INNOVATION WYRKSHOP

MAKERSPACE PLANNING GUIDE 2021

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Makerspace Planning Guide

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Introduction

Makerspaces are not just for hobbyists. Hands-on making empowers makers, and increases competence and confidence in areas that can extend quite far beyond Science, Technology, Engineering, Arts, and Math (STEAM) subjects. It doesn't just teach people how to master machinery, it teaches them how to solve problems with ingenuity and creativity. Through making, people learn how to fail successfully, and to tackle any of life's challenges with imagination, grit, and determination.

The Innovation Wyrkshop has long been a place of experimentation and where makers can sharpen these critical STEAM skills. Over the last several years, we've exponentially grown our programming — offering more and more hands-on learning and technology exposure opportunities to the 6,000 annual makers who call our makerspaces home. With Division of Vocational Rehabilitation partners, we were lucky enough to be provided the opportunity to build five additional spaces from the ground up throughout the state. In total, we've now constructed seven makerspaces across Wyoming, ranging from $35,000 introductory K-12 spaces to multi-million dollar, world-class facilities. Accordingly, we consider ourselves to be fairly well-versed in what it takes to build and deploy a successful makerspace. Every one of our facilities is a space where people from all walks of life can learn how to tap into incredible emergent tech, or make a project they've only ever dreamed of. And every one of our makerspaces is driven by a single fundamental concept: that *anyone* can be a maker.

The surge in popularity of this "Maker Movement" is, in part, driven by the slight decline of the current production-manufacturing economic model. More and more often, ordinary people are building projects and prototypes themselves, or learning new tools to pursue hobbies and passion projects. Together, these makers are a driving force pushing the world towards an incredibly exciting fourth industrial revolution. As traditional manufacturing changes, a "Desktop Manufacturing" revolution is on the horizon.

Enter the era of YouTube, and an open, collaborative internet. Millions of people share projects out on websites and social media, provide tips and ask questions of their cohort via forums. Tools that were once only available commercially, such as 3D printers, CNC routers, laser cutters, and even 3D scanners are small and affordable enough to sit on desks, in living rooms, garages, or in shared community workshops such as makerspaces. Makers are tapping into these resources to explore new tools and technology, often blending them into more traditional mediums, such as woodworking, sewing, and crafting.

Profound discoveries and innovations can be and have been made in makerspaces. These developments are often the result of someone with an idea and the newfound ability to bring those ideas to life using technology they might not have access to at home. For entrepreneurs, makerspaces can be spaces to build prototypes and proof-of-concept models that they can place directly in the hands of investors. For children and young adults, these spaces can be the spark that ignites a lifelong love of STEAM. This type of hands-on machine mastery, experiential learning can provide opportunities to develop skills, master machinery, and access emergent technology used increasingly across a huge array of industries. For all makers, these are spaces to break free from the mold of "consumer" and instead proudly start to self-identify as "DIY creators," "innovators," "entrepreneurs," and, of course, "makers."

Who this guide is for

We hope that this guide allows you to make an informed and data-driven decision during the planning stages of building out your own makerspace. Yours could be a brick-and-mortar location, as we have done with our "Wyrkshop" makerspace network, or even a mobile space that is driven out into the community.

Could you build any of the makerspace "tiers" detailed in this guide for less? Well, yes (and we hope you do)! This informational guide exists as simply that: a guide. As we've built out our spaces, we've kept detailed notes and kept careful track of the equipment, hardware, and software that our communities have engaged with and used heavily, or the workshops that the most makers have signed up for. Driven by that data, and supported by a large body of literature, we've compiled a list of typical costs and considerations when building a makerspace.

We're always looking for new ways to build out our maker family and provide this amazing technology to more communities, so please don't hesitate to reach out.

INNOVATION WYRKSHOP

Pricing Tiers

Makerspaces can effectively be broken down into four tiers based on the primary communities they serve as well as the subsequent equipment necessary to support these groups.

Tier 1m

Mobile Makerspace Lab

$40,117

includes all equipment, hardware, and software

An ideal space for small, quiet, or remote communities, or those wishing to test the waters and assess community interest in a makerspace.

Tier 1

Introductory Makerspace

$65,953

includes all equipment, hardware, and software

The best option for K-12 educators looking to spark an interest in STEAM and ignite innovation in a younger audience.

Tier 2

Rapid Prototyping, Entrepreneurial Facility

$249,891

includes all equipment, hardware, and software

Providing entrepreneurs and community groups access to incredible tech to help them achieve their innovative game-changing ideas.

Tier 3

Advanced Manufacturing & Research Facility

$505,607

includes all equipment, hardware, and software

No holds barred. A space providing unparalleled access to all major types of emergent technology in a space rivaling the longest-established East and West Coast makerspaces.

Best used for:	Tier 1m	Tier 1	Tier 2	Tier 3
K-12 experiential STEAM learning	✓	✓	✓	✓
Rapid prototyping	✓	✓	✓	✓
Entrepreneurial work		✓	✓	✓
Small batch production			✓	✓
Medium batch production				✓
Research, advanced material use				✓
Typical facility capacity	< 20	30	30	60+

Additional Considerations

Consideration must be made for staffing the makerspace, and there are three primary makerspace management models supported by the literature. The suggestions below were sourced from a large repository of papers and presentations from two major makerspace journals and accompanying conferences: the International Symposium on Academic Makerspaces (ISAM) and American Society for Engineering Education (ASEE). We also include one additional advanced hybrid management model, based on our own experience operating a Tier 3 facility with heavy foot traffic. Checkmarks denote recommended staffing options at each tier.

		Tier 1m	Tier 1	Tier 2	Tier 3
Volunteer model (no paid staff)	$0.00	✓			
Student-led model (5 student staff, 10 hours per week each)	$25,000		✓		
Professional model (1 full-time staff member, 40 hours per week)	$43,533		✓	✓	
Introductory hybrid model (1 full-time staff, 3 student staff)	$58,533		✓	✓	✓
Advanced hybrid model (1 full-time staff, 8 student staff)	$83,533			✓	✓

Annual operation costs should factor into the decision-making process. Equipment contributing to the figures provided as part of this guide have been selected due to their excellent reputation, excellent performance observed over a period of four years, popularity in industry, as well as exemplary customer support. Accordingly, machine obsolescence is only predicted to occur around five years, and only for smaller desktop and benchtop hardware and software. Industrial equipment included on these lists are expected to remain relevant for a period of no less than 10 years.

Operating costs:	Tier 1m	Tier 1	Tier 2	Tier 3
Consumables and materials budget	$5,000	$5,000	$10,000	$15,000
Outreach budget	$10,000	$10,000	$5,000	$5,000
Equipment repairs	$2,000	$2,000	$6,000	$10,000
Fuel	$4,328	-	-	-

In much the same way that many famous Silicon Valley companies were first started in incubators or garages, it's quite common for makerspaces to capitalize on existing space on campuses or within creative communities. Should space be unavailable, we've provided additional estimated costs necessary to start a brick-and-mortar facility entirely from the ground up. Annual estimated recurring costs are included as well.

Startup costs:	Tier 1m	Tier 1	Tier 2	Tier 3
Workstations (workbenches, seating)	$2,200	$22,350	$21,800	$43,600
Vehicle (retired school bus)	$12,000	-	-	-
Vehicle conversion (retrofit)	$5,000	-	-	-
Ventilation (to accomodate at least four large industrial machines)	-	-	$8,000	$8,000
Power conversion (to accommodate around four to six 240V machines)	$2,750	-	$1,375	$2,750
Recurring costs:				
Approximate size (square feet)	300	1000	2500	3500
Approximate commercial rental costs (assuming a state average of $9.00/sq ft)	-	$9,000	$22,500	$31,500
Utilities (electricity, gas, water, internet) (assuming a state average of $3.00/sq ft)	-	$3,000	$7,500	$10,500

Equipment

		Tier 1m	Tier 1	Tier 2	Tier 3
3D Printers	Introductory desktop FDM 3D printers	✓	✓	✓	✓
	Intermediate desktop FDM 3D printers		✓	✓	✓
	Advanced desktop FDM 3D printers			✓	✓
	Introductory desktop SLA (resin) 3D printers			✓	✓
	Industrial FDM 3D printers			✓	✓
	Industrial polyjet 3D printers				✓
3D Scanners	Introductory photogrammetry 3D scanning cameras	✓	✓	✓	✓
	Intermediate structured-light 3D scanners			✓	✓
	Advanced structured-light 3D scanners				✓
Laser Cutters	Introductory desktop laser cutters	✓	✓	✓	✓
	CO2 laser cutters		✓	✓	✓
	Fiber laser cutters				✓
Electronics	Microcontrollers	✓	✓	✓	✓
	Soldering equipment	✓	✓	✓	✓
	Introductory benchtop testing equipment			✓	✓
	Advanced benchtop testing equipment				✓
Woodshop Tools	Hand tools	✓	✓	✓	✓
	Handheld power tools	✓	✓	✓	✓
	Benchtop and table saws			✓	✓
	Benchtop sanders			✓	✓
	Drill presses			✓	✓
	CNC routers			✓	✓
	Planers				✓
	Lathes				✓
	CNC mills				✓
Sewing	Sewing machines	✓	✓	✓	✓
	Industrial sewing machines		✓	✓	✓
	Sergers			✓	✓
Extended Reality (XR)	Introductory XR	✓	✓	✓	✓
	Intermediate, portable XR	✓	✓	✓	✓
	Powerful XR			✓	✓

Mobile Makerspace Lab

Tier 1m
Package

$40,117
Equipment

Estimated Incidentals

$0
Annual staffing

$21,434
Annual operation

What happens when makers can't travel to the makerspace? We bring the makerspace to the makers.

Wyoming is unique in the fact that our wide open spaces and small state population mean that we have a higher number of remote or distance-learning communities with much greater distances between them than, say, the East Coast. This means that there could be greater demand for mobile makerspaces in areas where a brick-and-mortar location might not draw enough visitors to warrant purchasing equipment or fully staffing.

Mobile makerspaces can also fill a critical niche in areas where a school district may not have the budget for a full makerspace, or in areas that might lack the room or space requirements for a traditional, larger makerspace. In these scenarios, a traveling makerspace can be leased for a month, a semester, a term, even a year. Activities and workshops can be catered to specific school STEAM curricula, and students can gain temporary access to critical resources that might ignite a passion for making, STEAM, and anything in between. All you'll need is a good parking spot.

Micron STEM Bus, Oregon/Idaho

Maker[Space]Ship, San Jose Public Library

Utah STEM Bus

Wyoming Examples

None

Introductory Makerspace

Tier 1
Package

$65,953
Equipment

Estimated Incidentals

$25,000
Annual staffing

$17,290
Annual operation

Makerspaces are for *everyone*.

Studies have shown that the drive to explore, interact, and observe begins in early childhood. When young children enter school, they may already have substantial knowledge of the natural world, can think both concretely and abstractly, use a range of scientific reasoning processes, and are eager, curious, and ready to learn.

Providing access to high-quality STEAM tools, activities, and programming can strengthen these innate abilities. Introductory makerspaces have all the necessary creative tools and programming that have proven to be critical to setting children on a path to long-term academic and professional success.

Introductory makerspaces provide access to the most common types of emergent technology, including: desktop 3D printers, photogrammetric 3D scanners, small benchtop laser cutters, soldering kits and microcontrollers, introductory woodshop hand and power tools, sewing machines, virtual reality kits, 3D modeling and CAD software, and a plethora of K-12 engagement kits ranging from LEGO robotics to snap circuitry.

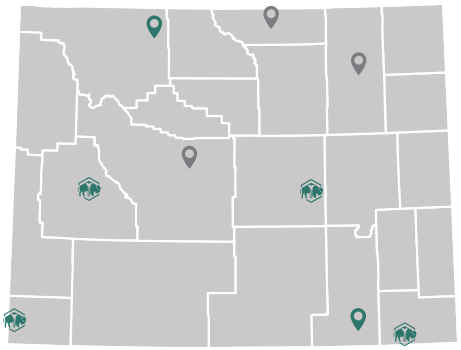
Creation Station


Golden Eagle Wyrkshop


Coe Student Innovation Center

Wyoming Examples

Creation Station, Casper
Golden Eagle Wyrkshop, Cheyenne
Pinedale Wyrkshop, Pinedale
Evanston Wyrkshop, Evanston
Powell Makerspace, Powell
Coe Student Innovation Center, Laramie



Rapid Prototyping, Entrepreneurial Facility

Tier 2
Package

$249,891
Equipment

Estimated Incidentals

$58,533
Annual staffing

$22,523
Annual operation

Emergent tech for entrepreneurs.

Despite being spread out across almost 98,000 square miles, communities across Wyoming are home to a huge number of innovators, inventors, makers, and creative types with a diverse range of skills and talents. It's critical that we provide equal opportunity and access to these communities as well.

You might find that many of these community makers work by themselves in their own garages, attics, and workshops, but rarely will they have access to the incredible emergent tech found in a typical makerspace. A robust entrepreneurial ecosystem that supports these innovators, provides access to critical technologies, and encourages them to develop new skills, innovate, and pursue their entrepreneurial ideas is very important in furthering Wyoming's economic growth.

Why not provide those community groups with access to advanced and industrial hardware and software that go a step above the standard introductory technology found in a Tier 1 makerspace. If the community can dream it up, a Tier 2 makerspace is equipped to help them make it a reality.


Phorge

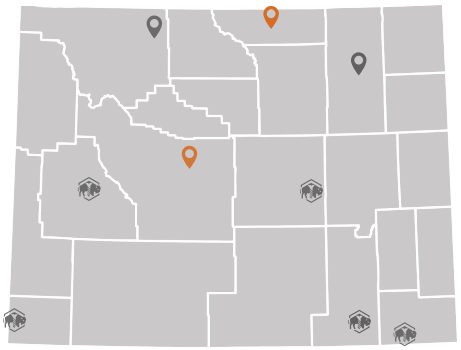

Maker Space 307


Maker Space 307


Maker Space 307

Wyoming Examples

Maker Space 307, Riverton
Phorge, Sheridan



Advanced Manufacturing & Research Facility

Tier 3
Package

$505,607
Equipment

Estimated Incidentals

$83,533
Annual staffing

$32,984
Annual operation

World-class equipment at your fingertips.

The most advanced makerspaces were actually some of the first pioneers and earliest adopters of the greater maker movement. Two decades ago, makerspaces got their start as fairly exclusive, high-tech clubs that began rapidly appearing across large research universities. Today, a collaborative group, the Higher Education Makerspaces Initiative (HEMI), is made up of some of these leading universities, including MIT, Yale, Stanford, Berkeley, Olin, Georgia Tech, and Case Western Reserve. HEMI helps to guide the crucial International Symposium on Academic Makerspaces (ISAM) conference and associated journal. All of these formidable, long-established makerspaces share similar goals: to provide a world-class , technical prototyping space for innovation and invention. A space where researchers, academics, entrepreneurs, and of course community members can tap into some truly cutting-edge technology.

These advanced innovation facilities provide access to incredible technology perhaps found nowhere else in the state and provide stimulus for local entrepreneurship. Our Tier 3 spaces may not span a full building, but the associated equipment should still help catapult any community to the front of the research and innovation-driven “Desktop Manufacturing” revolution.


Area 59

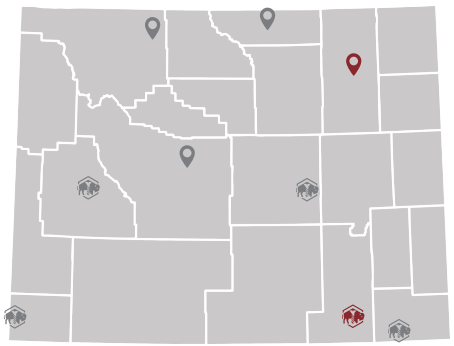

Area 59


Innovation Wyrkshop


Innovation Wyrkshop

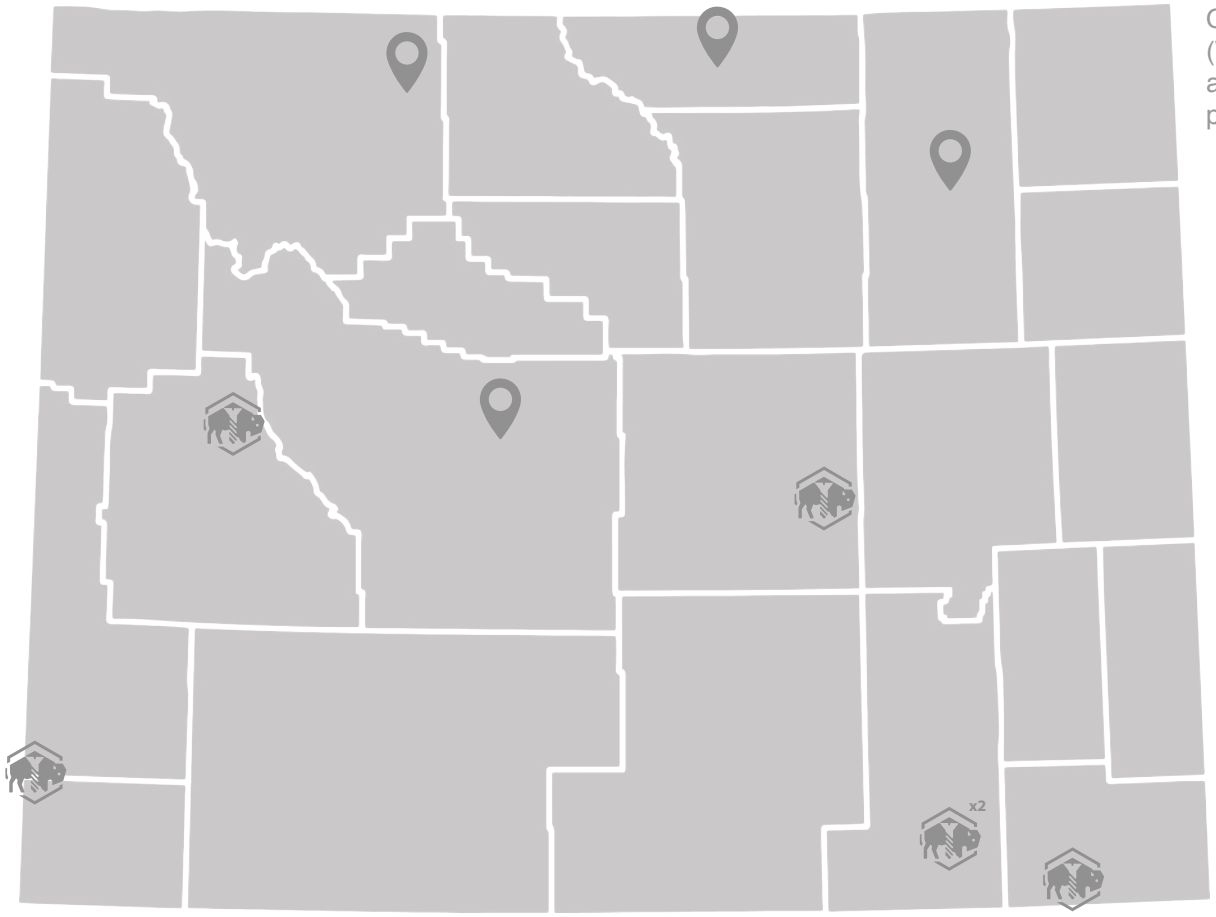
Wyoming Examples

Innovation Wyrkshop, Laramie
Area 59, Gillette College, Gillette



Existing Makerspaces

There are only ten major makerspaces in Wyoming. We hope you'll help us change that.

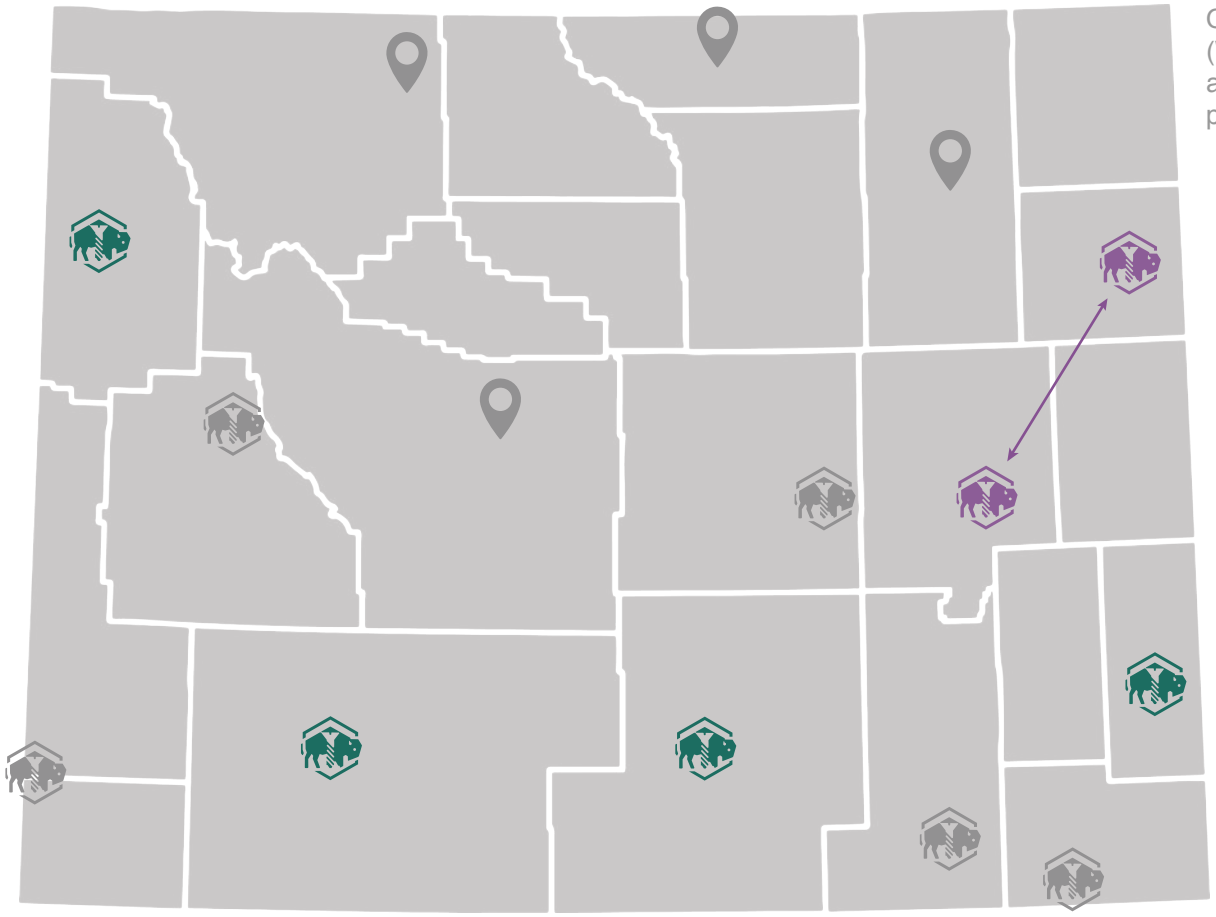


Our makerspaces (Wyrkshop icons) and statewide partners (pins)

Existing makerspaces	
Innovation Wyrkshop (University of Wyoming, Laramie)	Tier 3
Area 59 (Gillette College, Gillette)	Tier 3
Maker Space 307 (Riverton)	Tier 2
Phorge (Sheridan)	Tier 2
Powell Makerspace (Powell)	Tier 1
Golden Eagle Wyrkshop (LCCC, Cheyenne)	Tier 1
Creation Station: An Innovation Wyrkshop (Natrona County Library, Casper)	Tier 1
The Pinedale Wyrkshop (Sublette County BOCES, Pinedale)	Tier 1
The Evanston Wyrkshop (Uinta County BOCES, Evanston)	Tier 1
Coe Student Innovation Center (University of Wyoming, Laramie)	Tier 1

Our Aspirations, Year 1

Build out introductory Tier 1 and 1m spaces where none exist to create an even distribution of facilities statewide.

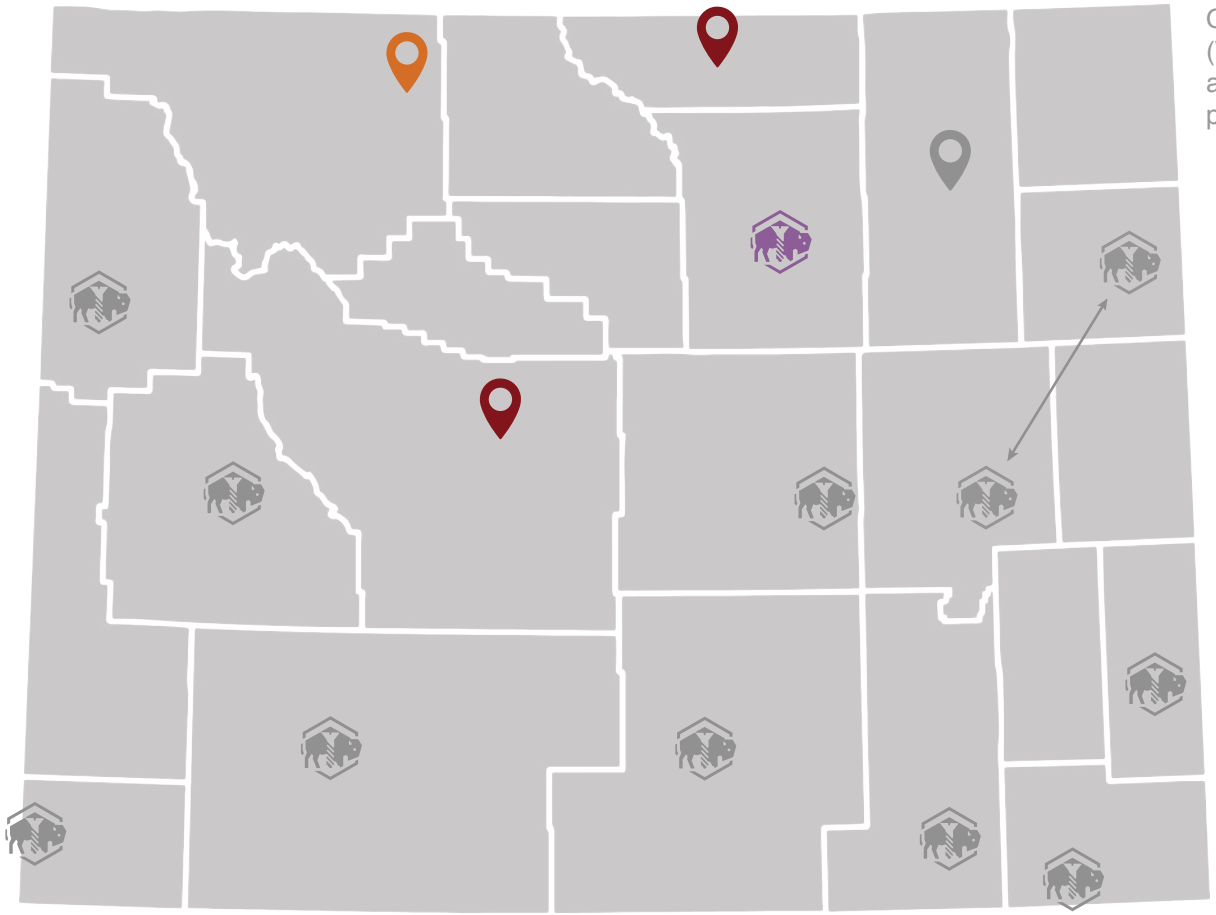


Our makerspaces (Wyrkshop icons) and statewide partners (pins)

Estimated costs, new spaces		Year 1	Year 2	Year 3
Eastern Wyoming College Wyrkshop (includes equipment, staffing, operations)	Tier 1	$108,243	$42,290	$42,290
Jackson Innovation Wyrkshop (includes equipment, staffing, operations)	Tier 1	$108,243	$42,290	$42,290
Rawlins Innovation Wyrkshop (includes equipment, staffing, operations)	Tier 1	$108,243	$42,290	$42,290
Western Wyrkshop (Western Wyoming Community College, Rock Springs)	Tier 1	$108,243	$42,290	$42,290
Northeast Wyoming Mobile Wyrkshop (includes equipment, staffing, operations)	Tier 1m	$61,551	$21,434	$21,434

Our Aspirations, Year 3

Bolster existing Tier 1 and Tier 2 partner facilities affiliated with Wyoming community colleges.



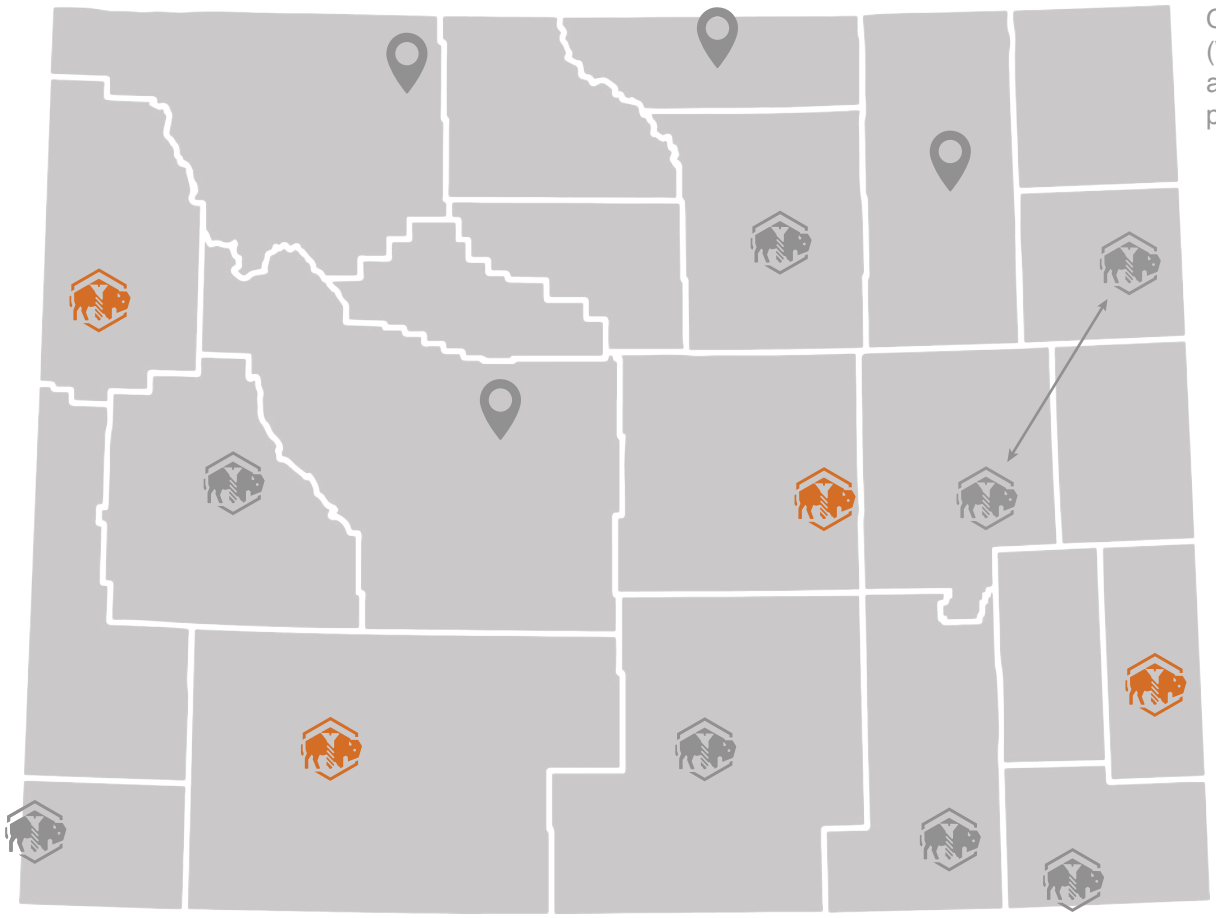
Our makerspaces (Wyrkshop icons) and statewide partners (pins)

Estimated costs, new spaces		Year 1	Year 2	Year 3
Johnson County Mobile Wyrkshop	Tier 1m	$61,551	$21,434	$21,434

Estimated upgrade costs, existing spaces		Cost
Maker Space 307 upgrade (Riverton)	Tier 3	$339,249
Phorge Makerspace upgrade (Sheridan)	Tier 3	$339,249
Powell Makerspace upgrade (Powell)	Tier 2	$242,471

Our Aspirations, Year 5

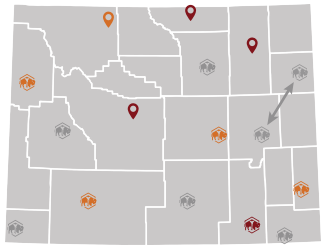
Upgrade Tier 1 Wyrkshop facilities to Tier 2 in areas connected to academic institutions or extension schools



Our makerspaces (Wyrkshop icons) and statewide partners (pins)

Estimated upgrade costs, existing spaces		Cost
Western Wyrkshop (Western Wyoming Community College, Rock Springs)	Tier 2	$242,471
Eastern Wyoming Wyrkshop (Eastern Wyoming College, Torrington)	Tier 2	$242,471
Creation Station (Natrona County Library, Casper)	Tier 2	$242,471
Jackson Innovation Wyrkshop (Jackson)	Tier 2	$242,471

Upgrading these spaces, particularly those affiliated with the eight higher education institutions, positions Wyoming well with a distributed network of makerspaces accessible by the entire population. By ensuring that each of these is at least a Tier 2 facility, we anticipate these spaces will be able to serve the majority of interests — from entrepreneurs and innovators to artists and creative communities throughout the state.



Return on Investment

So you've selected the type of makerspace you want to set up. What can your administration expect in return? Perhaps most notably, you should *not* expect a cash windfall. Let's explore why.

Unless your facility is charging exorbitant markups on materials, paid workshops, or expensive memberships, makerspaces are not known to be cash cows. Yours almost certainly won't bring in the 10x returns that most venture investors might expect. As an example, our Innovation Wyrkshop makerspaces are lucky enough to be funded through both grants and donor endowments. We charge nothing to attend workshops, our memberships are free, and we simply charge at-cost to use our consumable materials if a maker doesn't want to bring their own. All in an effort to keep energy barriers low and accessibility high. Still, some of our statewide partners charge monthly or annual memberships, and others charge small fees for makers to attend workshops. These are fine options, but ultimately aren't likely to fully fund your space.

The main return on investment (ROI) for makerspaces is not monetary, it's innovation. You'll be building communities, companies, and competent, confident makers to go out and contribute to Wyoming's future. Creative people are the beating heart of any successful makerspace, and you'll be making a meaningful investment in *them*.

The Innovation Wyrkshop in Laramie, a Tier 3 makerspace, at a glance. From October 2019 to January 2021, according to data collected from foot traffic and optional surveys, there were:

7,014 visitors

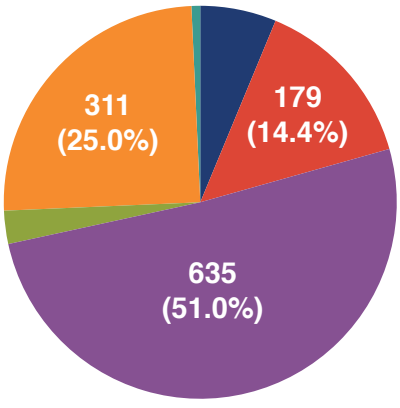
473 workshops offered

1,246 unique workshop attendees

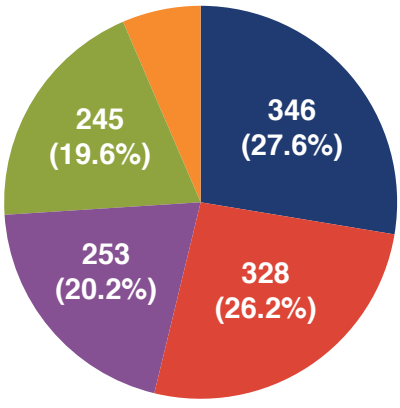
2,361 workshop badges earned

1,917 machines reserved

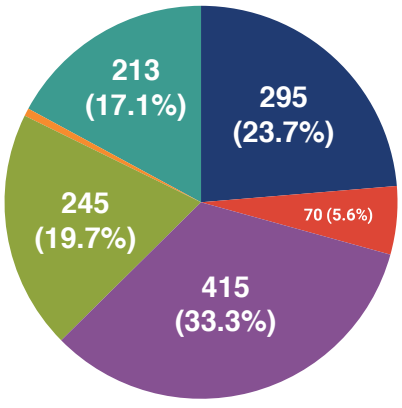
Maker identity:



Reason for use:



Project categories:



Entrepreneurial Endeavors

What's in store for the future of Wyoming innovation? Ask an entrepreneur who has spent time prototyping in a makerspace, and you're likely to get an optimistic response. Innovation typically occurs at the intersection of diverse backgrounds, ideas, and experiences, so when makers from different cultures, upbringings, income brackets, and different ways of thinking get in the same room, they can provide new, creative, innovative, wonderfully 'outside-the-box' ways of tackling complex problems.

By their nature, makerspaces are home to a huge diversity of people, backgrounds, cultures, and ideas. Every day, exciting new innovations are born in these community workshops, thanks to the shared resources available. Need access to a 3D printer or laser cutter to bring that bar napkin sketch to life? You're likely to find one (or several) at your local makerspace. Need to bounce ideas off an artist, or an engineer to draw up plans? Look no further. Here we highlight a small but exceptionally diverse number of projects that were prototyped in the Laramie Innovation Wyrkshop over the last year that you might expect in your makerspace as well:

A functional, 3D printed carbon fiber air intake assembly for a turbo diesel truck engine, designed and printed by a Gillette inventor.

Flexible rubber, custom-fit 3D scanned and 3D printed sneaker insoles by a Laramie-based shoe company.

3D printed housing for commercial, military, and recreational drone 'license plates' developed by a Marine Corp and Department of Defense contract group based out of Virginia.

3D printed biomedical filter housings and prototype molds designed by a Denver-based collaborative research group with help from University of Wyoming (UW) faculty and graduate students.

Rapidly produced laser-cut medical gown patterns designed and prototyped by a Laramie-based outdoor sporting goods store to address supply chain shortages.

An interactive, traveling STEAM science exhibit by UW graduate students, designed to highlight the huge diversity of microorganisms in soil samples.

2,000 custom-designed laser cut and 3D printed face shields to accommodate large dental loupes, allowing the Wyoming Dental Association to continue work amid pandemic supply chain shortages.

Laser-cut and woodshop-carved 'parklet' architectural models, a partnership between Laramie City Engineers, UW Dept. of Visual Arts faculty, and art students to beautify downtown Laramie.

A custom-fitted, 3D-printed, below-elbow prosthetic with unique violin adapter for a middle-school girl in Cheyenne who had always wanted to participate in orchestra.

A new business sparked by a retiree with limited mobility and a skilled woodworking student to design, build, and sell furniture and handmade projects.

An inexpensive, laser-cut tablet keyguard prototyped by a Wyoming Institute for Disabilities speech language pathologist who recognized that traditional keyguards are prohibitively expensive.

A weighted stylus for a client with an essential tremor, designed by student makers contracting with an occupational therapist, intended to improve quality of life.

Innovative Ideas in Action

Dental Dilemma

During the height of the COVID-19 pandemic, nationwide PPE supply chain shortages meant that many Wyoming dentists were unable to continue work until they met the new stringent CDC guidelines. Dental procedures typically produce signficant amounts of aerosols, which meant that all practicing dental facilities performing emergency care must wear face shields at all times. A problem for Wyoming dentists statewide was that dental loupes (the small magnification and LED devices that nest over safety glasses) were impossible to fit under the few face shields that dental staff were provided. Thus, dentists across the state were unable to work. Cue a conversation between makerspace staff and Dr. Ilene Choal of Laramie River Dental. Through discussion with makers and CAD designers, a prototype of a larger face shield that could accommodate dental loupes was developed and sent to the entire Wyoming Dental Association (WyDA) for review. After consultation, 2,000 face shields were rapidly produced and sent to hundreds of dentists around the state, enabling them to resume performing emergency care.

3D Printed Pumps

What if it were possible to own a pair of shoes that not only fit your feet perfectly, but were designed specifically around how *you* move, jump, and run? That question is at the mission of local Laramie and Denver shoe company *Hypo Footwear*. The answer? You can absolutely 3D print custom, dynamic shoe insoles form-fitted to the individual user. Hypo approached the Innovation Wyrkshop team, and a group of skilled makers quickly got to work 3D printing a series of soft, TPU-rubber prototypes for the Hypo team to test and approve. With the greenlight, Hypo Footwear is moving forward hiring interns and purchasing their own fleet of 3D printers. Expect some innovative footwear along the Front Range soon.

Licensed for Lift-Off

When it comes to drones, we're still in a bit of the lawless Wild West. Whether you spy a commercial, hobbyist, or even security drone flying overhead, it can be difficult to determine who owns it and whether it belongs in that airspace. That's where Vigilent Inc's *v.PASS* comes into play. The v.PASS is a patented device that can emit a secure and unique signal identifying the make, model, registered owner and operator, certifications and other appropriate FAA data. Law enforcement and first responders can quickly and easily identify critical information and take action accordingly. And the first housing that encapsulates the v.PASS tech? Prototyped and built right here in the Laramie Innovation Wyrkshop.

Ready to plan that makerspace?

Click to download

If you're ready to take that next step, we've created a supplemental, comprehensive guide for you to download that provides a very detailed list of common makerspace equipment makes, models, brands, categories, and quantities, as well as our rationale and recommendations for hardware and software at each makerspace tier.