketing required (posters, radio/TV announcements, newsletter insertions, newspaper ads, PAC agenda item, etc.), how will lists of participants be monitored, what will the invitations say and look like (i.e., emails, letters, website registration, contacts, etc.), how will participants register, when will reminders be sent, name badges for the day, groups determined, etc.

Opening the day: ice breaker activities, meet and greet, coffee/snacks at beginning, speaker topics/time to speak confirmed, guest speaker(s) invited, confirmed, MC necessary, formal or informal opening, special guests to be welcomed officially.

Coffee breaks and food: who will take charge of coffee, tea, drinks, snacks and lunch, ordering, catered event, pot luck, working lunch, how will food allergies and/or special diets be addressed (i.e., part of invitation, specific person to contact) a work-back schedule for each key action (i.e., facilitators, invitees, problem sketch, kits and pantry, food, etc.).

Capturing the day: will video, audio or pictures be taken, who will be responsible for media and

distribution, what will happen with prototypes (i.e., participants take them home, displays will be available after the event, transportation of prototypes to where they will be displayed), consent forms required, what would sponsors and/or grant funders require after the day.

Grouping participants with facilitators: how many participants in a group (best to consider even numbers — 4 or 6 participants per group and facilitator — since working in pairs is part of the design thinking process), who forms the groups, when do groups form on the day of the event, how will facilitators meet up with participants on the day, are areas assigned to groups or may groups chose their space, have a plan of how to combine groups if a participant or facilitator is not available on day of event.

Design thinking process: who develops the problem sketch, how/when will facilitators be trained, who will be responsible for photocopying and distribution of materials, pens/pencils /coloured markers.

Prototype building: what will be in the design kits, pantry and/or tool crib, who will do the purchasing of materials, who will be responsible for building the design kits, pantry, and/or tool crib for the day, when will kits be distributed to facilitators, who helps in the pantry, who helps with the tool crib, any special rules and/or regulations required to be posted for the day.

Reflecting on the day: how many three-fold presentation panels required, what materials will be available for this activity (i.e., coloured construction paper, coloured markers), who will organize the Gallery Tour and ensure every group is ready to present, what do participants need to know about the Gallery Tour, how long will the tour take, formal or informal presentations.

Clean-up of venue: who is responsible for clean-up of venue, who is responsible for removal/transportation of prototypes and three-fold presentation panels, what happens to left over food, who takes responsibility for collecting/distributing/storing design kits, pantry and/or tool crib.

Debriefing/evaluating the day: what have sponsors/funders requested, formal or informal process, what would a 'successful' day look like, what might be done differently, what worked, what required adjustments, what are participants saying.

Suggested Use
Modify this checklist to fit your event. Add more or less detail to suit the event being planned.

Draft Agenda

AM

8:30 Registration

9:00 Welcome By Hosts

9:15 Introduction to Design Thinking – Invited speaker

9:45 Linking Design Thinking, Trades, and Education – Invited Speaker

10:00 Formation of Groups and Morning Coffee

10:30 Start of project work

PM

12:00 Working lunch

1:00 Project work continues

3:00 Preparation of Group Presentation (organization of design notes, preparation for sharing

3:30 Closing comments and Introduction to Gallery Tour Process

3:45 Gallery Tour and Closing Reception

4:30 DONE!

Suggested Use
You can modify this agenda to fit your event. However, please recognize the Design Thinking is truly a 60–90 minute activity that is important to the project success. Also, the development of the group presentation is essential for personal reflection on the activity.

Group Facilitators' Roles and Responsiblities

Facilitator Guide for Maker Day: Celebrating The Best Gifts of Humanity – The Ability to Think Wisely and Tinker Creatively and Share Generously

Background
Maker Day 2013 was an invitation only event for educators that required all participants to thoughtfully and fully engage in design thinking and creative problem finding. At the heart of the day was the Maker ethos which "values learning through direct experience and the intellectual and social benefits that accrue from creating something shareable" (Martinez & Stager, 2013). The goal of the day was to develop an approach to assist educators to integrate making and tinkering into their classrooms.

Educators were introduced to Design Thinking, Inquiry; Making; and Hands on, Experiential Learning through their active engagement in a small group, problem finding, design challenge (program sketch). Groups were required to use some of all the materials in their kits. They could also make a pitch to take materials from a shared pantry of items and tools. To be successful, group members needed to collaboratively and creatively imagine, design, prototype, tinker, and share solutions to the design challenge.

Your Role and Responsibilities
As a group facilitator, it is your task to help your group experience the creative design cycle. Consider how you can accomplish the following tasks as generously as possible! The following ideas are only suggestions:

- Facilitate the design thinking process, using the provided d.School resources
- Help your group stay on task and be mindful of the time available
- Help your group make connections to the trades and professions
- Help your group select one design and build a viable prototype
- Help your group to reflect on their process and document it on the group trifold panel
- Discuss how they might integrate Making and Design Thinking into their practices

Please make sure you have a digital timing device with you —your phone or something— as you need to time/manage the Design Thinking Process activities.

Include your agenda for the day here— so facilitators can help keep activities on time.

Suggested Use

We used this document to help group facilitators understand their roles and responsibilities. All participants were organized into groups consisting of four participants and one facilitator.

SUGGESTED FACILITATION TIPS

Edit these tips to suit the design of your Maker Day

1. Each group member will have been assigned to one of the groups. Their group number is on their name tag that they received when they registered.

2. All participants with a numbered nametag are expected to actively and consistently participate in all group activities—there are no watchers or lurkers.

3. When you registered, you received your group's kit. No one is to look at the contents within the bag until you share it with them at Step 12 of this tip sheet. This is very important. If you show the kit too early, it may influence and limit project design ideas.

4. Please participate in the Low Fi Social Networking activity (8:30-9 a.m.). You can begin to identify your group members, but it is NOT necessary at this stage.

5. After the "official" speaking/opening, the MC will invite the participants to find their groups while getting morning coffee and find a good place for their group work. Please do not stray too far as you'll need access to the pantry of materials and the tools, plus the videographer/ media people may want to find you and your group.

6. Remind group members they can access coffee/tea and treats at any time during the day.

7. Read the Design Problem document to your group. Don't spend time discussing the problem at this stage, just tell your group members you will now lead them through the Design Thinking Process that will help them identify a possible solution.

8. Tell your group that once you start the Design Thinking Process, it will take 90 minutes and

How to facilitate your group (cont.)

there will be no breaks. Encourage your group to take a bio break before starting the Design Thinking Process activity

9. Personalize the Design Thinking script. You have a Facilitator's Guide in your Kit and you have worksheets for each of your group members. Distribute the worksheets and tell your group not to look ahead and to just follow your lead.

10. Facilitate the Stanford's dSchool Design Thinking Process (90 minutes)

11. Lunch. Once you have completed the Design Thinking activity and shared the various solutions, you can invite your group to pause and gather their lunch and bring it back to your group area. Invite them to glance at the pantry and the tool area as they gather their lunch.

Remember at this point groups will be moving at different rates and speeds.

Lunch needs to be eaten within the group
It's a working lunch.

12. Show your group the Kit items and determine which of the solutions the group is going to develop to the prototype stage.

13. Start building the prototype.

- Tell your group that they must use some of all the items in the kit, and tell then they can make a pitch to use some of the items from the pantry.
- Encourage them to explore the pantry/ tool crib. This is an important element of the experience.
- Remind the group of the design criteria from the Design Problem

Suggested Facilitation Tips

-Tool must be handheld
-Tool must be able to satisfy one of the concerns identified in Design Problem
-Tool must be unique yet usable and address a need
-Tool aligns with the mantra - Make it smaller, make it stronger, make it do more, make it easy to use, make it cheaper, make it clean, make it green.

14. Explain the purpose of the documentation process using the trifold panel

- The panel is to document the group's progress through the design thinking process: define, research, ideate, prototype, choose, implement, and learn
- Each group has total creative license with the production of their panel, but

-1 panel should annotate the group's copy/version of the Maker Manifesto
-1 panel should elaborate on its design process/prototype
-1 panel should share how group imagines it could integrate Design Thinking and Making in their professional practices in their schools

15. Encourage the group to work hard, push for detail

16. Ensure everyone takes an active role in the work – no passive partners

17. Explain the Gallery Tour

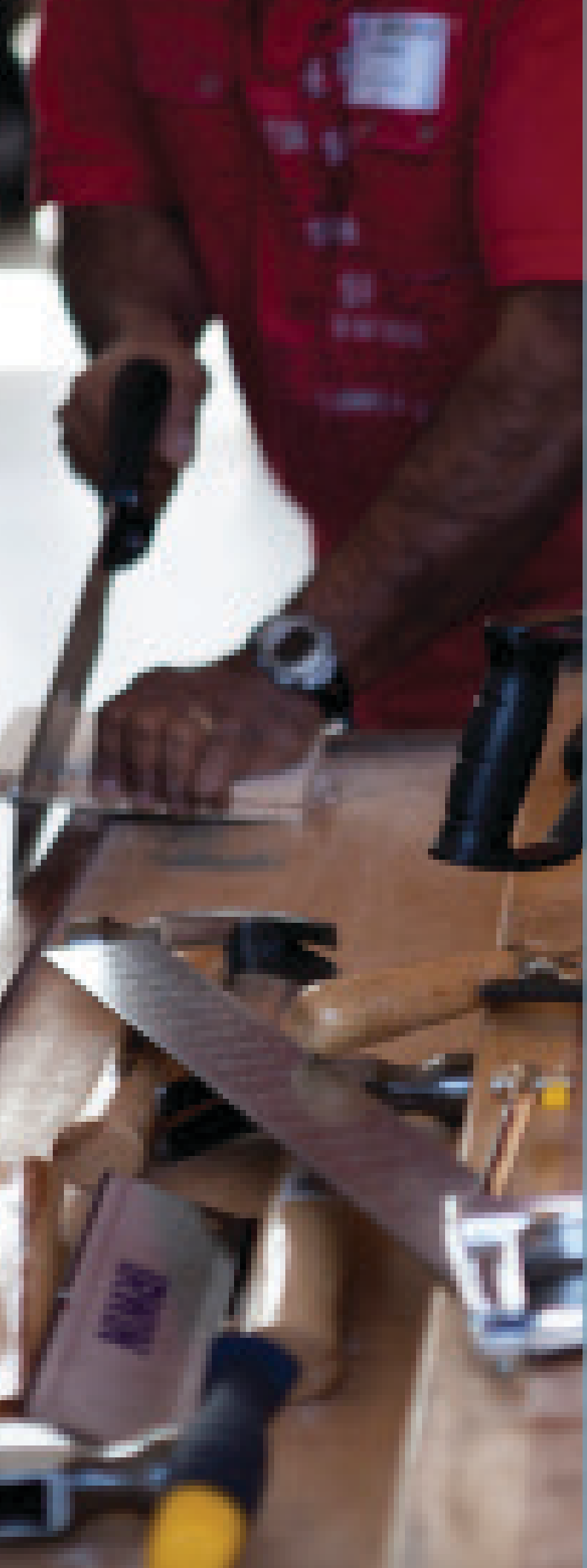
- Each group needs to set up a table with its trifold panel and prototype
- Trade off as to which one of the group stays that your table to explain

18. Tell participants they will receive access to Maker Day Online Toolkit. The toolkit will include all the resources used during Maker Day as well as photos/videos of the presentations, panels and prototypes.

19. Before the Gallery Tour please get your group to help you clean up your workspace.

- If you have items that are reusable,please put them back in your kit or return them to the pantry. If items are too small or trash, please dispose of them in the proper recycling bins provided
- Tools and materials in the kits will be reused by the Innovative Learning Centre
- If group members have spare time, ask them to help clean up the pantry and tool area.

Thanks in advance for your facilitation... your efforts, energy, enthusiasm, attention to timing and process to all help make Maker Day a success!



Designing a Design Problem

Whether you invite students into a maker project through (1) an inquiry question (2) position it as problem to be solved, or (3) cast it within a scenario, what aligns it to the Maker Movement is the intentional use of design thinking and the hands-on construction of a solution, using real tools and materials. A design problem or problem sketch creates a narrative from which participants can use design thinking to find creative solutions to problems through empathy and research.

In a School Setting

When we bring the Maker approach into a school, we may want to guide the students using an **inquiry orientation.** Wiggins and McTighe (2006) offer guidance in approach in their book, *Understanding by Design.* Central to their approach is the suggestion of thinking with the end in mind. This has lead to their work being called **backward design** as it considers the learning objectives, an approach, the use of materials and resources, while still allowing students to have an active role in determining individual aspects of the project and the ways in which it might be completed. The teacher has an active role in shaping the inquiry with the students and guides the students to use the available materials and resources within the specific context of the learning environment and curriculum under study.

Three Approaches to Forming a Design Problem

1. Inquiry (Alberta Learning, 2004) allows curriculum to be explored through authentic experiences – a key contribution of MAKING to teaching and learning activities. Authentic learning encourages students to inquire into things that are real and of interest to them. It positions the learning activities as problems to be solved. **Edutopia has a site sharing tools, tips and ideas about problem-based learning (PBL)**

2. According to Mayer and Wittrock (2006), problem solving is "cognitive processing directed at achieving a goal when no solution method is obvious to the problem solver" (p. 287). They explain students need five kinds of knowledge to be successful problem solvers:

- **facts:** knowledge about characteristics of elements or events, such as "there are 100 cents in a dollar";
- **concepts:** knowledge of a categories, principles, or models, such as knowing what place value means in arithmetic or how hot air rises in science;
- **strategies:** knowledge of general methods, such as how to break a problem into parts or how to find a related problem;
- **procedures:** knowledge of specific procedures, such as how to carry out long division or how to change words from singular to plural form; and
- **beliefs:** cognitions about one's problem-solving competence (such as "I am not good in math") or about the nature of problem solving (e.g., "If someone can't solve a problem right away, the person never will be able to solve it") (Mayer & Wittrock, 2009).

3. Scenarios are a form of story or narrative. They can be used to introduce students into a project. The purpose of a scenario is set a scene for a project and to create a common starting point. A scenario can also give the parameters for the project, outlining any limiting factors, special conditions and time/context constraints. Scenarios are creative ways of imagining a "different future" or an alternative way

of doing something. They help the students visualize the context for the task as they usually cover environmental, social, technical, political and economic concerns.

The sample task in the toolkit uses a problem sketch approach. The component of the problem sketch help frame a task within the following:

- background (Overview)
- context (Design Rationale),
- scenario (Problem Scenario),
- character for assessment/evaluation (Success Determinants), and
- rules/limitations (Parameters)

Suggested Use
This document links Maker activites to school settings and introduces the use of a design challenge.

Martinez and Stager (2013) suggest there are eight elements of a good project. The following list is modified from their book, Invent to Learn, and Gary Stager's web resource, which is shared in the Resource section of the toolkit.

1. Purpose and Relevance
Is the project personally meaningful? Does the project prompt intrigue in the learner enough to have him or her invest time, effort, and creativity in the development of the project?

2. Time
Sufficient time must be provided for learners to think about, plan, execute, debug, change course, expand, and edit their projects. Class time affords students equal access to expertise and materials; projects may also need sufficient out-of-school time.

3. Complexity
The best projects combine multiple subject areas and call upon the prior knowledge and expertise of each student. Best of all, serendipitous insights and connections to big ideas lead to the greatest payoff for learners.

4. Intensity
Children have a remarkable capacity for intensity that is rarely tapped by the sliced-and-diced curriculum. Projects provide an outlet for the exercise of that intensity. Think about how long kids can spend mastering a video game, reading a favorite book series, memorizing the attributes of Pokemon, or building a tree house, and you have a good template for successful project-based learning.

5. Connected
During great projects students are connected to each other, experts, multiple subject areas, powerful ideas, and the world via the Web. The lessons learned during interpersonal connections that are required by collaborative projects last a lifetime.

Designing a Design Problem

CONTINUED

6. Access
Students need access to a wide variety of concrete and digital materials anytime, anyplace. Personal student laptops make this possible, but we also need adequate access to craft materials, books, tools, hardware, software, and Internet access that allow learners to follow paths we may never have anticipated.

7. Shareable
This is the big idea of project-based learning! Students need to make something that is shareable with others. This provides a great deal of motivation, relevance, perspective making, reciprocal learning, and an authentic audience for the project.

8. Novelty
Few project ideas are so profound that every child needs to engage in its development in every class, or year after year. Yes, that means that it may be time to rethink the annual marshmallow adobe project. If one student makes a fantastic discovery during a project, others can learn from it without slavishly repeating the steps of the pioneering student. In a healthy community of practice, learning continues and knowledge is shared naturally without coerced repetition (http://stager.org/articles/What%20Makes%20a%20Good%20Project.pdf)

Not all Maker activities start with a problem sketch or a challenge. Typically at non-profit or commercial Maker Spaces, individuals come to a site like the TechShop in Menlo Park, CA (one of the first and started in 2006) with a project they would like to work on or a tool they would like to learn.

SAMPLE PROBLEM SKETCH

Design Challenge: Our Aging Society

Overview
In 2011, Human Resources and Skills Development Canada reported that 15.3% of British Columbia's population was classified as aged (age 65 and over). It also predicted that this population would increase to 23.8% by 2036. As a result, there is a real concern about providing support structures for these citizens.

Design Rationale
The population of BC prides itself on being mobile, whether it is by driving, riding public transportation, biking or walking. Mobility is important for many reasons, including shopping, accessing health care, and participating in social gatherings— just to name a few. Research suggests aging in place is beneficial on many levels, but experience tells us that as people age it becomes increasingly difficult to satisfy their need to enjoy the activities that make life rewarding as well as participate in everyday tasks.

Problem Scenario
Your team has been selected to develop the prototype of a tool that will help this identified population with their need to get out of their homes and participate in public outings.

This tool must be handheld and be able to satisfy one of the following identified concerns:

- Getting dressed
- Transportation/travel
- Personal Security
- Carrying purchases
- Paying for purchases
- Shopping for food, clothing, other personal items
- Maintaining their homes— basic repairs, gardening, etc.

Success will be determined by:

- Uniqueness and usability of the tool
- Alignment of the prototype with the design
- Ability of your tool to help the elderly get out and about
- Alignment to design motto: "Make it smaller, stronger, do more, be easier to use, be cheaper, be clean, be greener"

Parameters:

- You must use some of all the items in tool kit in some way
- You may make a pitch to use the materials found in the Pantry.
- You should use the tools located in the Shared Tool Area

Suggested Use

This design challenge was used for Maker Day 2013. You can use this challenge or modify this document to create your own design challenge. Please read the document—Designing a Problem Sketch/Design Challenge for background information.

Suggested Use

We used this document to help group facilitators understand their roles and responsibilities. This is a checklist to go with the Facilitator's Guide.

What is needed to host a Maker Day?

Facilitator Guide Stanford Materials

blogs.ubc.ca/centre/files/2013/11/MakerDayFacilitatorGuide_Revised-copy.pdf

Facilitator Checklist

The Facilitator Guide is a larger document that guides you through your role. This checklist is offered to help you make sure you have addressed each component of the design/prototype/reflection process.

1. Check you have all your group members. Make sure you know what's in your kit and how to use the items

2. Make sure you have read the **Design Problem** document and understand it. Read it to your group.

3. Make sure you have read through the **Design Thinking** suggested script and understand how to facilitate it

4. Monitor your group to make sure they use some of everything in their kit

5. Remind your group of the design criteria from the **Design Problem**
   - Tool must be handheld
   - Tool addresses the design challenge
   - Tool must be unique yet usable and address a need
   - Tool aligns with the mantra: ***Make it smaller, make it stronger, make it do more, make it easy to use, make it cheaper, make it clean, make it green.***

6. Remind your group to think of items they would like to include on the reflection panel. The panel is to document the group's progress through the design thinking process: *define, research, ideate, prototype, choose, implement, and learn*

7. Ensure everyone takes an active role in the work— no passive partners

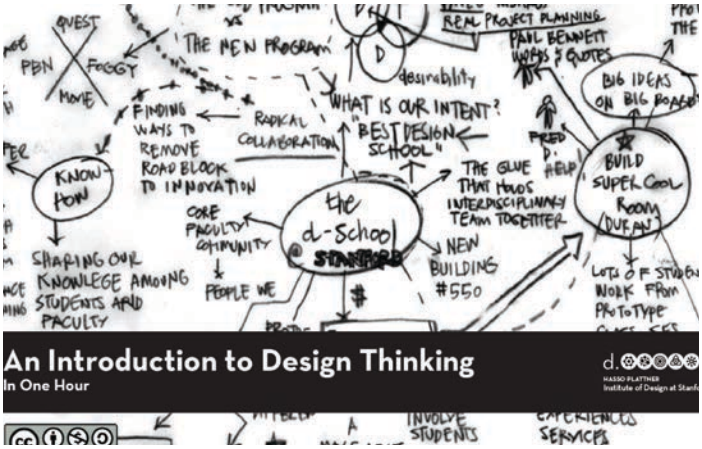
8. Explain the purpose of Gallery Tour. Each group needs to set up a table with its trifold panel and prototype. Trade off as to which one of the group stays at your table as host.

Suggested Use

We used this document to help group facilitators understand their roles and responsibilities. This is a checklist to go with the Facilitator's Guide

Participants' Guide

blogs.ubc.ca/centre/files/2013/11/TheAgingToolProject.pdf



Design Thinking Resources

Stanford's d.School is developed some open access design thinking materials. These materials are available to use and repurposing under Creative Commons licensing.

Website
Site of Stanford's "virtual crash course" in design thinking. On this site are sample projects, facilitator workshop guides, and a video.

dschool.stanford.edu
Design for Educators

K12 Lab Network
k12lab.org

Reflection Panels

Each group is asked to create a documentation panel to record and foster reflection on their design thinking, tinkering, and making process. We view making the panel as a way of helping to make the group's "thinking visible" (Eisner, 1998). For many of you, documentation aligns with the Reggio Emilia approach (http://ecrp.uiuc.edu/v13n2/wien.html) which views documentation as a type of design process. It suggests documenting as a visual way of capturing thinking and learning activities and inviting discussion about what is collected and how it is portrayed on the panel. This form of curating content supports the reflective practice that is so important for educators during professional development activities.

For Maker Day, we believe the reflective panels are essential to support a group's progress through the design thinking process: define, research, ideate, prototype, choose, implement, and learn.

While each group should be encouraged to exercise their creative license in the production of their panel, we suggest that each panel should have a minimum of three components. To facilitate the panel design, we suggest purchasing the cardboard, trifold display panels from a store such as Staples. Because of the short timeframe available to make the panel, we cut each trifold in half, horizontally, and found that groups had adequate space to document their work.

Suggested panel structure:

- 1 panel should annotate the group's copy/ version of the Maker Manifesto
- 1 panel should elaborate on the group's design process/prototype
- 1 panel should share how the group imagines they could integrate Design Thinking and Making in their professional practices in their schools

References

Eisner, E. (1998). The kind of schools we need: Personal essays. Portsmouth, NH:Heinemann

Wine, C., Guyevskey, V., & Berdoussis, N. (2011). Learning to Document in Reggio-inspired Education. Retrieved from http://ecrp.uiuc.edu/v13n2/wien.html

14

Participant Groups Kit Contents

15

See Appendix (p.46-47) for a list of items and a detailed cost/source list.

Suggested Use

The Appendix on page 46-47 the basic kit items provided to each group. The quantities support a group of four participants/group. Please note, some items must be purchased in bulk so the itemized prices reflect the Bulk costs divided by 15 kits. Bulk item prices are shown at the end of the list. Fifteen groups are ideal for an efficient, high energy, collaborative Maker Day.

Maker Day Tool Crib

16

See Appendix (p.48-49) for a list of items and a detailed cost/source list.

Suggested Use

The following is a list of the basic items provided in the Tool Crib. The quantities supported 15 groups with four participants/group. Each group made one prototype project solution to the design challenge.

Mark Hatch

MAKER MOVEMENT MANIFESTO

MAKE
Making is fundamental to what it means to be human. We must make, create, and express ourselves to feel whole. There is something unique about making physical things. These things are like little pieces of us and seem to embody portions of our souls.

SHARE
Sharing what you have made and what you know about making with others is the method by which a maker's feeling of wholeness is achieved. You cannot make and not share.

GIVE
There are few things more selfless and satisfying than fiving away something you have made. The act of making puts a small piece of you in the object. Giving that to someone else is like giving someone a small piece of yourself. Such things are often the most cherished items we possess.

LEARN
You must earn to make. You must always seek to learn more about your making. You may become a journeyman or master craftsman, but you will still learn, want to learn, and push yourself to learn new techniques, materials, and processes. Building a lifelong learning path ensures a rc and rewarding making life and, importantly, enables one to share.

TOOL UP
You must have access to the right tools for the project at hand. Invest in and develop local access to the tools you need to do the making you want to do. The tools of making have never been cheaper, easier to use, or more powerful.

PLAY
Be playful with what you are making, and you will be surprised, excited, and proud of what you discover.

PARTICIPATE
Join the Maker Movement and reach out to those around you who are discovering the joy of making. Hold seminars, parties, events, maker days, fairs, expos, classes, and dinners with and for the others makers in your community.

SUPPORT
This is a movement, and it requires emotional, intellectual, financial, political, and institutional support. The vest hope for improving the world is us, and we are responsible for making a better future.

CHANGE
Embrace the change that will naturally occur as you go through your maker journey. Since making is fundamental to what it means to be human, you will become a more complete version of you as you make.

Suggested Use
Consider having participants annotate this manifesto to help them consider the place of the Maker Movement in their work. It should also be used on the Group Presentation tri-fold reflective panel.

http://www.techshop.ws/images/0071821139%20Maker%20Movement%20Manifesto%20Sample%20Chapter.pdf

18

Gary Stager

What Makes a Good Project

What Makes a Good Project?

Eight elements to guide great project design

by Gary Stager, Ph.D.

Illustrated by Rive & Reynolds

Teachers instinctively know that projects are worthwhile, even if they do not understand every facet of a good project or have experience supporting project-based learning. For too many students, the term "project" means any activity that is not worksheet-based or takes longer than a 42-minute class period. I have seen too many instances of unimaginative assignments turned into projects just by giving students weeks for completion. That five paragraph essay about caribou is transformed into a project when students are given two months to obsess over it. The inevitable procrastination leads to increased stress and an imperceptible improvement in quality.

The protean nature of computers as constructive material with which you may explore powerful ideas and express yourself in a myriad of ways makes a wider range and depth of projects possible like never before. The Constructivist Consortium is committed to using computers in creative ways in which interdisciplinary projects demonstrate student competence and connect knowledge domains. Open-ended software supports learning diversity and allows multiple entry points into a sea of ideas. Seymour Papert once said, "If you can make things with computers, then you can make a lot more interesting things."

Making things is better than being passive, but making good things is better still!

The Constructivist Consortium believes in Papert's theory of constructionism; the idea that the best way to construct knowledge, or understanding, is through the construction of something shareable, outside of a student's head. Those artifacts are commonly thought of as projects, even though the project development process is where the learning occurs. Such artifacts are evidence of learning.

Elements of a good project

Purpose and Relevance. Is the project personally meaningful? Does the project prompt intrigue in the learner enough to have him or her invest time, effort, and creativity in the development of the project?

Time. Sufficient time must be provided for learners to think about, plan, execute, debug, change course, expand, and edit their projects. Class time affords students equal access to expertise and materials; projects may also need sufficient out-of-school time.

Elements of a good project

- Purpose and Relevance
- Time
- Complexity
- Intensity
- Connected
- Access
- Shareable
- Novelty

Complexity. The best projects combine multiple subject areas and call upon the prior knowledge and expertise of each student. Best of all, serendipitous insights and connections to big ideas lead to the greatest payoff for learners.

Intensity. Children have a remarkable capacity for intensity that is rarely tapped by the sliced-and-diced curriculum. Projects provide an outlet for the exercise of that intensity. Think about how long kids can spend mastering a video game, reading a favorite book series, memorizing the attributes of Pokemon, or building a tree house, and you have a good template for successful project-based learning.

Connected. During great projects students are connected to each other, experts, multiple subject areas, powerful ideas, and the world via the Web. The lessons learned during interpersonal connections that are required by collaborative projects last a lifetime.

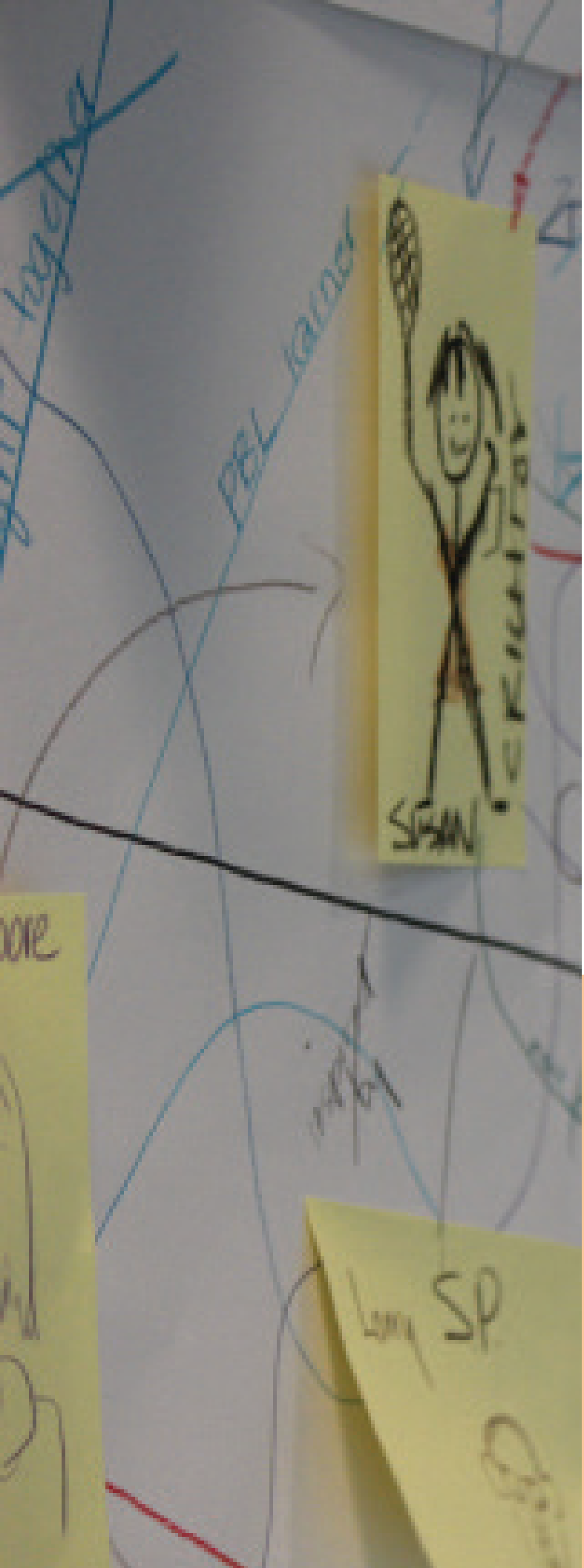
While there is some merit in organizing student groups to "teach" collaboration, I prefer a more natural environment in which students collaborate (or do not) based on their own needs.

Collaboration may consist of observing a peer, asking a quick question, or by working with the same teammates for the duration of a project.

Access. Students need access to a wide variety of concrete and digital materials anytime, anyplace. Personal student laptops make this possible, but we also

20 the creative educator

blogs.ubc.ca/centre/files/2013/11/What-Makes-a-Good-Project-copy.pdf



Ice Breaker

Because a Maker Day professional development day brings together a variety of people, icebreaker activities are often a fun way to meet and greet.

We used the Low Tech Social Network to bring people together during the registration process for Maker Day 2013.

(gogamestorm.com/?p=477)

For Maker Day 2013 participants were encouraged to make their initial contributions during the registration process and before the event actually started. The participants were encouraged to revisit the activity during the day to make additional connections.

If you decide to use the Low Tech Social Network make sure to use paper that is more SQUARE than linear to encourage a range of connections. Unfortunately, we used a long piece of paper and the connections were harder to make.

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APPENDIX

Maker Day Tool Crib

* Estimated cost as of Winter 2014

Item	Quantity	Note	Suggested Source	Approximate Cost
First Aid Kit	1	Basic Kit	Access to school First Aid kit	N/C
V Block	5 large	Used to hold 3 – 4" pipe for cutting	Ask a shop teacher to make them	N/C
V Block	5 small	Used to hold up to 1" pipe for cutting	Ask a shop teacher to make them	N/C
Power Drill	2	Cordless electric drill Kit – Approx. $100 ea	Building supply store	$200.00
Drill bits	1 package	Small size set to create holes for wire or bolts		$15.00
Spade bits	3	Sizes to match outside dimension of PVC pipe		$10.00
Doweling	15 lengths/ various thickness	Individual lengths could be pre cut; much cheaper than dowel lengths from hobby stores 1/2" x 72" = $5.19 ¾" x 72" = $5.99 ¼" x 48" = $1.40		$61.60
Hack saws	3	Easier to cut with than wood saws		$29.97
Hack saw blades	3	Fine blades to reduce chipping		$11.97
Ratchet clamps	5	Used to make cutting safer; use with v block to hold round material $3.00 ea		$15.00
PVC (1/2") – 90° elbows	15	Used for structural supports/framing		$8.85
PVC (3/4") – 90° elbows	15			$11.85
PVC (1") – 90° Elbows	15			$16.35
PVC (1/2") – 45° elbows	15			$10.35
PVC (3/4") 45° elbows	15			$17.85
PVC (1") 45° elbow	15			$23.85
PVC (1/2") Tee	15			$11.85
PVC (3/4") Tee	15			$11.85

Item	Quantity	Note	Suggested Source	Approximate Cost
PVC (1") Tee	15		Building supply store	$22.35
PVC (1/2") Cross	10		Building supply store	$17.90
PVC (3/4") Cross	10		Building supply store	$17.90
PVC (1") Cross	10		Building supply store	$27.90
PVC (1/2") Coupling	15		Building supply store	$7.35
PVC (3/4") Coupling	15		Building supply store	$8.85
PVC (1") – Coupling	15		Building supply store	$19.35
PVC (1/2") – Cap	10		Building supply store	$4.90
PVC (3/4") – Cap	10		Building supply store	$6.90
PVC (1") – Cap	10		Building supply store	$9.90
PVC (1/2" – ¾") Bushing	5		Building supply store	$2.95
PVC (1/2" – 1") Bushing	5		Building supply store	$8.90
PVC (3/4" – 1") Bushing	5		Building supply store	$5.95
PVC (1/2") pipe	10' x 10' pieces		Building supply store	$21.90
PVC (3/4") pipe	10' x 10' pieces		Building supply store	$26.90
PVC (1") pipe	10' x 10' pieces		Building supply store	$36.90
Vinyl Electrical Tape	3 rolls	Comes in red, yellow and green $1.49/roll @ 66 feet/roll	Dollar store	$4.47
Cord	1 roll	40 feet	Dollar store	$1.99
Small magnets	Mixture of sizes	Consider sheets of magnets that can be cut	Dollar store	$1.25
Washers	1 box	Small sizes to match cotter pins	Machine shop	$2.99
Cotter pins	1 box	Small box of mixed sized pins Package of 144 misc pieces	Princess Auto	$2.99
Nuts and bolts	1 box	Small box of mixed sized sizes Box of 172 misc size pieces	Princess Auto	$9.99
Velcro	1 box	Velcro can be cut into appropriate lengths ¾ x 66 feet	Princess Auto	$9.99
Styrofoam	Small pile	Use recycled Styrofoam from packing – used in place of wood	Recycling centre	Free
Cardboard	Small pile	Sheets of various thickness – used in place of wood	Recycling centre or Costco	Free
			Approximate Total	$736.81

Participants Group Kit Contents

* Estimated cost as of Winter 2014

Item	Quantity	Note	Suggested Source	Approximate Cost
Small Washers	10	Match to size of the cotter pins	Auto supply/machine store	Bulk cost*
3" Ardox nail	2	Used as a punch/awl for holes	Building supply store	Bulk cost*
Small garbage bag	4	Used to replace fabric/ create water proofing	Building supply store – size for kitchen garbage	Bulk cost*
Glue gun	1	Replacement glue for guns	Craft Store Tool store	$6.00
Glue sticks	1 package		Craft Store Tool store	$1.25
Modeling clay	Half package	Crayola makes a three colour package	Craft Store	$1.50
Jute twine	3 metre		Dollar store	Bulk cost*
Marbles	5		Dollar store	Bulk cost*
Duct tape	Small roll	48' x 5 mm	Dollar store	$1.25
Jumbo straws	10		Grocery store	Bulk cost*
Bamboo skews	10		Grocery store	Bulk cost*
Coloured cocktail straws	10		Grocery store	Bulk cost*
Tooth picks	25		Grocery store	Bulk cost*
Tongue depressors	10	Purchasing in medical supply store - much cheaper than craft store	Medical Supply store	Bulk cost*
Sharpie pen	1		Office supply store	$1.20
Cardboard trifold display	½ sheet cut in half horizontally	Used for project reflection/demonstration of learning	Office supply store	Bulk cost*
Graph paper	5 sheets		Office supply store	Bulk cost*
Brads	8	Used to make articulated joints	Office supply store	Bulk cost*
12" Ruler	1	Metal is best for both measuring and cutting straight edge	Princess Auto	$2.99
Utility knife	1	Put replacement blades in the Pantry	Princess Auto	$2.99
Tie wire	15 metres	This wire is easy to bend and cut with nail nose pliers	Princess Auto	Bulk cost*
Zip ties	10		Princess Auto	Bulk cost*

Item	Quantity	Note	Suggested Source	Approximate Cost
Needle nose pliers	1		Dollar store	$1.99
Cotter pins	4	Used to make joints/ moveable parts	Princess Auto	Bulk cost*
Small springs	2	Used to make push-able buttons	Princess Auto	Bulk cost*
Cardboard sheet	32" x 48" sheet	Can be used to protect table tops and be used for projects	Recycle store or Costco	Free
Cardboard box	Wine box with dividers	Good source of multiple weight cardboard	Liquor store	Free
Bag to hold contents			Staples	$.99
			Non-bulk items cost/kit	$20.16
			1/15 of bulk items	$4.61
			Approximate total per kit	$24.77

Bulk cost* Items	Source	Price – before tax
Box of 100 washers	Industrial supply store	$2.99
Ardox nails – 3" box of 75 nails	Building supply store	$4.89
Small kitchen size garbage bags 60/box	Building supply store	$5.99
Jute twine 300 feet	Princess Auto	$1.99
Marbles – bag of 102	Dollar store	$1.25
Jumbo straws - 200	Dollar store or grocery store	$2.99
Bamboo skewers – 100	Dollar store or grocery store	$1.99
Coloured cocktail straws – 200	Dollar store or grocery store	$1.99
Toothpicks – 1,000	Dollar store or grocery store	$1.25
Tongue depressors	Medical supply store	$10.99
Cardboard trifold – cut in half	Office supply store – Staples	$13.89
Graph paper – 100 sheets	Office supply store – Staples	$5.39
Tie wire – 18 ga x 30 metres	Princess Auto	$2.29
Zip ties – 100 mixed	Dollar store	$1.25
Cotter pins – box of 144 misc. pieces	Princess Auto	$2.99
Small springs – bag of 101 mixed sizes	Princess Auto	$3.99
Brad – box of 100	Office supply store – Staples	$2.96
Sub total		$69.08

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