Welcome, and thank you for coming.

I hope to demonstrate the value of 3D-printed assistive technology and why 3D-printed keyguards are the best way for you to get started with this new technology.

Ken Hackbarth

I am the president of Volksswitch – an organization devoted to the democratization of assistive technology by leveraging the power and promise of 3D printing.

First, a bit about me.

I am the president of Volksswitch.

As the slide says, Volksswitch is an organization devoted to the democratization of assistive technology by leveraging the power and promise of 3D printing.

Volksswitch is committed to designing customizable, personalizable, 3D-printable devices and putting those designs in the hands of the people who need them.

Prior to my current position I worked for almost three decades as a systems architect for AT&T Bell Laboratories and its subsequent divestitures.

I have a Master of Science in Systems Engineering from the University of Arizona and a Master of Education in Special Education, with a concentration in assistive technology, from Bowling Green State University.

Examples of Free, 3D-Printable AT Designs

Without further delay, let's look at some examples of freely available, 3D-printable, assistive technology designs.

“Quick-Zip” Zipper Aid

Cost of plastic: **3¢**

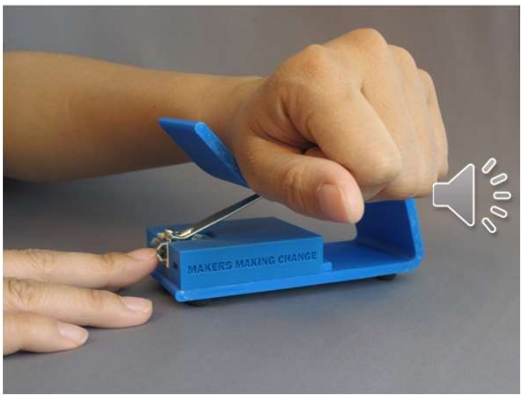
I’m going to quickly cycle through several examples.

Each example will include a picture of the device and the cost of the plastic required to print one. If additional hardware is needed, that cost is not included.

The title of each slide includes a hyperlink to the 3D model. As do the slide notes.

https://pinshape.com/items/25738-3d-printed-zipper-aid-and-easy-keychain-ring

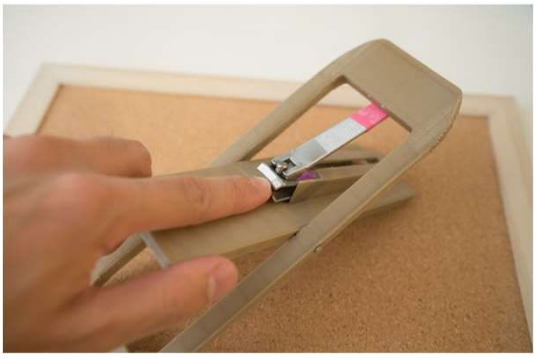
Nail Clipper Holder



Cost of plastic: **$1.23**

https://www.thingiverse.com/thing:2810056

Nail Cutter for One Hand



Cost of plastic: **$1.19**

https://www.thingiverse.com/thing:2937655

Kobayashi Fidget Cube

Cost of plastic: **75¢**

https://www.thingiverse.com/thing:1269699

Arm Spork

Cost of plastic: **53¢**

https://www.thingiverse.com/thing:640839

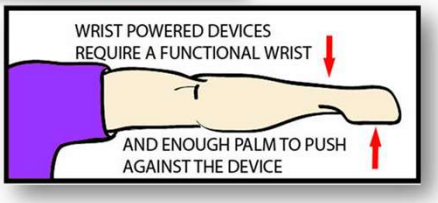
Thumb Prosthesis

Cost of plastic: **89¢**

https://www.thingiverse.com/thing:2246592

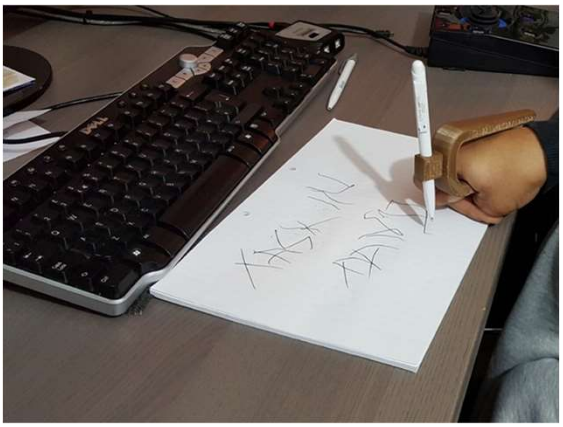
Wrist-Powered Prosthetic Hand

Cost of plastic: **$3.00**



http://enablingthefuture.org/upper-limb-prosthetics/cyborg-beast/

Disability Friendly Pen Holder



Cost of plastic: **68¢**

https://www.thingiverse.com/thing:1324235

Drawer Opening Assistive Device

Cost of plastic: **68¢**

https://pinshape.com/items/25355-3d-printed-drawer-opening-assitive-device

Smart One-Handed Bottle Opener

Cost of plastic: **46¢**

https://www.youmagine.com/designs/smart-one-handed-bottle-opener

Universal Cuff Stylus

Cost of plastic: **75¢**

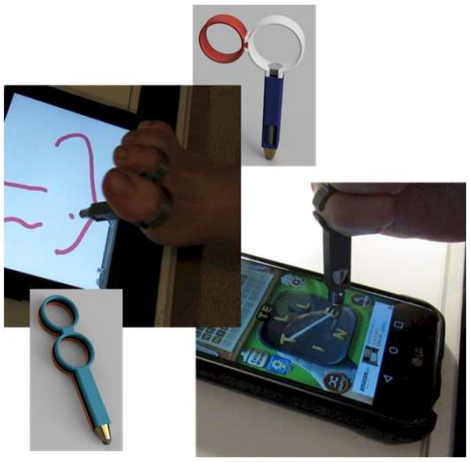
https://www.thingiverse.com/thing:3490198

Dyslexia Reading Bar

Cost of plastic: **35¢**

https://www.thingiverse.com/thing:2802065

Sixth Finger/Toe Stylus



Cost of plastic: **17¢**

https://www.thingiverse.com/thing:3483326

Bottle Opener

Cost of plastic: **50¢**

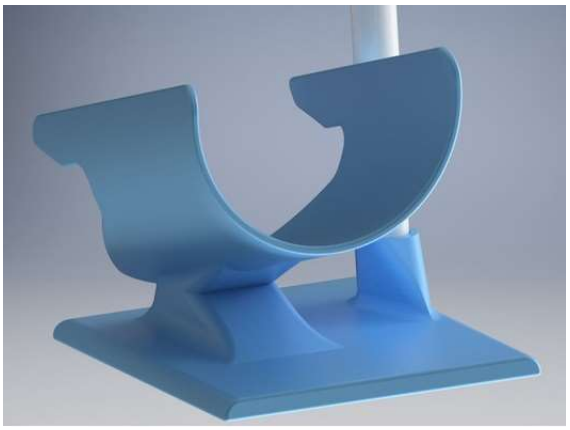
https://www.thingiverse.com/thing:2801157

Pop-top Can and Bottle Opener

Cost of plastic: **75¢**

https://www.thingiverse.com/thing:3043598

Sock Helper Mobility Aid



Cost of plastic: **$4.69**

https://www.thingiverse.com/thing:2482788

Magnetic Shoelaces

Cost of plastic: **25¢**

https://www.thingiverse.com/thing:3028911

Beverage Holder

Cost of plastic: **$3.50**

https://www.myminifactory.com/object/3d-print-the-next-beverage-holder-57768

Head Pointer

Cost of plastic: **$1.15**

https://www.thingiverse.com/thing:2542267

LipSync

Cost of plastic: **$1.84**

https://www.thingiverse.com/thing:2800937

Ergonomic and USB Adaptable Switch

Cost of plastic: **$1.46**

https://www.thingiverse.com/thing:3191057

DIYAT Switch V1

Cost of plastic: **57¢**

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The People's AT

https://www.thingiverse.com/thing:2792191

Volksswitch - the People's AT Switch

Cost of plastic: **$1.46**

https://www.thingiverse.com/thing:3819575

Round Flexure Switch

Cost of plastic: **$2.00**

https://www.makersmakingchange.com/project/round-flexure-switch-60mm/

ATMakers MX Switch

Cost of plastic: **17¢**

https://www.thingiverse.com/thing:3230906

Universal Wireless Switch Access

Cost of plastic: **34¢**

https://pinshape.com/items/25409-3d-printed-universal-wireless-switch-access

Microwave Door Opener

Cost of plastic: **$1.37**

https://www.thingiverse.com/thing:642874

Scale Model of the Eros Asteroid

Cost of plastic: **83¢**

http://nasa3d.arc.nasa.gov/detail/eros

Open Assistive Technology - Key Turner

Cost of plastic: **15¢**

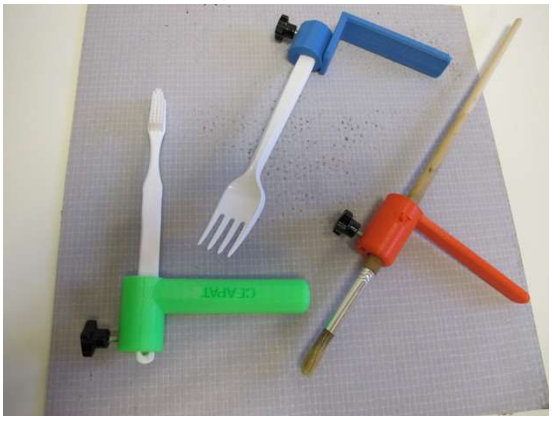
https://www.thingiverse.com/thing:1852950

Toothbrush Adapter

Cost of plastic: **62¢**

https://www.thingiverse.com/thing:2394134

Easy Grip Hand Support



Cost of plastic: **40¢**

https://www.thingiverse.com/thing:1086395

Universal Cuff Utensil Holder

Cost of plastic: **50¢**

https://www.thingiverse.com/thing:3492411

Doorknob Lever Adapter

Cost of plastic: **$1.52**

https://www.thingiverse.com/thing:640852

C-Clamp Threaded Mounting Adapter

Cost of plastic: **15¢**

https://www.thingiverse.com/thing:3541114

50mm Piko Button Camera Mount

Cost of plastic: **10¢**

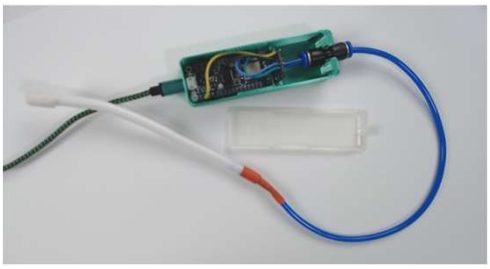
https://www.thingiverse.com/thing:3197435

Lateral Leg Support for Wheelchair

Cost of plastic: **63¢**

https://www.thingiverse.com/thing:2257895

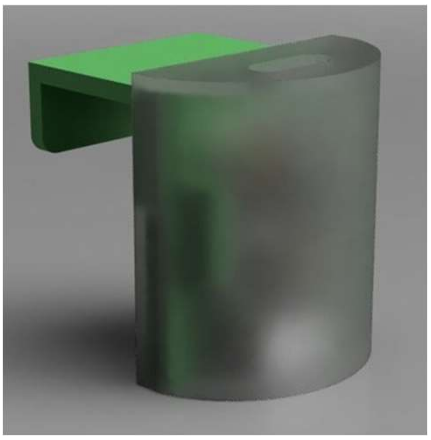
Sip and Puff Interface



Cost of plastic: **36¢**

https://www.thingiverse.com/thing:3458117

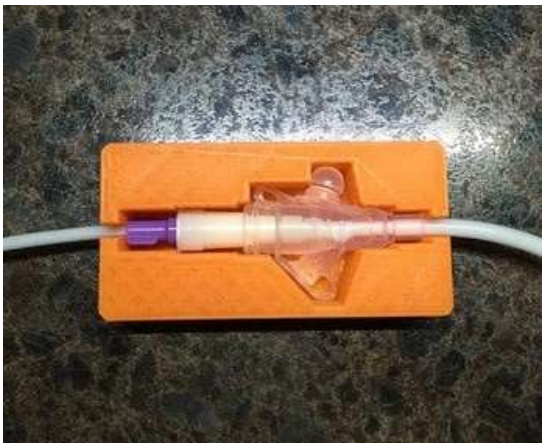
Little HandRaiser Housing



Cost of plastic: **15¢**

https://www.thingiverse.com/thing:3172905

Feeding Tube Holder



Cost of plastic: **77¢**

https://www.thingiverse.com/thing:2804715

Urinary Catheter Carrier

Cost of plastic: **$2.62**

https://www.thingiverse.com/thing:3299750

Urinary Sampling Pocket Holder

Cost of plastic: **$2.22**

https://www.thingiverse.com/thing:2849882

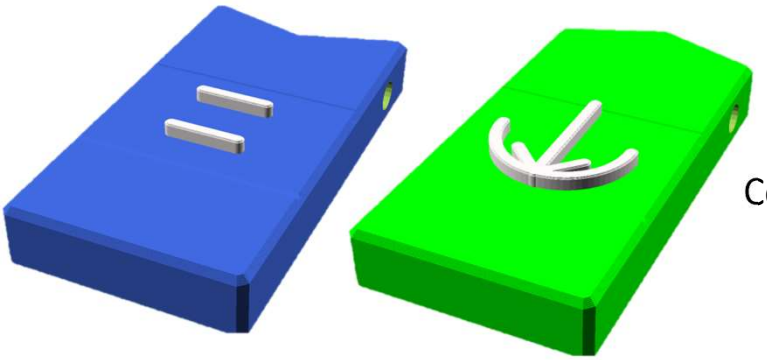
Keyguards for Chromebooks and iPad Keyboards

Cost of plastic: **50¢ to $1**

https://volksswitch.org/index.php/volks-devices/keyguards-for-chromebooks/

https://volksswitch.org/index.php/volks-devices/keyguards-for-ipad-keyboards/

Bliss Tactile Symbols



Cost of plastic: **30¢**

per symbol

https://volksswitch.org/index.php/volks-devices/bliss-tactile-symbols/

Customizable Head Pointer

Cost of plastic: **$2.24**

https://volksswitch.org/index.php/volks-devices/customizable-head-pointer/

Here's a compilation of some of the best sites to visit if you're looking for AT designs.

The Thingiverse and Printables sites are repositories of 3D models in general. You'll need to search specifically for assistive devices, but they have hundreds of designs.

Thingiverse is in decline while Printables is on the rise.

MyMiniFactory focuses on "selling" designs, but you may find something there that you wouldn't find on a more open site.

The remaining sites focus entirely on assistive technology. My favorite is Makers Making Change. They curate their designs rather than just serving as a repository.

If you get into modeling AT, I encourage you to post your designs to, at least, Thingiverse or Printables, and Makers Making Change.

I also encourage you to license your designs as Open Source so that people can easily customize them if necessary.

A Problem-Solving Story - measuring flour/sugar in cooking class

Downloading and printing free AT designs is one thing but imagine the possibilities available to you when you have your own personal design and manufacturing capability.

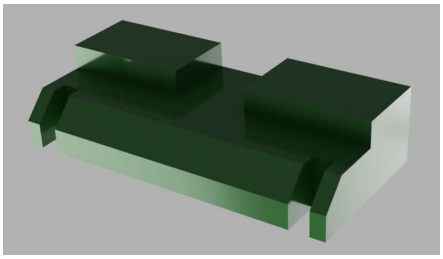
- Let me tell you a story…

https://youtu.be/MoOUV8i_HLg

Measuring flour/sugar in cooking class

$10

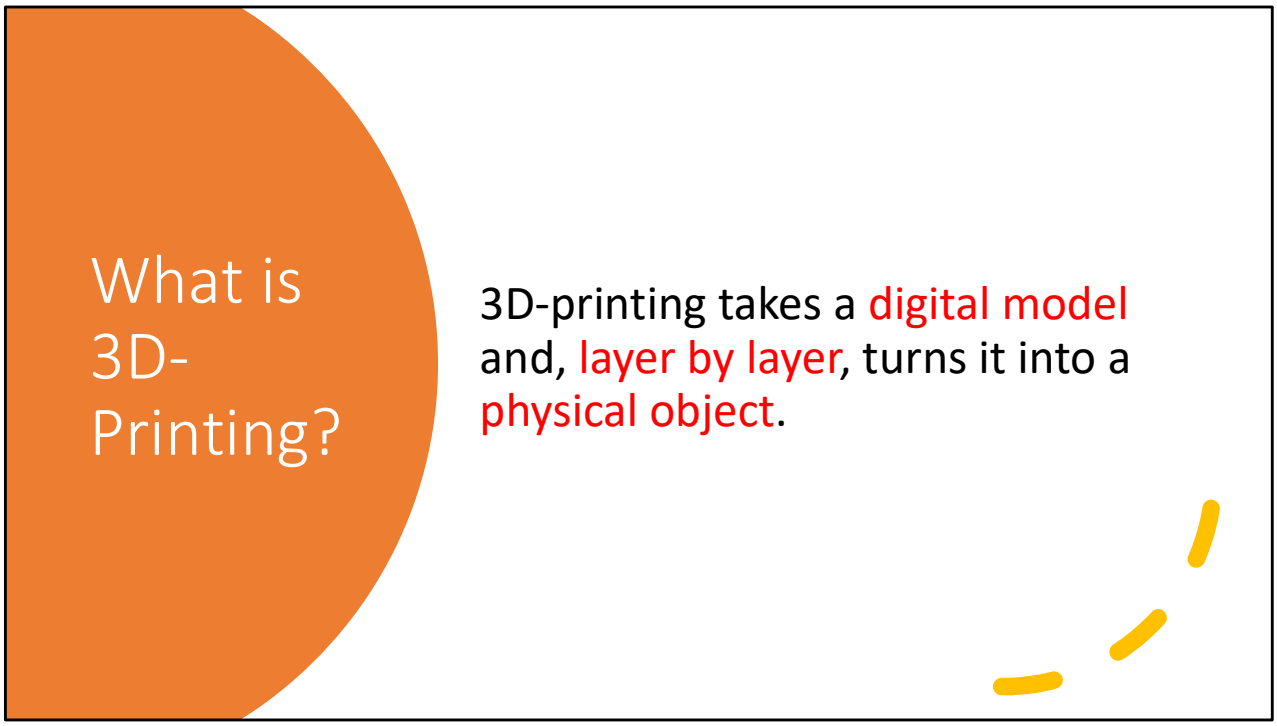
+



2 x 25¢

How much does this solution cost?

Ten dollars for the shoe box and 50 cents for the two stops.



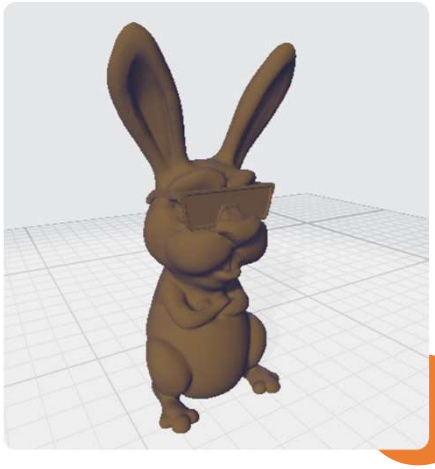
Assuming you're curious about the possibilities, let's start by establishing a baseline understanding 3D-printing.

I apologize if you're already adept with 3D-printers – I'll try to keep this quick.

The simplest definition of 3D-printing that I can think of is **"3D-printing takes a digital model and, layer by layer, turns it into a physical object."**

Start with a 3-dimensional digital model

3D-printing takes a digital model and, layer by layer, turns it into a physical object.

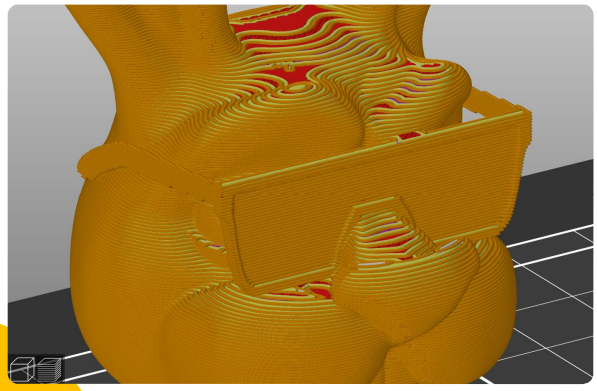


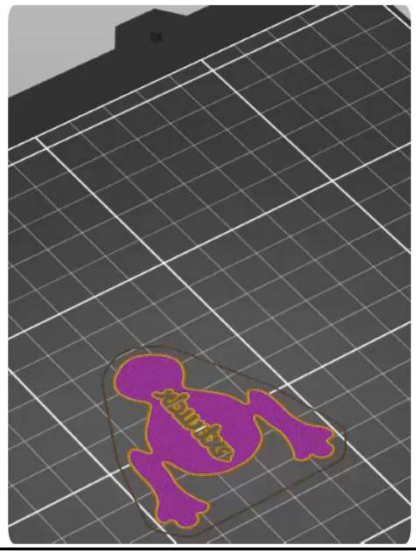
A digital model is a virtual object, meaning that it only exists inside a computer. It's created using specialized software called "computer-aided design" or CAD software.

In this example, someone has created a virtual rabbit wearing sunglasses.

Slice the model horizontally into layers

3D printing takes a digital model and, layer by layer, turns it into a physical object.





That digital model is then sliced into a series of horizontal layers by another piece of software called, of all things, a “slicer”.

The slicer then tells a 3D-printer to print each layer on top of the previous, starting at the bottom.

•

Printing the layers produces a physical object

3D printing takes a digital model and, layer by layer, turns it into a physical object.

A 3D printer uses thermoplastic filament or photo-sensitive resin to create the final physical object.

The instructions can be repeated over and over to create additional, exact copies of a design.

You can vary the color of the filament or even the composition of the filament to create custom versions of the object or an object with special properties – like flexibility.

Why is 3D-Printing Unique?

- 3D printers are inexpensive, general-purpose machines, using inexpensive materials.
  - Traditional manufacturing uses expensive, special-purpose machines.
- The time from idea to prototype or functional object can be very short.
  - Traditional manufacturing methods involve costly, time-consuming processes.
- Rapid prototyping and low cost encourages iteration toward a best fit/design.
  - Traditional manufacturing targets an average customer and is reluctant to modify a design because of the associated costs.
- "Local manufacturing" facilitates consumer involvement.
  - Customers rarely participate directly in the design of traditional products.

With that in mind, why is 3D-printing so unique? How does it differ from traditional manufacturing?

- 3D-printers and the materials they use are relatively cheap. The printers are general-purpose by nature and can create a different item each time they run.
  - Traditional manufacturing methods utilize expensive, special-purpose machines and processes. Once those machines and processes are in place, there's no tolerance for changing the final product or producing anything else.

- Because the design is created using software, and the 3D-printing is easy to do, you can implement a 3D-printed solution very quickly.
  - In the traditional manufacturing world, a tremendous amount of time is put into the design of the product and process before a single machine is turned on or a single object is produced.

- Rapid production of a physical object, as well as the fact that the cost of materials is so small, means that 3D-printing supports and encourages iterating until the final result is just right.
  - Expensive machines, materials, and processes force the manufacturer into a result that is locked in stone. If it doesn't fit you well, then <u>you</u> can change so it does.

- Inexpensive printers and plastic filament make it possible to have a 3D-printing "factory" local to

you in your home or business and put the creation process close to the people who will use the end product. This facilitates their involvement in shaping the design so that it works well for them.

- Traditional manufacturers must design for an average customer and can't accommodate customization and personalization of their products.

3D Printing is the future:
The value is in the Design
The factory is in your home or business (or space!)

– the INTL. space Station Wrench

Here is a fun example of why 3D printing is the future of manufacturing.

As a caveat, I have to say this may just have been a stunt by NASA…

Anyway, several years ago, the astronauts on the space station needed a wrench to perform their work.

NASA was able to design a wrench for them, email the design to the space station, and then the astronauts printed it on the space station's 3D-printer.

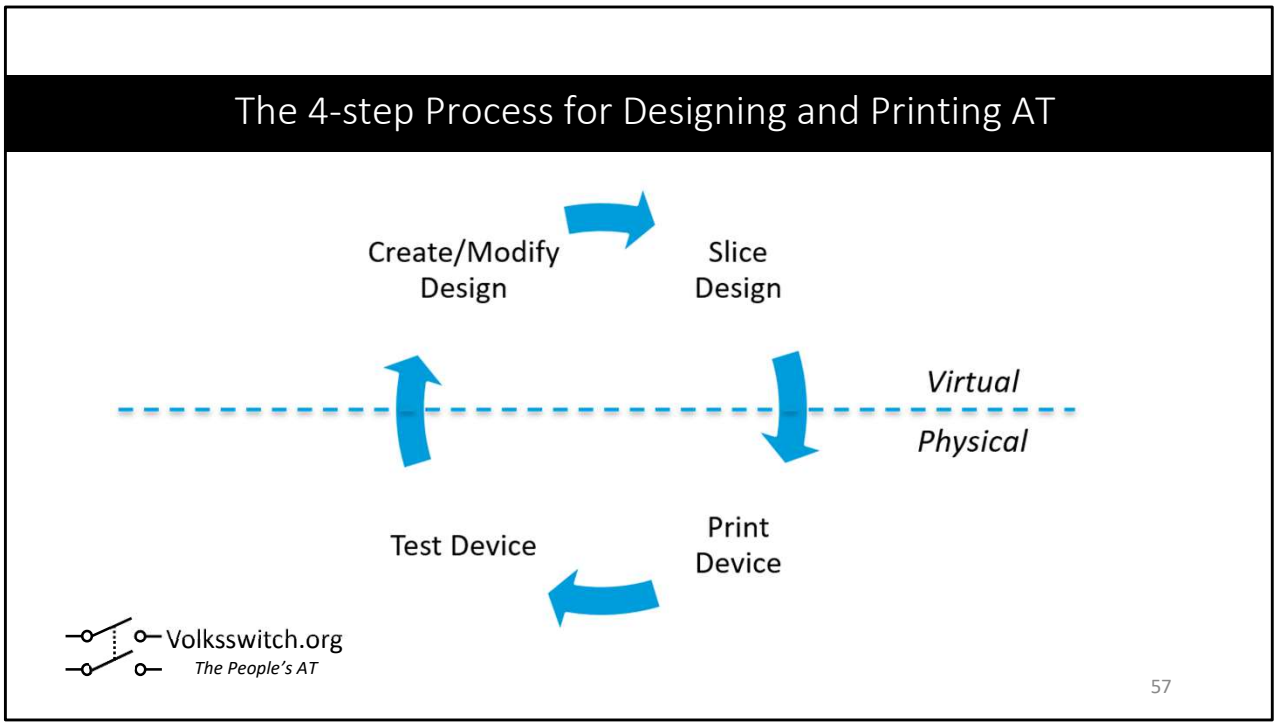
You can 3D-print that wrench for yourself by downloading the design from the NASA website.

https://www.nasa.gov/mission_pages/station/research/news/3Dratchet_wrench

In the future, the value of a product won't be in the physical object but instead it will be in the design which you'll purchase, download, and turn into a physical object yourself.

Many manufacturers already make spare parts for their products available to download and

and 3D-print.



But how does 3D design and printing of DIY assistive technology work in actual practice?

As I said earlier, the process exists in both the virtual world of computer software and the physical world of 3D printers and human beings.

The process begins on the upper left side of this diagram with the creation of a design – a 3D model.
If you've downloaded a design that someone else created, then they've performed this step for you.

In truth, the process of AT design begins with the identification of a need or problem and a discussion of possible solutions.
You then draw-up the leading contender as a 3D design using CAD software.

In Step 2, you slice the design and hand the instructions to the 3D printer.

In Step 3, you print the device.

Step 4 is the critical step of testing the device.

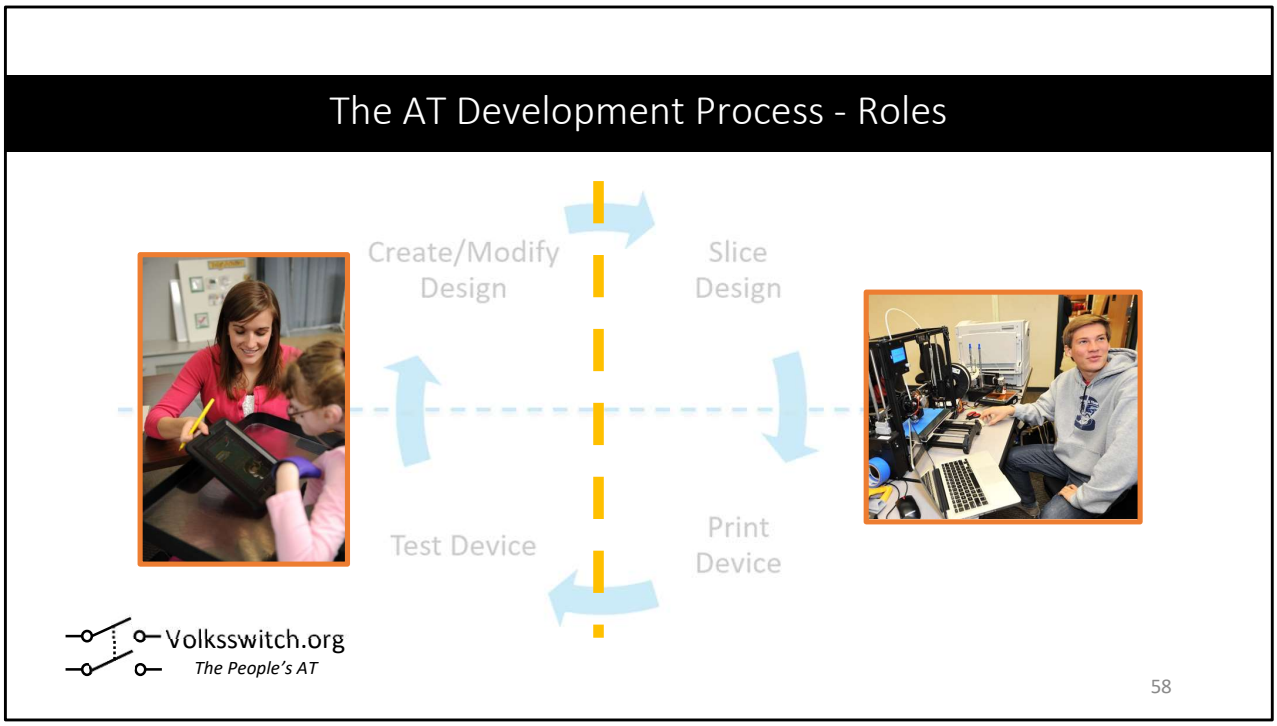
BTW, great ideas on paper don't always translate to great ideas in the real world.

If you're like the rest of us, testing will identify the shortcomings of your design or tell you that you need to take an entirely different route.

In either case, you go back to your original design and incorporate the improvements necessary, or create an entirely new design.

The process repeats or "iterates" until you confirm that your device meets the needs of your customer.

On the other hand, you may learn that the user's needs simply cannot, <u>or should not</u>, be addressed with a 3D-printed device.



Now I'm going to slice this cycle vertically and talk about the different roles involved.

The role on the left is responsible for identifying a need, initiating the creation of a design, evaluating how well the design fulfills the need, suggesting modifications, and, if necessary, kicking off another iteration.

The role on the right is responsible for understanding the capabilities of technologies like 3D-printing, providing feedback regarding those capabilities, and creating prototypes of a design.

Note that, a role is different from a person. It's possible for a single person to perform both roles if they have the necessary skills.

Soapbox:

Sometimes it's hard for people who live on the left side to communicate their thoughts to the people on the right and vice versa. That's because they tend to speak different languages.

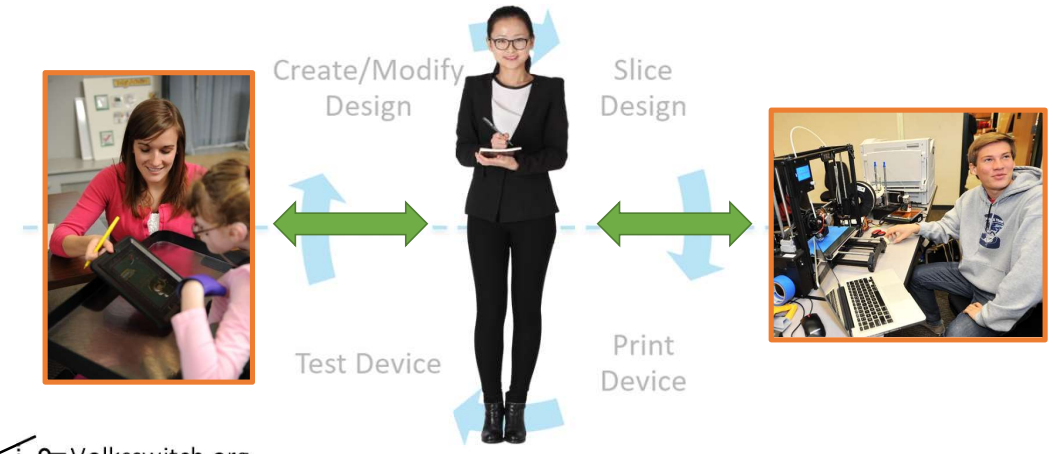
And sometimes it's hard for the people on the left to give bad news to the people on the

right. Bad news like, “this approach isn’t meeting the user’s needs”.

The people on the left sometimes feel they’re not as smart as the people on the right and therefore must be wrong if there’s a disagreement.

In truth each role brings a unique set of skills and value to the process. Those different skills are critical to producing a successful result.

The AT Development Process – Roles (cont.)



Volksswitch.org
The People's AT

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A Little More Soap:

If necessary, it can be helpful to introduce a third role, and a third person, into the process, who's job it is to facilitate communication and keep the project on track.

In the commercial world, this person would be called a product or project manager.

It's best if they have some knowledge of both sides of the discussion.

3D-Printed Keyguards - Your Gateway to 3D-Printed Assistive Technology

I hope I've piqued your interest regarding what's possible with a 3D printer.

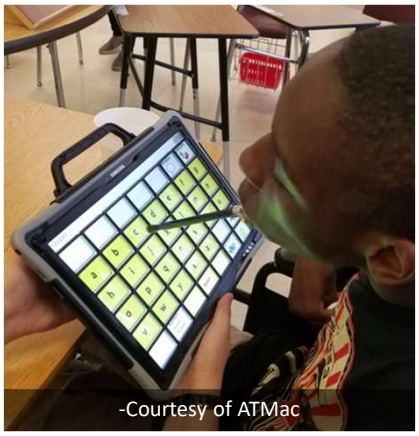
I hope you're excited about the wealth of high value, freely available, 3D-printable, AT designs that you can take advantage of - right now.

Unfortunately, you may believe that there's an impenetrable technological and financial wall between you and those devices.

If so, I want to convince you that there's a passageway through that technological and financial wall called 3D-printed keyguards.

What is a Keyguard?

- A keyguard is a plate which sits over a keyboard or touch screen, with spaces that a user can put their fingers or a pointer through to hit the keys.
- Users who have trouble with fine motor control often find that keyguards help them to hit the key they're aiming for.
- Users who have weakness or fatigue that makes it difficult to hold up their arm can rest their hand on the keyguard while pressing keys.
- Keyguards can make a big difference to a user's accuracy and ability to hit the part of the screen they're aiming for.



I'm sure that many of you are already familiar with keyguards.

- For those who aren't, a keyguard is a plastic plate that sits on top of a keyboard – or now, much more often, a tablet. The plastic limits access to only those places where openings have been cut in the plate.

- Keyguards help people with limited fine motor-control to effectively interact with the app on their tablet.

- They also allow people who are easily fatigued to rest their hand on the tablet without triggering some action within the app.

- They can make a huge difference in a user's productivity.

How Many Keyguards Might I Need?

- **As a therapist** you will need a set of evaluation keyguards. These keyguards will need to support each of the tablets and cases you recommend, each of the apps you recommend and each of the app configurations you recommend.
- If you only recommend 2 different tablets, each with two different cases, running 2 different apps in 4 possible configurations you will need **2x2x2x4 = 32 evaluation keyguards**. If 25% of those are lost or broken over time, you will need an additional 8 keyguards for a total of **40 evaluation keyguards**.
- **As an individual** using a tablet with a keyguard, you will need a keyguard for each app you use and additional keyguards as your skills improve or decline.
- What about the development of new tablets, cases, and apps?
- *How many would you need if you could reduce the cost by 99%?*

How many keyguards do you need?

- That will depend on the number of tablets and apps you will use or recommend, how many ways the apps can be configured, and how many tablet-cases you may use, now and in the future.

- If you only deal with two different tablets, each in two different cases, running two different apps, and four different configurations for those apps, you will need 2 times 2 times 2 times 4, or 32 keyguards. If a quarter of those break or are lost over time, you'll need an additional 8 keyguards for a total of 40.

- Users will need new keyguards as their skills improve or degrade over time.

- And there are bound to be new tablets, cases, and apps in the future… I suspect that

you’re thinking that there’s no way you could possibly afford 40 keyguards.

- But what if you could cut the cost of a keyguard by 99%? Well, you can!

Evaluation Keyguards printed for Imagine! Colorado –

2 tablets, 2+1 Cases, 1 AAC App, 4 Configurations

I designed and printed evaluation keyguards for an SLP at Imagine! Colorado.

They support 2 different tablets, one of which could be placed in two different cases., just one app – Go Talk Now, and 4 possible layouts of the app.

In total, she needed 10 keyguards to perform her evaluations.

How Much Does a Keyguard Cost?

- A Commercial Keyguard

KEYGUARD ASSISTIVE TECHNOLOGY

TouchChat Keyguard

Final Cost: $71

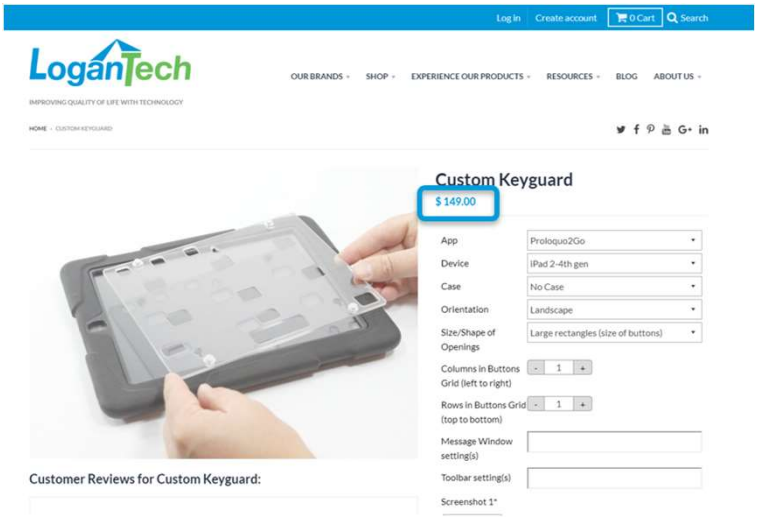
How much does a commercial keyguard cost?

Here's a page from the Keyguard AT website. (https://www.keyguardat.com/touchchat-keyguard/)

Keyguard AT is the largest producer of laser-cut keyguards in the US and possibly globally.

I purchased a keyguard from them for the TouchChat app running on an iPad 2 - and the final cost was $71.

The Cost Could Be Much More than $71



LoganTech sells keyguards for their systems and this one costs about $150.

What if I design a keyguard myself and have it 3D-printed?

What if I designed and 3D-printed that TouchChat keyguard myself?

How hard is it to design a keyguard?

First, how hard is it to design a keyguard?

At Volksswitch we've created a free keyguard designer that makes the design process easy.

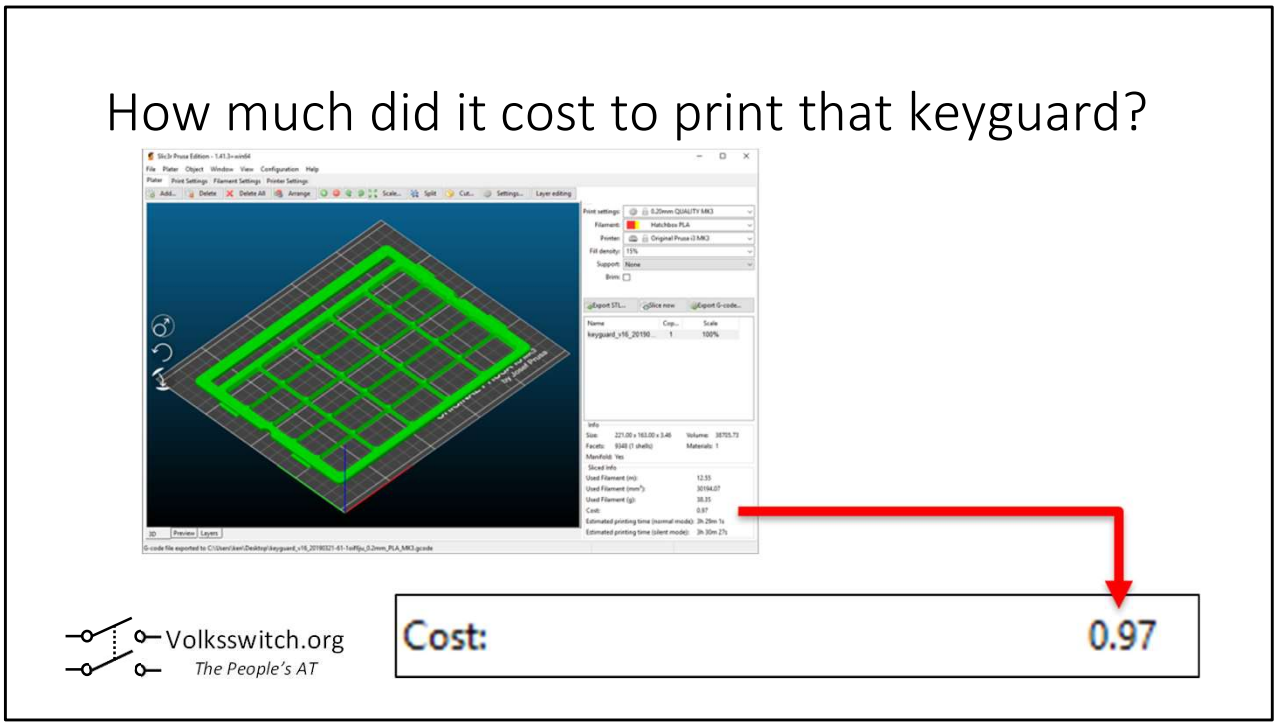
Note that this video is, more than a bit, out of date. It's demonstrating the use of version 24 of the designer, but the current version is 55, soon to be 56.

https://youtu.be/UgonofNVDS4

Is it difficult to 3D-print a keyguard?

And, how difficult is it to 3D-print a keyguard?

https://youtu.be/JIRfpSQjnV8



How much did it cost to print a keyguard?

Well, it depends on how much plastic-filament was used.

This is a screen capture from the slicer program.

If you tell the slicer how much you pay for a 1 kg roll of filament, the program will tell you how many grams of filament your print will require, and it'll calculate the cost of the print.

In this case, my keyguard cost 97 cents.

Hands-on with some 3D-printed keyguards

Let’s look at the kinds of keyguards that are possible to create with the Volksswitch keyguard designer.

https://youtu.be/LLOPouYxjMo

Another Cool Bit of DIY AT - the Voice It

One last bit of DIY assistive technology that has unlimited possibilities…

The Voice It

- Can be used with the Bliss Tactile Symbols (pre-recorded voice files)
- Add sound to any object
- Entire books can be "voiced"
- $130 in off-the-shelf parts
- Can be assembled with a screwdriver
- Record your own voice files
- Multi-language support

The Voice It is a simple, DIY device that reads an RFID tag and then plays a recording associated with the word or words it finds on the tag.

We originally conceived of the Voice It as a way to give a voice to our Bliss Tactile Symbols. You can see a few of them in the picture, surrounding an assembled Voice It.

You can build a Voice It in less than 45 minutes using about $130 of off-the-shelf parts and a screwdriver. RFID tags can be purchased online for anywhere from 15 to 30 cents, each.

We provide free voice files for all of our tactile symbols in both English and Spanish. And adding a new language is a simple matter if you know someone who speaks that language.

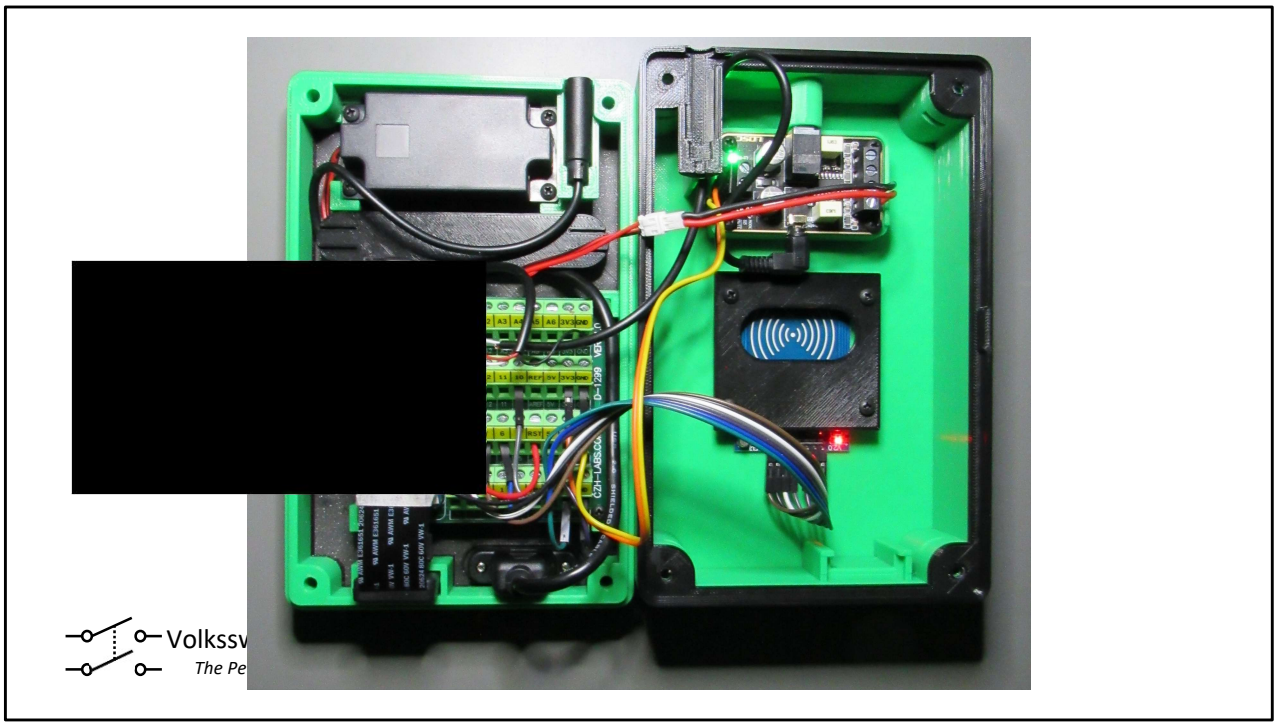
It’s also simple to extend the recordings to add a voice to just about anything from a plush toy to a children’s book

Voice It device homepage link:

http://bit.ly/3TA9Kjv

A Look Inside and How the Voice It Performs

Let’s peek inside and then see how it works in practice.



The design centers around an Arduino processor, a rechargeable battery, an RFID reader card, and a speaker with amplifier.

The case is entirely 3D-printed.

You don’t have to solder any wires and you don’t have to know how to program the Arduino.

Step-by-step instructions are provided along with a list of materials for you to purchase from Amazon.

- Let’s look at the Voice It in action.

https://youtu.be/y6KXqkRKtZI

BTW, we’re currently working on a new version that can read a QR code and play an associated recording – perfect for reading books.

OK, let’s say you’re convinced, and you want to get a 3D printer.

Let’s look at some options.

Can I Afford a 3D Printer?

How much does a quality 3D-printer cost?

Note that quality is often in the eye of the beholder, but I'll give you my view.

How much does a 3D Printer cost?

Artillery (Evnovo) Sidewinder X2: $399

Build surface:

300 x 300

Prusa i3 MK3S+: $649 (kit),

$899 (assembled)

Build surface:

250 x 210

A high-quality 3D printer may be much cheaper than you think.

I've owned several 3D printers over the last 6 years and here are my two current favorites. The best I can say is "current", this is a fast growing and changing market.

The first is the Artillery Sidewinder X2 which sells for around $400.

The second is the Prusa i3 MK3S+ which you can get in kit form for $650 and fully assembled for about $900.

(By the way, I highly recommend assembling your printer from a kit when you can. What you learn in the process, will make you much more confident when you encounter issues down the road.)

The Sidewinder has a 300 mm by 300 mm build surface while the Prusa has a 250 mm by 210 mm build surface.

If you think you'll be making keyguards with your printer, I recommend that you purchase one with a build surface that is at least 250 mm on one of the two dimensions.

Both of these printers are more than capable of printing keyguards. Prusa has the best customer support of any 3D-printer manufacturer in the consumer market.

FYI…Prusa i3 MK4 – kit $899, assembled $1099.

How can I justify purchasing a 3D printer?

- If you need to invest in keyguards, the cost differential between commercially purchased keyguards and 3D printed keyguards, is sufficient to justify purchasing a 3D printer after 5 to 10 keyguards.
- With a 3D printer you can explore the full range of free pre-designed AT.
- Based on this information can you put together a business case, a grant proposal, a bake sale?

Can you justify purchasing a 3D printer?

- If you save, on average, $90 for every keyguard that you print rather than purchase, you can justify the cost of a 3D printer in as few as 5 to 10 keyguards.
- Once you have a 3D printer, you can begin to explore the full range of free, pre-designed, assistive technology along with designing and printing your own solutions – which could lead to even more savings.
- How difficult would it be to use this information to put together a grant proposal – or a bake sale?

Are there any ways to obtain 3D-printed AT without a 3D printer?

What if the barrier is still too great - or maybe you're not ready to make that kind of commitment?

How can you get access to 3D-printed assistive technology without a 3D Printer?

The school district's STEM teacher(s)

A few of the Colorado school districts:

JEFFCO PUBLIC SCHOOLS STEM

ST. VRAIN VALLEY SCHOOLS
academic excellence by design
science | technology | engineering | math

Cherry Creek Schools STEM & INNOVATION
OFFICE OF STEM AND INNOVATION
SCIENCE, TECHNOLOGY, ENGINEERING, AND MATHEMATICS

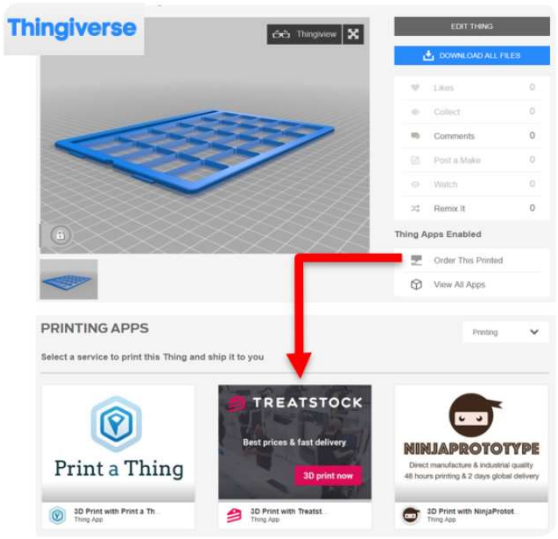
If you're employed in a school district, or even just a member, many districts offer STEM and STEAM programs. (I don't know what the Canadian equivalent of a US school district is.)

These middle school and high school STEM classes often have 3D printers that are just sitting and gathering dust.

You can give the teachers and students a reason to dust off those printers and CAD software to produce devices that will change people's lives. Not to mention, an opportunity to teach the students a skill that will actually make them attractive to colleges and employers when they graduate.

I highly encourage school, assistive technology teams, to reach out and partner with the STEM teachers in their districts.

Online Printing Services



- *Keyguard AT* *$71*

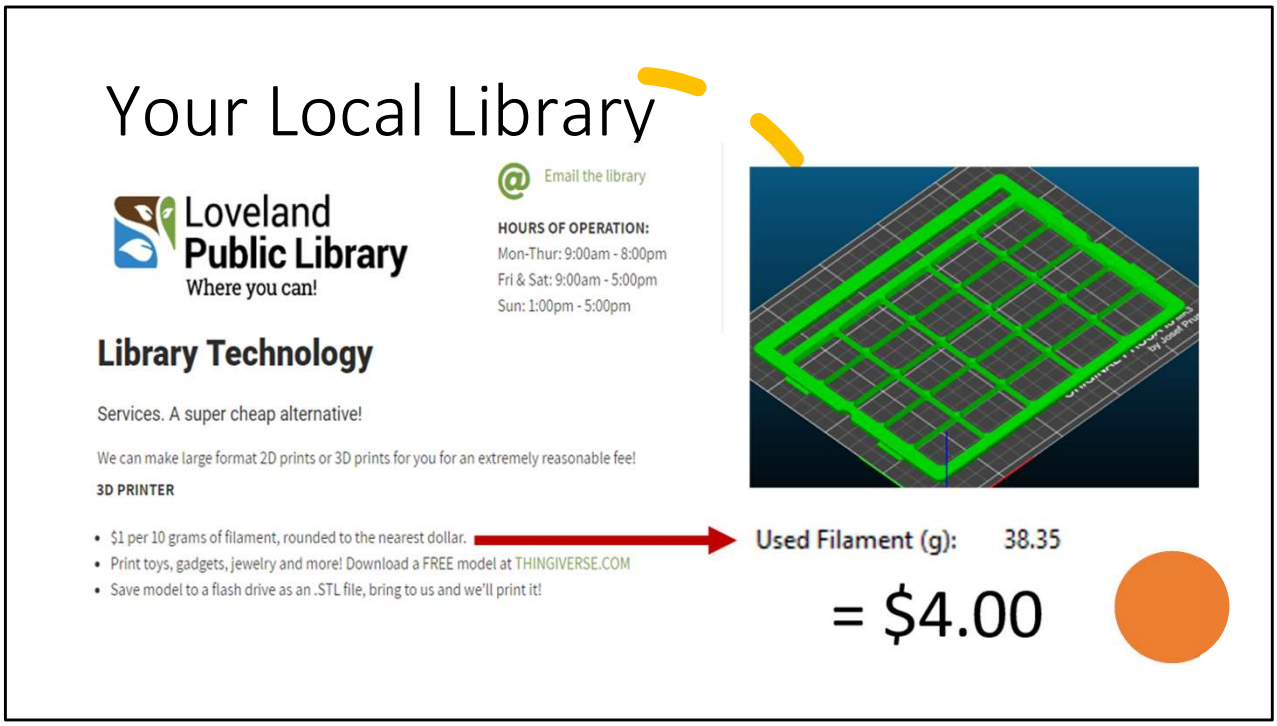
- Print a Thing $23 ($47 savings)
- TreatStock $17 ($50 savings)
- NinjaPrototype $20 ($51 savings)

There are several online companies who will print your design.

Thingiverse supports submission of designs to 3 different services.

I sent my TouchChat keyguard design to all three to find out what they would charge.

The prices vary somewhat, but on average, represent a 2/3 savings over purchasing the same keyguard from Keyguard AT.



You also may have a local library with a 3D printing service.

This library is located a few miles from me, and they charge just 10 cents per gram of plastic filament to print a design.

Remember that my slicer program told me that the TouchChat keyguard requires 40 grams of filament.

That's a total of $4.00 for a keyguard, and I didn't have to purchase or maintain the printer, nor did I have to purchase and store the filament.

3D-Printing Facebook Groups

(29) Active Groups Dedicated to Generic 3D Printing:

3D printing, 3D Printing Stls, 3D Printing RC, 3D Printing Miniatures and Terrain, **3D Printing Useful Things!**, Functional 3D Printing, 3D Printing For Beginners, 3D Printing Club 3DPC.tech, 3dfigureprints.com 3D Printing Models STL, 3D Printing Geeks, The Tabletop 3D Printing Guild, 3d printing things, 3D Printing, Creality CR-10s 3D Printer User Group, 3DHeals: 3D printing in Healthcare, 3D Printing - Show & Tell, 3D Printing For Everyone, 3D Printing For Christmas Light Enthusiast Group., Forward 3D printing, Anet A6 3D printer (RepRap Prusa i3), 3D Printing Egypt, XYZ Da Vinci 3D Printer Users Group, Dazz3D Printing Group, 3D Printing United Kingdom, 3D Printing Malaysia, 3D PRINTING PHILIPPINES, 3D Printing South Africa, 3D Printing Australia, Bristowne 3D Hobby Prints, St. Louis 3d Printing Society

(26) Active Groups Dedicated to the Prusa line of Printers:

Prusa 3D Printer Owners, Original Prusa i3 MK3 Support and Discussion, Prusa i3 mk3 users group, Original Prusa i3 MK3 Print Showcase, Anet A6 3D printer (RepRap Prusa i3), Prusa Prints, Geeetech Prusa i3, Prusa Community Useful Products, Geeetech Prusa 3D Printer, Prusa MK2S Owners (post/ask Anything, Uncensored), FLSUN 3D PRINTERS DELTA PRUSA I3 & CUBE, Original Prusa i3 MK3 Makers, U3dprintshop 3d printing community, 3DHeals: 3D printing in Healthcare, RepRap Prusa i3 3D Printer Support Group, Anet prusa i3 3D printer Malaysia (Official), Anet A8 y Prusa i3 en español, impresión 3D, Original Průša i3 Mk2/S/MK3/MMU komunita, Estado51PRUSA, Prusa Bear Argentina, ESTADO PRUSA (ESTADIDAD AHORA), Stampanti 3D Anet e Cloni Prusa i3 - Stampa 3D Italia, Oryginalna Prusa i3 MK1/MK2/MK3 Polska, TEVO Tarantula Prusa i3 Deutsch, die ORIGINAL-Gruppe ;-), Imprimante 3D - Anet A8, clone Prusa, impression 3d Prusa i3 anet a8 fr, Prusa I3 Portugal

(33) Active Groups Dedicated to the Artillery line of Printers:

Artillery Sidewinder X1 3D Printer Owners Group [Official], Artillery Sidewinder X1(EVNOVO)/mod/fix international group, Artillery Sidewinder X1 works show, Artillery Sidewinder X1 3d Printer, Artillery Sidewinder X1, Artillery Sidewinder X-1 Files Only, Artillery 3D Printer Sidewinde X1r, Artillery Sidewinder X1 & Genius FR Francophone imprimante 3D, ARTILLERY Sidewinder X1 3des España/Spain, Artillery (Sidewinder X1, Genius, etc.) Aide Francophone (imprimante 3D), Artillery Sidewinder X1 Grupo de propietarios Español, Artillery Sidewinder X1 3D Drucker für den deutschsprachigen Raum, Artillery Sidewinder X1 PTBR Português, Artillery Sidewinder X1 & Genius - Deutsche Gruppe, Artillery Sidewinder x1 Ultimate Mod, Artillery Sidewinder X1 & Genius Italia New Generation - © Official Group, Artillery Sidewinder X1 3D Printer België / Nedereland, Artillery Sidewinder X1 pour les nuls Aide et conseils, Artillery sidewinder x1 , Genius , Entraide Amélioration Familiale, Artillery sidewinder x1, Artillery Sidewinder X-1, Artillery Sidewinder X1 3D Drucker Germany, Artillery Sidewinder X1 Middle East Group, Artillery GENIUS 3D Printer Owners Group [Official], Artillary Sidewinder & Genius BEGINNERS Group, Artillery Sidewinder X1 Australian Support, Artillery (Evnovo) SX1 / Genius - FR, Artilerry Sidewinder PT, Artillery Sidewinder/ Genius 3D printing beginners (Noobs), Artillery Sidewinder X1 - Deutschland - Österreich - Schweiz, ARTILLERY SIDEWINDER ARGENTINA, Artillery Sidewinder 3D Printer Owners Group Philippines, Artillery Sidewinder X1 Deutsche Gruppe, Artillery Sidewinder X1 Polska (SWX1)

This is a listing of Facebook Groups that focus on 3D printing in general… the Prusa line of printers… and the Artillery line of printers.

Don't try to read it. I just want to give you a sense of the number of such groups.

Most of the people in these groups are excited about 3D printing as a technology but they've tired of printing Yoda heads and Baby Groots – or now I guess, Baby Yodas.

Their shelves are full of decorative items and they're wondering if that's all there is to this technology.

If you post to a few of these groups and describe your need, I guarantee you'll hear from someone who is dying to finally use their printer to create something of real value.

You may need to reimburse them for the filament and postage but, then again, you may not.

BTW, Maker’s Making Change is located in Canada, and they provide this kind of service.

Join a Parent's Group and Pool Resources

Are you a member of a parent's group?

Could the members of the group pool their resources and purchase a 3D printer and plastic filament?

I suspect that every parent's group harbors at least one father who'd love to do the research, purchase and house the printer, and become an expert in its use.

I wouldn’t be honest if I didn’t admit that I have some concerns about 3D-printing, especially 3D-printed assistive technology.

I think this is the most subtle dark-side of 3D-printed AT.

It’s easy to become overly enamored with the technology and to start to see every problem as having a 3D-printed solution.

What are the limitations of 3D-printed AT?

- 3D printing materials have limited strength and temperature/UV stability
- Open-Source designs and devices are unlikely to have undergone extensive testing to validate their safety and effectiveness
- Liability for injury is unclear
- *You cannot create a transparent object*

As you think through possible responses to a need or solutions to a problem, be very clear about all the demands on that solution – especially those related to safety.

- Because consumer-grade 3D printers print with thermoplastics, the devices they produce will always have limited strength and a limited range of environmental temperatures. They may also degrade if exposed to sunlight for long periods of time.

- Those wonderful, freely downloadable designs you find on the web have probably not been tested with respect to their safety or even their effectiveness. So, you're probably going to be the tester.

- If a device should fail and someone should get hurt, it's unclear who's liable – if anyone.

- And because this is a presentation, to a large extent, about keyguards, you should know that you can't create the equivalent of a laser-cut, acrylic keyguard – because you can’t produce a transparent 3D-printed device.

Some assistive technology is NOT a good match for 3D Printing

-Avoid printing items that could cause significant injury if they fail…

Uncovering Challenges and Opportunities for 3D Printing Assistive Technology with Physical Therapists

- McDonald, Comrie, Buehler, Carter, Dubin, Gordes, McCombe-Waller, Hurst

3.2.2 Designing a Crutch Tip (Figure 3)

Crutch tips are located at the bottom ends of the crutches and support the user's weight and maintain balance while the user is mobile. Due to a high volume of student users, the PT professors' crutch tips frequently go missing and a third of their crutch tips are lost every year. PT professors believed 3D printed crutch tips could replace missing crutch tips on their pre-existing crutches.

Figure 3. (Left) A 3D printed crutch tip installed onto a crutch. (Top Right) Different iterations of 3D printed material to test crutch tips. (Bottom Right) A 3D printed crutch tip in comparison to original crutch tip.

They're wrong! They don't understand the limitations of the technology.

Cost of a commercial crutch tip: $6.60
Cost of a 3D printed crutch tip: $ 1.47
Cost of a fall due to crutch tip failure… ??

Volksswitch.org
The People's AT

I was shocked when I came across this journal article that says, "PT Professors believed that 3D-printed crutch tips could replace missing crutch tips on their pre-existing crutches."

A commercial crutch tip, which is more complex in its design than you might think at first glance, costs about $6.50.

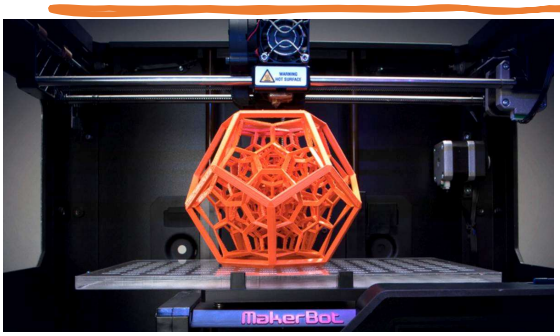
A 3D-printed crutch tip costs about $1.50 – so that's a $5 savings per crutch tip - or is it?

If the 3D-printed crutch tip fails, how much will that cost?

The bottom line is - never use a 3D printed device in a situation where failure of the device could result in injury to the user.

Proceedings of the 18th International ACM SIGACCESS Conference on Computers and Accessibility, Reno, Nevada, USA — October 23 - 26, 2016
Pages 131-139

What are the Dangers of 3D Printing?



- The nozzle can be very hot: 360°F to 500°F.
- The print surface can be hot: room temp to 140°F.
- Some filaments are smelly – ABS, in particular.
- Most filaments produce ultrafine particles and volatile compounds while printing.
- The printer can't see you and may pinch or injure you if you get in the way of a moving part.

- **Just leave the printer alone in a well-ventilated room until it's done printing and has cooled down.**

Most 3D printer owners, who get hurt, cut themselves with the scraper that came with the printer trying to remove prints that are stuck to the print surface.
- Waiting until the print surface has cooled down to room temp can help with print removal.

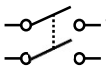
You may be concerned about the safety of 3D-printing. In my opinion, it's a relatively safe technology.

Some vendors may make a big deal about 3D-printing safety and charge schools thousands of dollars for a "school safe" 3D printer. They do this by putting their printers in cabinets with special fans and filters. These companies typically sell entire systems that, among other things, lock you into an overpriced filament. Strangely, their printers often represent 3D-printing technology that's several years old.

In reality, you can take some simple steps to ensure that everyone remains safe around the 3D printer…

AT that is a good candidate for DIY & 3D Printing

- It presents rich opportunities for customization
- There is no commercial option, or it represents a significant cost savings over a commercial device
- It doesn't need to support loads greater than 50 lbs. or temperatures greater than 150 degrees Fahrenheit
- It doesn't require transparency or softness and will spend a limited amount of time directly in contact with the user's skin
- It will likely require iterations to fit the individual physically, functionally, or aesthetically
- The device can be modeled as a collection of 2 and 3 dimensional primitives as opposed to purely organic shapes



Lastly, how can you recognize an AT device that's a good candidate for 3D modeling and printing?

Look for these characteristics:

- One of the most important characteristics is that it screams out to be customized or personalized. If one size fits all, then traditional manufacturing techniques can produce thousands of them for pennies. Because the needs of disabled individuals vary so greatly, assistive technology often requires customization. You should ensure that your design has customization built in. Try to avoid designs that will only meet a single individual's needs.

- Commercial manufacturers of assistive technology have devoted their lives to serving a traditionally underserved community – often on very thin margins. If your design doesn't represent a breakthrough in customization and personalization, or doesn't

offer a significant cost savings for families, then you should abandon your plans and go with the commercial device.

- 3D-printed, plastic devices are stronger than you might think, but you shouldn't ask too much of them. You shouldn't expose them to pressures greater than 50 lbs. Also, they may be printed at temperatures double the boiling point of water, but they will begin to deform at temperatures much less than that. You should focus on devices that can be used at room temperature. Avoid using or storing them in places like the dashboard of your car in summer.

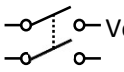
- A 3D print is composed of a series of very thin layers. Those layers will be visible on all vertical surfaces and can be abrasive when placed against sensitive skin. You can smooth these surfaces by wet sanding them but that will add additional time and effort to the process.

- The 3D-modeling and printing process facilitates iteration, so the fact that a device will require iteration before it's a good fit, is a sign that you're on the right track in choosing this technology.

- 3D modeling tools work with geometric primitives like circles, squares, cylinders, and cubes. If you can visualize your device as a combination of these primitives, then your modeling work will be a lot easier, and you'll be able to build-in a great deal of customization. You can model organic shapes by taking 3D-scans of an object, but that's usually a sign that your model will only meet the needs of a single individual.

How do 3D-printed keyguards stack-up?

- ☑ It presents rich opportunities for customization
- ☑ There is no commercial option, or it represents a significant cost savings over a commercial device
- ☑ It doesn't need to support loads greater than 50 lbs. or temperatures greater than 150 degrees Fahrenheit
- ☑ It doesn't require transparency or softness and will spend a limited amount of time directly in contact with the user's skin
- ☑ It will likely require iterations to fit the individual physically, functionally, or aesthetically
- ☑ The device can be modeled as a collection of 2 and 3 dimensional primitives as opposed to purely organic shapes



Remember how I told you that 3D-printed keyguards are your gateway to 3D-printed assistive technology? Let's see how well they stack up against these characteristics.

- Volksswitch has created a single keyguard designer that should allow you to create almost any keyguard for tablets. Since there are 10s of tablets, 10s of cases, 10s of apps, each of which can be configured in 10s of ways, sufficient customization had to be built into the designer to support 10s of thousands of possible keyguards.

- A 3D printed keyguard can cost from 1/3rd to 1/100th as much as a commercial keyguard. As such, it can make it possible for an SLP to have, on-hand, all the keyguard variants that they need when evaluating the abilities of an individual. They can be produced in a rainbow of colors and support mounting methods that are simply impossible when starting with a simple sheet of acrylic.

- Keyguards rest on the surface of a tablet. That means that they have no special

strength requirements. If you step on one and break it, you will likely have broken the tablet as well, and you'll have bigger problems than a broken keyguard. In any event, replacing the keyguard will only set you back a few dollars. They're typically used in home and school environments, so they're rarely exposed to extreme temperatures.

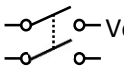
- An opaque, 3D printed keyguard will often be preferred over a transparent one, and a user may place their hand on a keyguard, for support, but probably not for an extended period.

- When you're designing the first instance of a keyguard – especially if you're working with someone in another location – you'll probably need to give them multiple drafts of the design, which they'll test for effectiveness, before settling on a final specification.

- Finally, a keyguard is literally a rectangular block of plastic with holes cut in it. (Note that with 3D-printing you don't actually, cut holes. Instead, you lay down plastic everywhere but where the holes should be.)

Questions?

Send an email message to **ken@volksswitch.org** to ask follow-up questions, receive a copy of this presentation, and make suggestions.



I'd now like to open the session for questions.