D.I.WIRE PRO

BY PENSA LABS

Orthodontics & the D.I.Wire Pro

This is a selection from reports on the orthodontic industry research conducted during the development of the D.I.Wire Pro (2017-2018).

The original reports were created for internal use, and a general report was made for sales and marketing purposes.

Some information has been redacted to protect I.P.

Where would the D.I.Wire Pro fit into the orthodontic landscape?

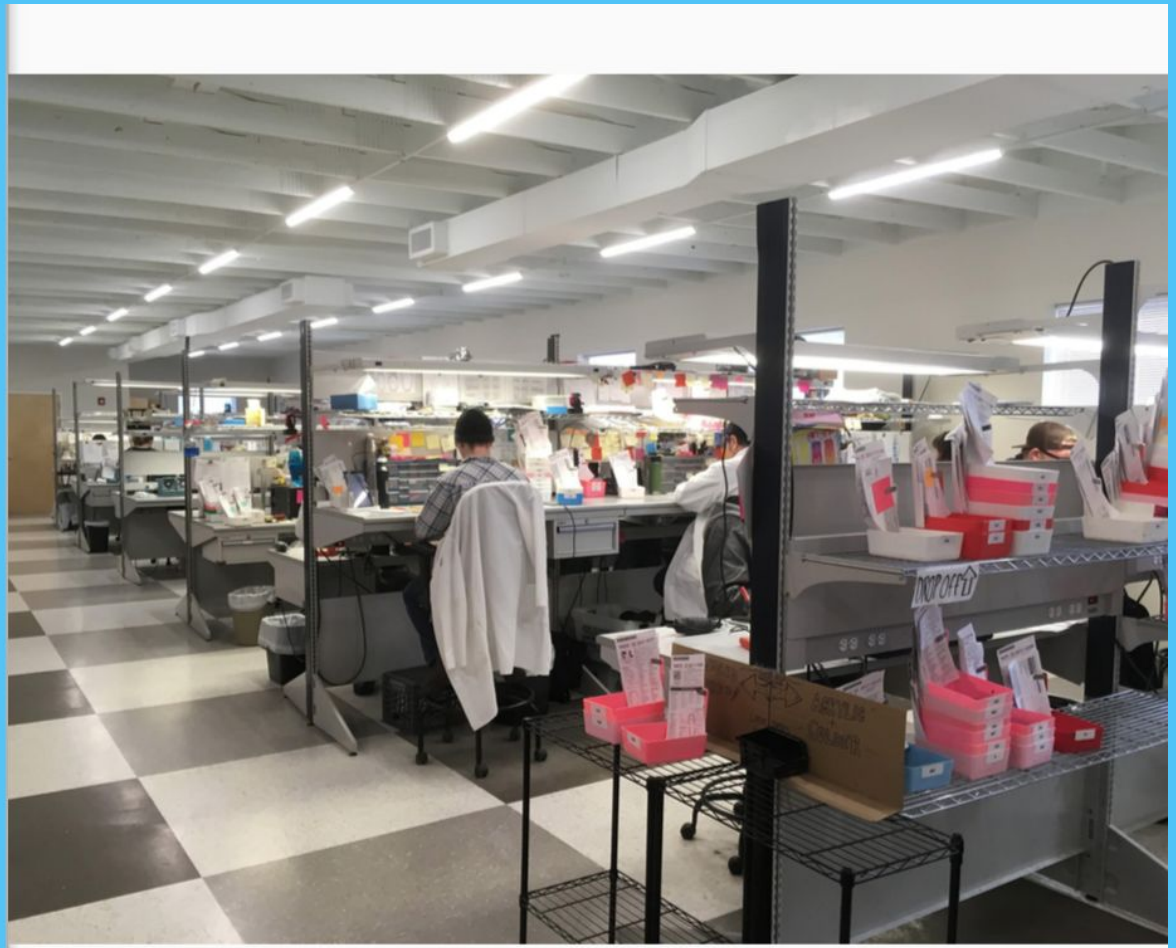
"Fast adoption of digital flow has allowed the business to rapidly expand, over double the size in 2 years."

-- Ortho Doctor/Owner, Large Lab

WIRE BENDING

WHERE DO WE FIT IN IF WE HAVE 2D BENDS?

"The benders would become assemblers-- the benders would still do springs and other small shapes."



Lab production: wire bending area

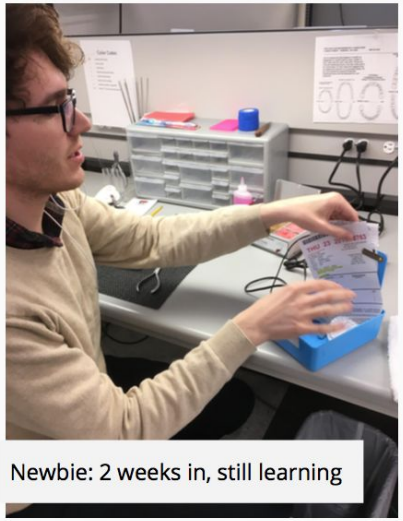
Industry Research Overview

Distributed over the course of about six months, primary and secondary research went into understanding industry needs and opportunities.

COMPANIES & PEOPLE

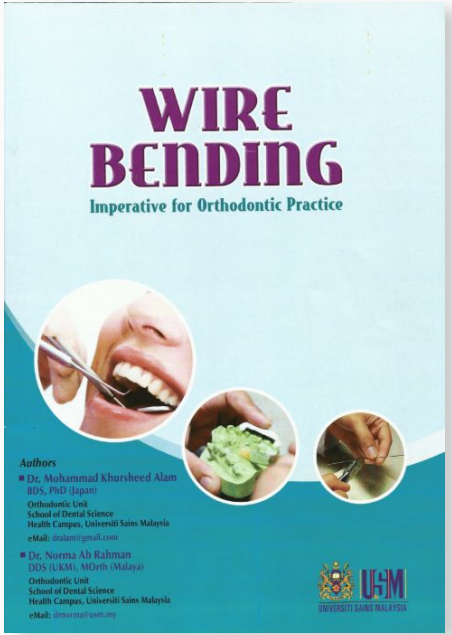
Detailed observations were taken from in person interviews and secondary research online.

WIRE AREA - Wire Techs



Newbie: 2 weeks in, still learning

Master: 10 y EO Lab



COMPANIES & PEOPLE

Research subjects came from contacts recruited at tradeshows, and from business networking.

INTERVIEWS OR VISITS

- 7 companies
- 2 smaller labs (< 20 employees)
- 3 medium labs (> 20 employees, < 40)
- 2 larger labs (> 40 employees)
- 9 people: Business side, doctor side

REGIONS & RELATED INDUSTRY

- Wire suppliers
- Software suppliers
- International labs
  (Asia, Europe, South America)

95% of all orthodontic wire is bent by hand.

Despite the industry having some of the most sophisticated digital tools, including scanners and 3D printers, a vast majority of orthodontic wire is bent by hand. The tools available for wire are either pliers in skilled hands, or industrial bending machines that cost close to $100k each.

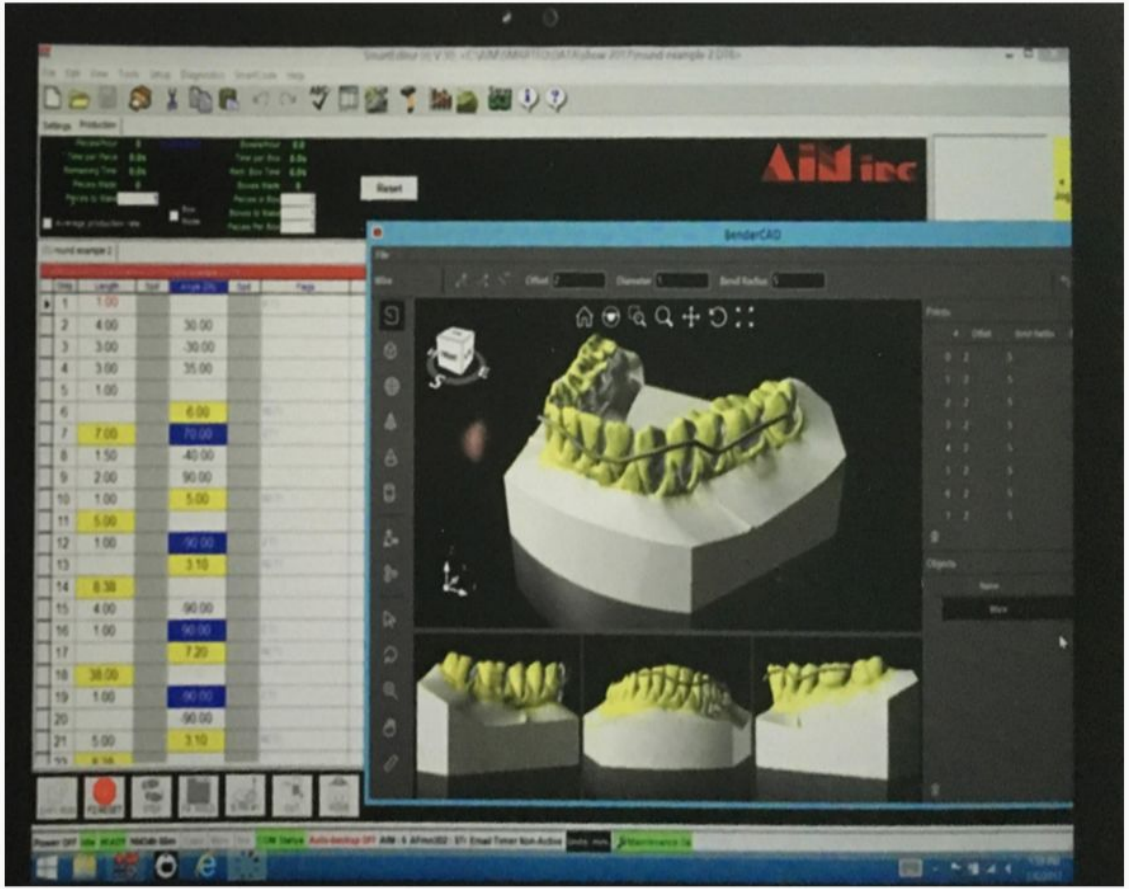
COMPETITION

- Aim 3D Ortho Bender “Benchtop size”
- Approx. $75-90k
- Software imports STL of teeth, draw in wire, run simulation to check for problems in background, send to machine through material profile
- Calibration tool shipped with machine

COMPETITION

Aim 3D Ortho Bender

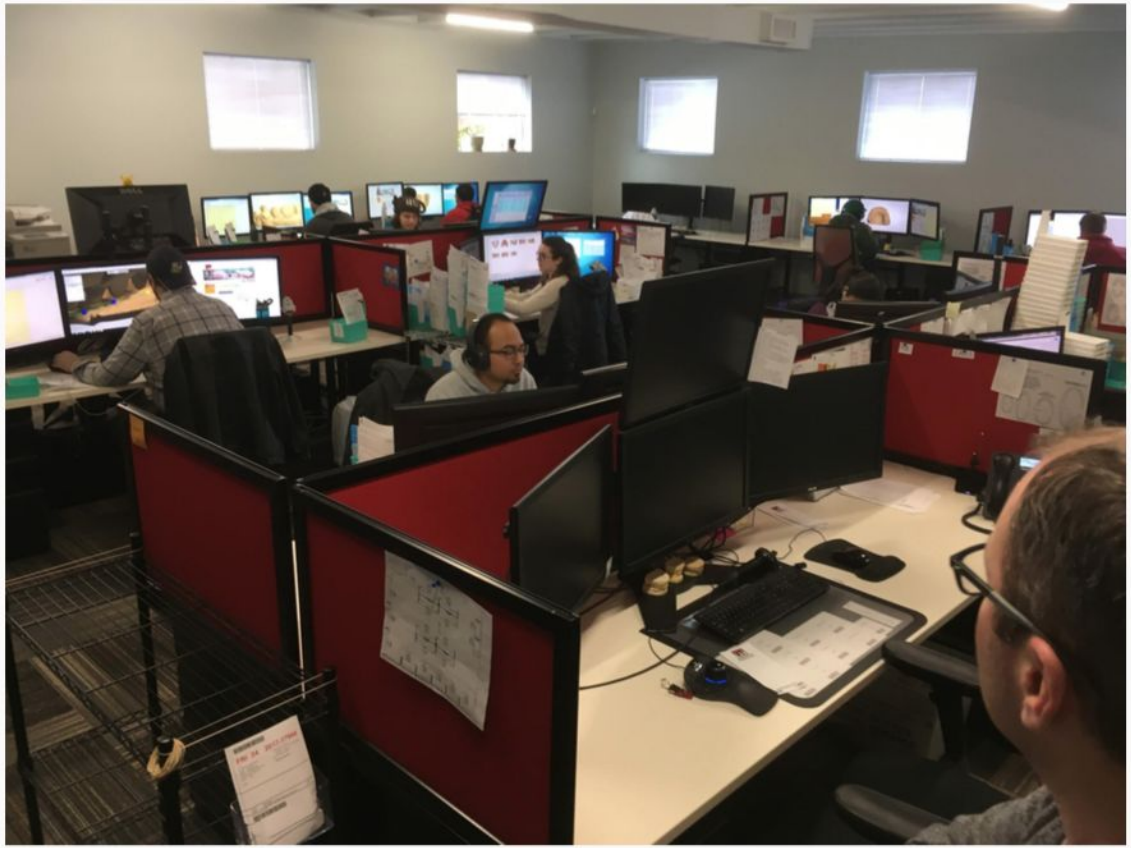
- Software imports STL of teeth, draw in wire, run simulation to check for problems in background, send to machine through material profile



DIGITAL / CAD

CAN WE PARTNER WITH SOFTWARE MAKERS TO BUILD DIGITAL-TO-DIGITAL WORKFLOW?

WHAT CAN WE DO TO MAKE DATA ENTRY WORKFLOW FIT INTO LAB WORKFLOW?



Lab production: digital file prep area

STRATEGIC CONTEXT

Overview

- Current capabilities & workflow
- Design Considerations
- How do we fit into current workflows within offices and labs?
- What would make the PRO a success across the orthodontic vertical?
- Questions & Discussion

Where Are We Now
&
Where Are We Going?

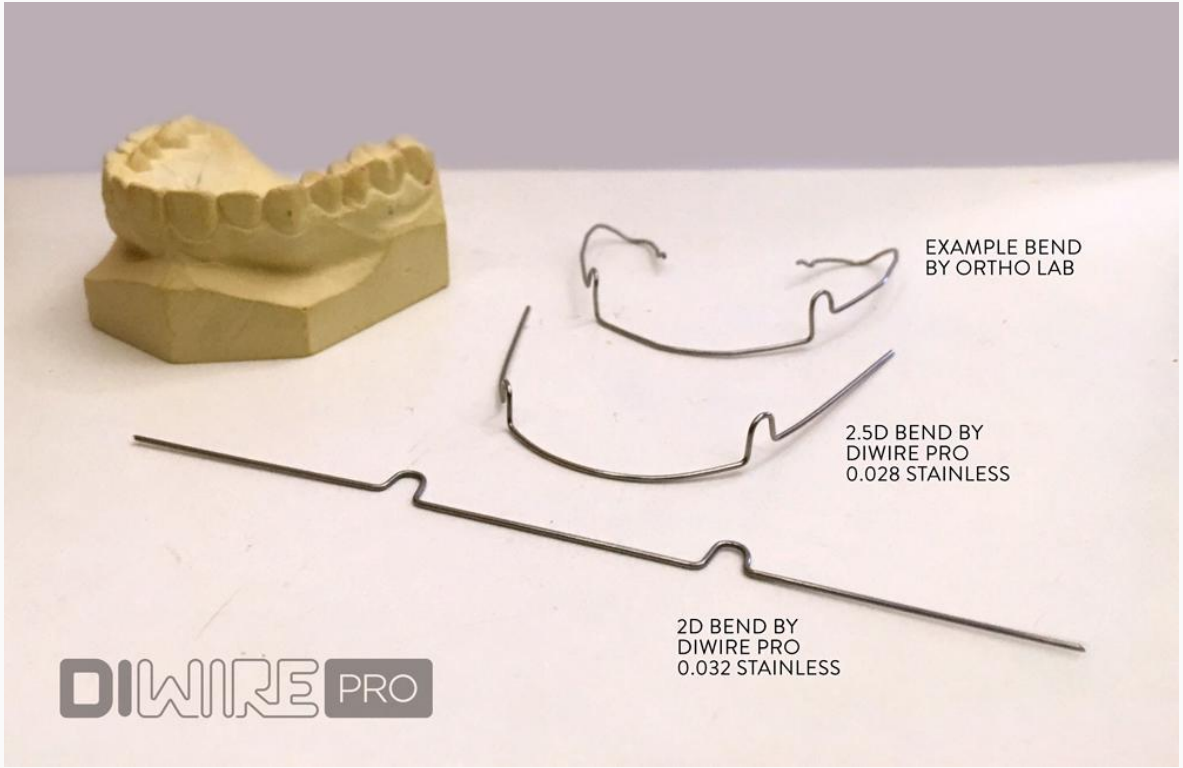
CURRENT CAPABILITIES

Tolerances:
+ /- 0.5 °
+/- 0.1 mm

Approx. 1.5 min.
to produce 1 piece

Wire diameters:
0.027” - 0.032”

Material:
Stainless, round wire



DESIGN CONSIDERATIONS

Three major problems surface when creating workflows that will integrate well for ortho needs:

Data Input:

How to get measurements into our software from prescriptions, plasters, and digital scans?

Operator confidence:

How can we build workflows that users are able to use quickly?

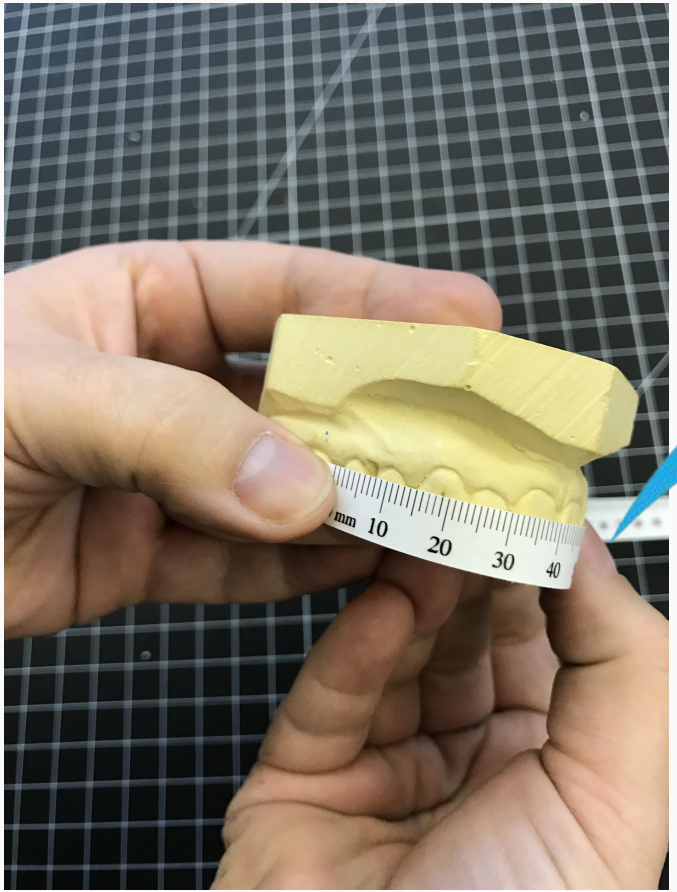
- Code-phobias
- On-boarding support

Output:

What shapes should we focus on, considering 3D is not yet an option?

Should we address shape or material variation requirements first?

CURRENT SAMPLE PRODUCTION: Manual to Digital



DIWire File Edit Mode Help

DIWire

Material Profile a

Wire Material: a
Wire Thickness: 0.125 in
Feed Wheels: 125FeedWheel
Bend Head: 125BendHead_a

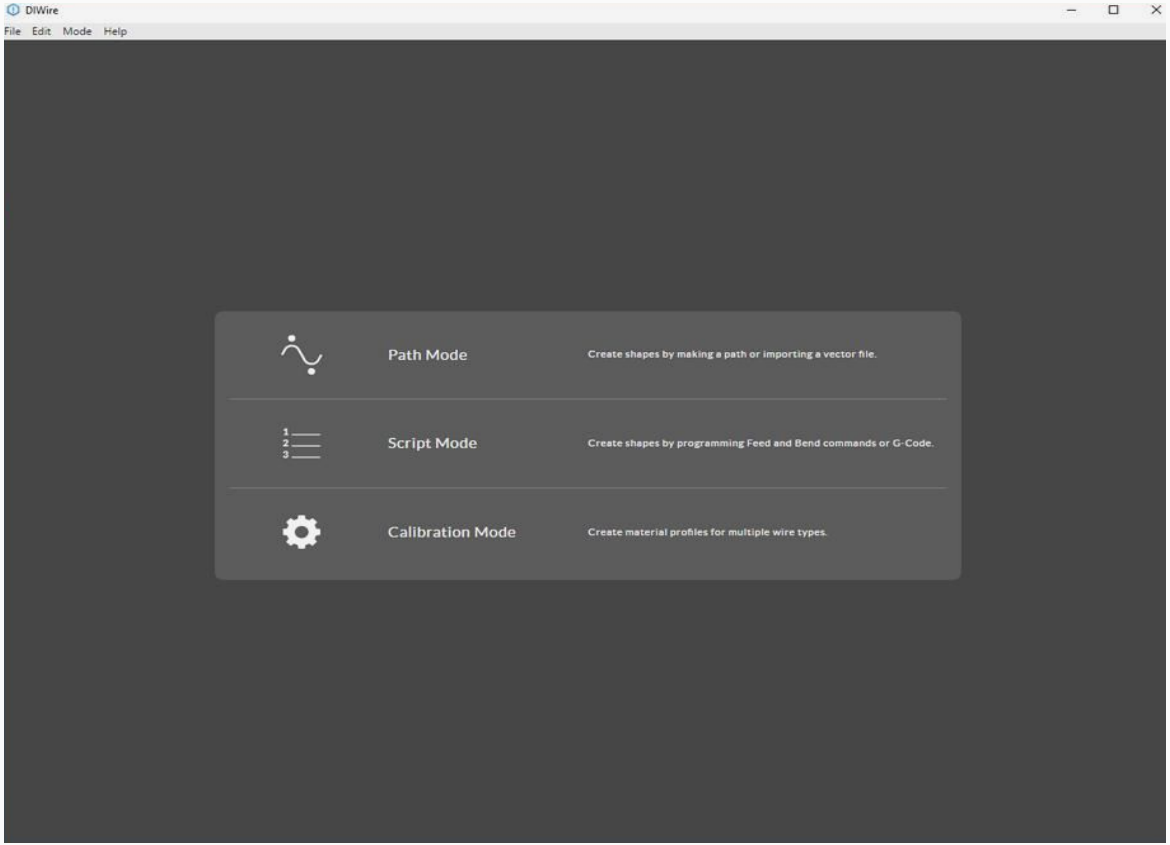
List of Commands

Command			
		Repeat 2:	Repeat the sequence specified amount
Bend	G1 A90	*Bend 90*	Move the bend pin the specified degrees
Feed	G1 X10	*Feed 10*	Feed the wire the specified amount
End		*End*	Close open command
Repeat	Bend	*Repeat 2:*	Repeat the sequence the specified amount
Bend	G1 A90	*Bend 90*	Move the bend pin the specified degrees
Feed	G1 X10	*Feed 10*	Feed the wire the specified amount
End		*End*	Close open command
Repeat	Bend	*Repeat 2:*	Repeat the sequence the specified amount
Bend	G1 A90	*Bend 90*	Move the bend pin the specified degrees

```
1  g90 g0 a0z0
2  a-30
3  g91 g0 x76
4  g90 g0 a75
5  a20z-4
6  a80
7  g91 g0 x2
8  g90 g0 z0
9  g90 g0 a0
10 g91 g1 a-25x2 f1000
11
12 repeat 15:
13 g90 g0 a-45
14 a-10
15 g91 g0 x.5
16 end
17
18 g90 g0 a0z-4
19 g91 g0 x4
20 g90 g0 a-95
21 z0
22 a70
23 a-30
24 g91 g0 x39
25 g90 g0 a75
26 a30z-4
27 a60
28 g91 g0 x3.5
29 g90 g0 z0
30 g90 g0 a0
31 g91 g1 a-25x2 f1000
32
33 repeat 16:
```

HOME RUN STOP JOG

WIREWARE 2.0- Approaches based on our current modes of working



Wireware 2.0 does offer options for inputting patient info.

Path Mode:
Import premade SVG, customize in interface

Script Mode:
Use premade code blocks based on lab specifications, customize numerically

WAYS TO WORK

Possible customization methods based on shape considerations:

- Arch shapes: create libraries or code blocks for a set of sizes based on individual lab specifications
- Custom Labial Bows with Loops: user input determines sizes
- Adaptations for 3rd Dimension: rethink base shapes

POSSIBLE WORKFLOWS

Based on in-depth research, our designers and engineers were able to propose solutions for the orthodontic use cases.

Each method of input would result in a custom output, and could be implemented at a variety of stages in the appliance production process.

DETAILS OMITTED TO RESPECT I.P.

INPUT CONCEPT 1: “Plug-in”
Applet in Wireware 2.0
Could be written to integrate with a variety of ortho software

INPUT CONCEPT 2: “Custom Script Mode”
Custom Script Tool in Wireware 2.0
Would allow users to enter data from 3rd party software

INPUT CONCEPT 3: ”Path Mode based”
Grab, drag/drop shapes Enter specific dimensions

POSSIBLE WORKFLOWS

The first solutions for workflows were designed to increase speed of individual output production by 20-40%.

Research showed that getting accurate bends that still required hand-finishing would still be of major value in larger labs.

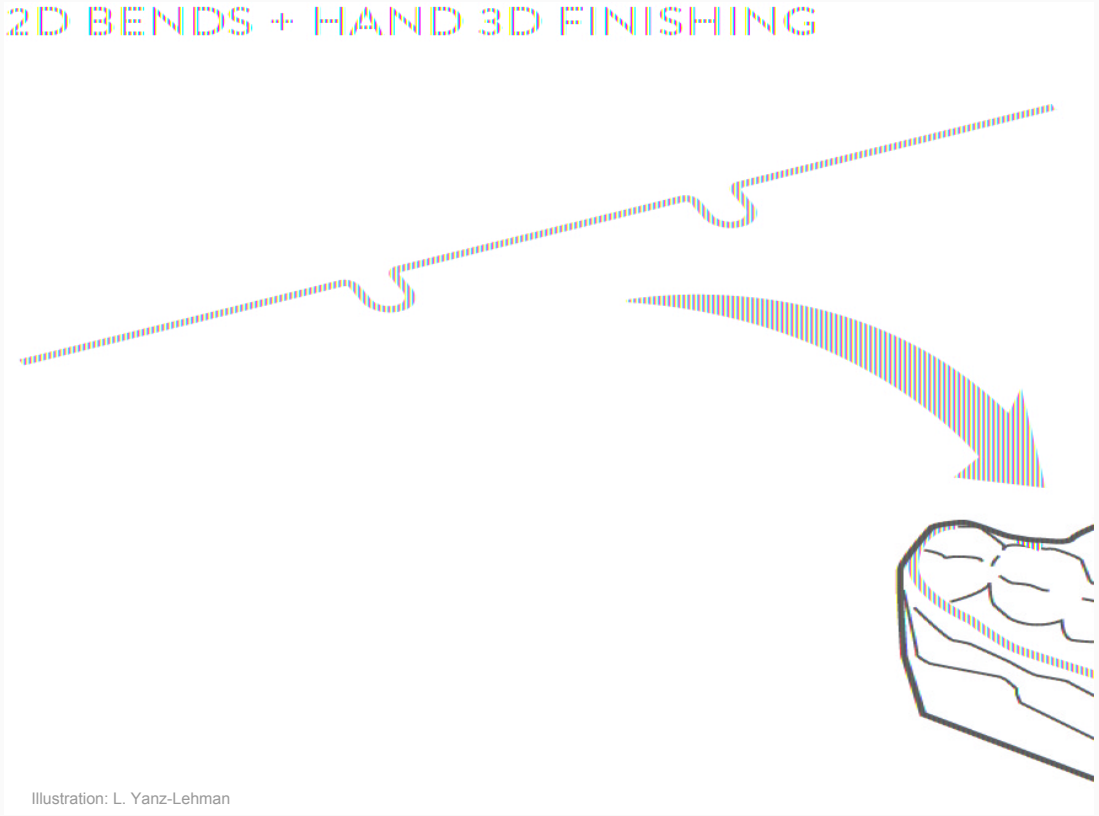
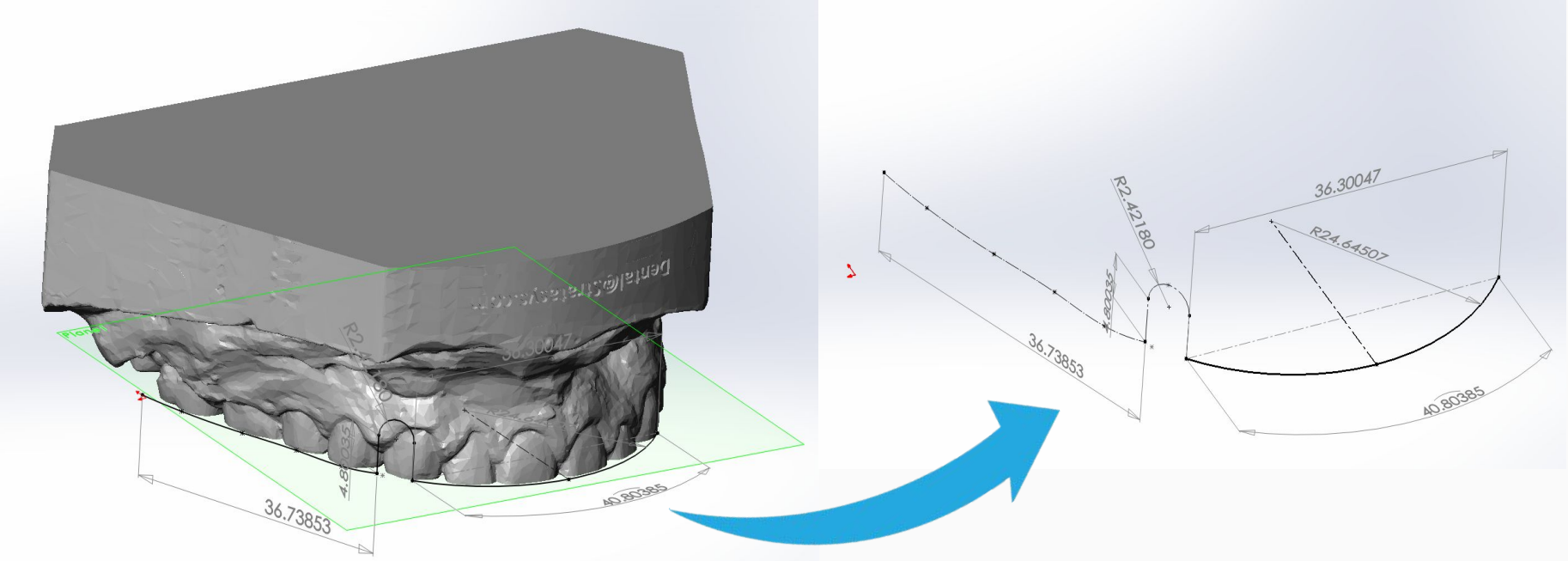


Illustration: L. Yanz-Lehman

LOOKING AHEAD:

WAYS TO WORK - DIGITAL TO DIGITAL



SOFTWARE INTEGRATION & COLLABS

ABSOLUTELY OVERWHELMING REQUESTS TO WORK WITH STLs

- Hold off on contacting these until after other mile markers

Top three software systems we encountered:

- 3Shape: they use a vector that they wrap with a wire stl for viewing
- Easy Rx: custom-made by orthodontists with lab practices
- Dolphin

ACCESSORIES & MACHINE CONSIDERATIONS

- Need to test with straightener - Novo #02
- Requests for auto cutter: we can do this with the experimental 3D hardware for diameters 0.027 - 0.030 now
- Will need significant onboarding support for labs, possibly in person

OTHER CHALLENGES

HIPAA:

Considering that patient-specific data is part of a medical record, any storing of files customized for patients would need to be kept in compliance with state and federal regulations.

Our software does not need to address this, but working with labs and doctors to insure files are secure and integrated into their EMR systems would be important.