Appendix

Evaluating Leg Length Discrepancy during Total Hip Arthroplasty

> Enhancing Conventional Surgical Workflows

Master Thesis Jan S. van Ackeren

Evaluating Leg Length Discrepancy during Total Hip Arthroplasty

Master Thesis

November, 2020

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Enhancing Conventional Surgical Workflows



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DESIGN FOR M luture

IDE Master Graduation

Project team, Procedural checks and personal Project brief

This document contains the agreements made between student and supervisory team about the student's IDE Master Graduation Project. This document can also include the involvement of an external organisation, however, it does not cover any legal employment relationship that the student and the client (might) agree upon. Next to that, this document facilitates the required procedural checks. In this document:

- The student defines the team, what he/she is going to do/deliver and how that will come about.
- SSC E&SA (Shared Service Center, Education & Student Affairs) reports on the student's registration and study progress.
- IDE's Board of Examiners confirms if the student is allowed to start the Graduation Project.

0 USE ADOBE ACROBAT READER TO OPEN, EDIT AND SAVE THIS DOCUMENT

Download again and reopen in case you tried other software, such as Preview (Mac) or a webbrowser

STUDENT DATA & MASTER PROGRAMME

family name	van Ackeren	Your master programme (only select the options that apply to you):		
initials	J.S. given name Jan Sebastian	IDE master(s):	IPD Dfl SPD	
student number	4763033	2 nd non-IDE master:		
street & no.		individual programme:	(give date of approval)	
zipcode & city		honours programme:	Honours Programme Master	
country		specialisation / annotation:	Medisign	
phone			Tech. in Sustainable Design	
email			Entrepeneurship	

SUPERVISORY TEAM **

** chair	Ir. lemkje A. Ruiter	dept. / section:	HCD / AED
** mentor	MSc. Tianyun (Helen) Yuan	dept. / section:	SDE / MD
2 nd mentor	MSc. Hilbrand Bodewes		
	organisation: Zimmer Biomet		
	city: <u>Delft</u>	country: <u>Neth</u>	erlands

comments Additional contact persons include: (optional) Dr. Stephan Vehmeijer (Reinier de Graaf Hospital) Ir. Matthijs Netten (TU Delft)

Chair should request the IDE
Board of Examiners for approval
of a non-IDE mentor, including a
motivation letter and c.v

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Second mentor only applies in case the assignment is hosted by an external organisation.

0

Ensure a heterogeneous team. In case you wish to include two team members from the same section, please explain why.

Procedural Checks - IDE Master Graduati	ion				ŤU Delft
APPROVAL PROJECT BRIEF To be filled in by the chair of the supervisory tear	n.				
chair Ir. lemkje A. Ruiter	_ date _			signature	
				-	
CHECK STUDY PROGRESS To be filled in by the SSC E&SA (Shared Service I The study progress will be checked for a 2nd tim				after approval of the	project brief by the Chair.
Master electives no. of EC accumulated in total: Of which, taking the conditional requirements nto account, can be part of the exam programme					ear master courses passed
List of electives obtained before the third semester without approval of the BoE		10		into mitoling i	year master courses are.
)
name	_ date _			signature	
FORMAL APPROVAL GRADUATION PROJE To be filled in by the Board of Examiners of IDE T	U Delft. Plea				parts of the brief marked **.
Next, please assess, (dis)approve and sign this P			iteria belov		
 Does the project fit within the (MSc)-program the student (taking into account, if described activities done next to the obligatory MSc sp 	, the	Content:	\bigcirc	APPROVED) NOT APPROVED
courses)?		Procedure:	\bigcirc	APPROVED	
Is the level of the project challenging enough					
MSc IDE graduating student?Is the project expected to be doable within 1	00				
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 MSc IDE graduating student? Is the project expected to be doable within 1 working days/20 weeks ? Does the composition of the supervisory tear 	n			signature	comments

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Personal Project Brief - IDE Master Graduation

Determining Leg Length Discrepancy (LLD) during Total Hip Arthroplasty

Please state the title of your graduation project (above) and the start date and end date (below). Keep the title compact and simple. Do not use abbreviations. The remainder of this document allows you to define and clarify your graduation project.

start date 08 - 06 - 2020

06 - 11 - 2020 end date

INTRODUCTION **

Orthopaedic Surgery often involves joint reconstruction or joint replacement with an orthopaedic prosthesis. One of the most common procedures, in particular with elderly people, is hip replacement surgery or Total Hip Arthroplasty (THA). There are different approaches to a THA, one of which is the Anterior Approach. With this approach an interval between muscles is chosen to provide access to the hip joint, which is less invasive to the patient (improving recovery time) but limits the surgeons operational field of view. This thesis will primarily be dealing within the context of the Anterior Approach, yet may not be limited to it.

During the procedure, the surgeon will remove the Femoral head, clean and reamer the Acetabulum for receival of the implant cup and liner. Afterwards, the Femur is being prepared for the fitting process. During this process the surgeon will use increasing size templates of the Femoral stem implant (which simultaneously act as reamers - 14 sizes) in combination with a neck piece (3 sizes) and a head (7 sizes), to determine the correct configuration and therefore leg length and femoral offset. This evaluation and selection for the final configuration is aided by various X-Ray images taken during each fitting and compared to the reference image, taken right before surgery. Additionally, an assisting nurse, or in some cases the surgeon him-/herself will evaluate the length of the legs by straightening the pelvis, positioning the patient's feet perpendicular to their body and trying to line up the heels (or in some cases ankles), by pressing against them. This is an iterative process, which is not only time consuming, but also neither precise nor quantified.

In some cases, if not carried out correctly patients will end up suffering from leg length discrepancy (LLD), which not only reduces their quality of life but also the lifespan of the implant and in most cases leads to malpractice lawsuits against the orthopaedic surgeon. Post-operative LLD is reported after almost 1/3 of THAs and can range from 3 - 70 mm, leading to great discomfort of the patient.* Additionally, post-operative LLD may lead to other problems with the musculoskeletal and nervous system (e.g. Sciatica).

Subsequently, an opportunity presents itself for increasing the accuracy of the implant configuration and evaluation process, while streamlining the work flow and efficiency of the surgical procedure itself. Furthermore, tackling this problem effectively would result in more positive post surgical results and less negative consequences for all parties.

(*Source: Dundon, J. M., & Mays, R. R. (2019, July 15). Revising Substantial Leg Length Discrepancy in Total Hip Arthroplasty Using Computer-assisted Navigated Systems: A Case Series of Three Patients. Retrieved March 1, 2020, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC6741389/)

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IDE TU Delft - E&SA Department /// Graduation project brief & study overview /// 2018-01 v30		
Initials & Name J.S. van Ackeren	Student number 4763033	
Title of Project Determining Leg Length Discrepancy (LL	D) during Total Hip Arthroplasty	

Personal Project Brief - IDE Master Graduation

introduction (continued): space for images

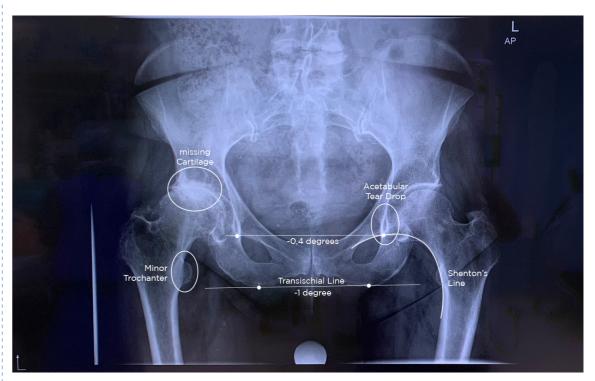


image / figure 1: Important reference points when evaluating pre-operative LLD (on X-Ray)



image / figure 2: ____Left: Fitting instruments

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Title of Project Determining Leg Length Discrepancy (LLD) during Total Hip Arthroplasty

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Right: Nurse evaluating LLD by pushing against the heels

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PROBLEM DEFINITION **

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Assessing LLD during THA is not only one of the most time consuming parts of the procedure, but it is also among the most important evaluations during the procedure. Based on the evaluation surgeons will choose the implant configuration that the patient will have to live with for 10-15 years. In case of the implant not being placed correctly, the patient will need to compensate with corrective shoe insoles, corrective surgery may be performed and subsequent malpractice lawsuits towards the surgeon (and team) may follow. Either scenario is unfavourable to the patient, surgeon and clinic, as it may result in discomfort (patient), damage to reputation (surgeon and clinic) and increased costs for all parties involved.

The primary scope of this project will therefore be to make the procedure of assessing leg length in real-time during THA more accurate, reliable and efficient. The secondary scope will be to factor in femoral offset and include it into the evaluation process.

THA is the primary documented cause of post-operative LLD. Yet, Literature suggests that there may be other orthopaedic surgeries that cause perceived post-operative LLD, such as knee replacement surgery or total knee arthroplasty (TKA).** Therefore the stretch goal of this project, will be to develop a solution that is not only applicable for THA, but could be used for other procedures that require accurate reference taking, evaluation and repositioning of the human anatomy, such as TKA.

(**Source: Tipton, S., Sutherland, J., & Schwarzkopf, R. (2015, September). Change in Limb Length After Total Knee Arthroplasty. Retrieved March 1, 2020, from https://www.ncbi.nlm.nih.gov/pmc/articles/PMC4536512/)

ASSIGNMENT **

In order to tackle the proposed problem, this research will examine existing literature describing methods for LLD. evaluation. Thereafter, research will be expanded to evaluate the feasibility and desirability of various Indoor Positioning,

Spacial Reference and Tracking systems: mechanical, electronic and digital.

Research question:

How can Indoor Positioning, Spacial Reference and Tracking Systems help to prevent post-operative Leg Length Discrepancy (LLD) in real-time during Lower Limb Arthroplasty (LLA)?

Research:

Current LLD evaluation methods, upcoming technologies and contextual bottlenecks. Research into systems, such as Ultrasound Identification, Infrared, Ultrawide band, Laser trackers; and mechanical.

Design:

Develop a (non-)invasive device or method to enable real-time evaluation of leg length during an THA in the OR, using methods based on current technologies and trends. The solution may be mechanical, electronic or digital (software) based; or potentially a combination.

Create:

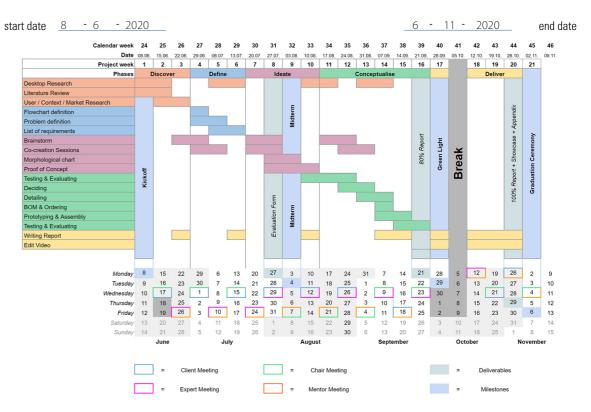
A detailed concept and physical prototype, ready for pre-production engineering. A human centred approach is imperative, so that the solution will be supportive of the user's tasks without negatively impacting any aspect of the surgical procedure.

DE TU Delft - E&SA Department /// Graduation project brief & study overview /// 2018-01 v30			Page 5 of 7
nitials & Name	J.S. van Ackeren	Student number 4763033	
Fitle of Project	Determining Leg Length Discrepancy (LLD) during Tota	l Hip Arthroplasty	

Personal Project Brief - IDE Master Graduation

PLANNING AND APPROACH **

Include a Gantt Chart (replace the example below - more examples can be found in Manual 2) that shows the different phases of your project, deliverables you have in mind, meetings, and how you plan to spend your time. Please note that all activities should fit withis the given net time of 30 EC = 20 full time weeks or 100 working days, and your planning should include a kick-off meeting, mid-term meeting, green light meeting and graduation ceremony. Illustrate your Gantt Chart by, for instance, explaining your approach, and please indicate periods of part-time activities and/or periods of not spending time on your graduation project, if any, for instance because of holidays or parallel activities.



The planning for this project is divided into five phases: Discover, Define, Ideate, Conceptualise and Deliver. During each phase, adequate methods, tasks and activities have been chosen in order to facilitate the progress. Some tasks, such as desktop research or brainstorms, are iterative in nature and will occur in many phases throughout the entire process.

The analytical phases (discover and define) will be executed in the first third of the project, so that by the Midterm meeting, opportunity areas, clear directions and initial ideas can be discussed. During the Ideation and Conceptualisation phases, the project will turn more concrete and tangible by the day. In anticipation for a lack of time towards the end, each phase will be finalised and documented through report writing.

The calendar indicates meetings, deliverables and milestones. Meetings are scheduled in 2 week intervals and will take place in alternating pairs. The pairs change in 6 week intervals and get randomised in the last month. It is to be taken into consideration, that these pairs are flexible in their arrangement and may be adjusted during the course of the project.

The project will be executed in a full-time fashion, whereas I will be working on a part-time Student Assistant (SA) position in my free time. The planning with regards to the SA position will be re-evaluated by the Midterm meeting. Furthermore, I will allow myself a small break end September, just after the Green Light meeting.

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Initials & Name	J.S.	van Ackeren			Student number

Title of Project Determining Leg Length Discrepancy (LLD) during Total Hip Arthroplasty



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Personal Project Brief - IDE Master Graduation

MOTIVATION AND PERSONAL AMBITIONS

Explain why you set up this project, what competences you want to prove and learn. For example: acquired competences from your MSc programme, the elective semester, extra-curricular activities (etc.) and point out the competences you have yet developed. Optionally, describe which personal learning ambitions you explicitly want to address in this project, on top of the learning objectives of the Graduation Project, such as: in depth knowledge a on specific subject, broadening your competences or experimenting with a specific tool and/or methodology, Stick to no more than five ambitions.

Whereas others feel estranged in hospitals and ORs, they feel strangely familiar to me.

To give you some background, I come from a medical family and everyone who isn't a surgeon, is a scientist of some sort in related fields (e.g. biology). I assisted my father in a cataract surgery for the first time, when I was 16; after which he told me about the first time he assisted my grandfather during open heart surgery at the age of 16. My grandfather from my mom's side was a teacher of engineering at the military academy in former Yugoslavia and although I barely have any recollection of him, our family home is filled with things he made. This was my reality while growing up and I always wondered how I can combine my creative interests with my family values and heritage.

Creating is what drives me. In particular creating useful products or tools for people to use is what drives me. A useful product or tool can be the difference between a mediocre job and a job well done. Tools are what differentiates us Humans from many other species and formed us into the high performance species we are today. On the contrary it means, that when we want to achieve peak performance, we are at the mercy of our tools. Surgeons in particular need to be high performing and therefore deserve the adequate tools to do so. This has been my motivation, not only for this Thesis, but for some time now and is the reason for me wanting to work on a project, that is not only medical, but surgical in nature.

I am excited that after having started IPD with a Medisign specialisation two years ago and having managed to secure a project of surgical nature, I get to work with and hopefully improve the work of healthcare professionals in the OR. But aside from creating a complementary tool for Orthopaedic surgery, there are other ambitions that I have for this project. I want to deepen my understanding of mechatronic systems and work on integration of tangible and digital product features. Additionally, I want to demonstrate (more to myself than anyone else) that I am fully capable of independently developing a complex product, so that I can be sure that I will be a reliable team player in the future.

After all, product development as well as surgery is a team sport.

FINAL COMMENTS

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 Initials & Name
 J.S. van Ackeren
 Student number 4763033

 Title of Project
 Determining Leg Length Discrepancy (LLD) during Total Hip Arthroplasty

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Appendix A |15

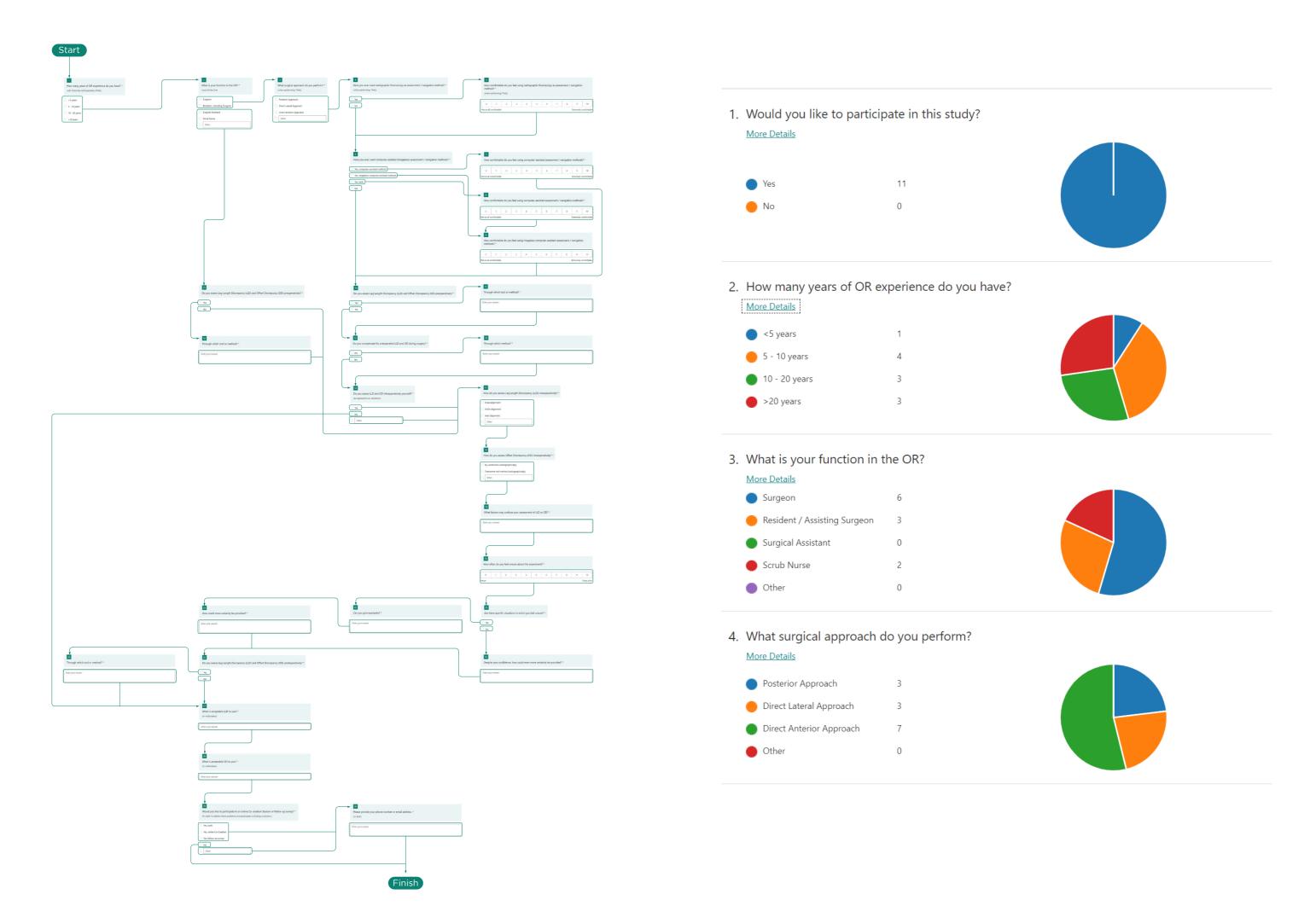


Due to the size of the report the access link is provided instead:

https://www.lroi-report.nl/app/uploads/2020/10/PDF-Online-LROI-annual-report-2019-min.pdf

Appendix B |19



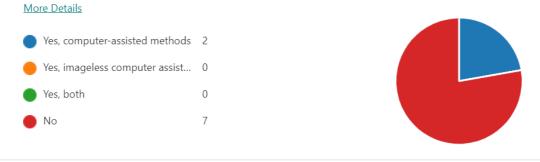


Appendix C | 23

- 5. Have you ever used radiographic fluoroscopy as assessment / navigation method? More Details 5 Yes
 - 🛑 No 4
- 6. How comfortable do you feel using radiographic fluoroscopy as assessment / navigation method?



7. Have you ever used computer-assisted (imageless) assessment / navigation methods?



8. How comfortable do you feel using computer-assisted assessment / navigation methods?

Promoters	0	
Passives	1	
Detractors	1	

More Details



9. How comfortable do you feel using computer-assisted assessment / navigation methods? More Details

0
0
0

10. How comfortable do you feel using imageless computer-assisted assessment / navigation methods?

More Details		
Promoters	0	
Passives	0	
Detractors	0	

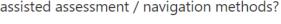
11. Do you assess Leg Length Discrepancy (LLD) and Offset Discrepancy (OD) preoperatively? More Details



12. Through which tool or method?

More Details











Latest Responses "X-ray"

12. Through which tool or method?

9 Responses

ID↑	Name	Responses
1	anonymous	Physical examination LLD and bij rontgen evaluation OD
2	anonymous	Templating software Orthoview mainly, and manually during surgery, anatomical landmarks (obturator, greater and lesser trochanter)
3	anonymous	Physical examination with boards
4	anonymous	X ray, kliniek
5	anonymous	just checking the heels of the patient in supine position and on the out patient clinic in standig position feeling the iliac crest hight.
6	anonymous	Physical examination X pelvis level of lesser trochanter
7	anonymous	Manual
8	anonymous	On conventional x-ray
9	anonymous	X-ray

13. Do you compensate for preoperative LLD and OD during surgery?





14. Through which method?

More Details



Latest Responses "Fluoroscopy, and clinical assessment"

14. Through which method?

7 Responses

ID↑	Name	Responses
1	anonymous	By radiograph
2	anonymous	Based on pre- landmarks (ob
3	anonymous	Sizing the pro
4	anonymous	Offset, kopje
5	anonymous	Xray
6	anonymous	Resection oste Angle.
7	anonymous	Fluoroscopy, a

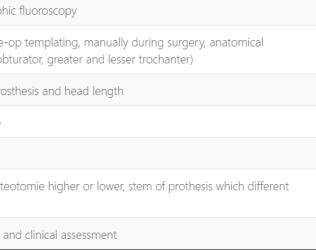
15. Do you assess LLD and OD intraoperatively yourself? More Details

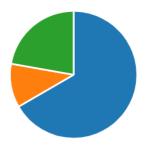


15. Do you assess LLD and OD intraoperatively yourself?

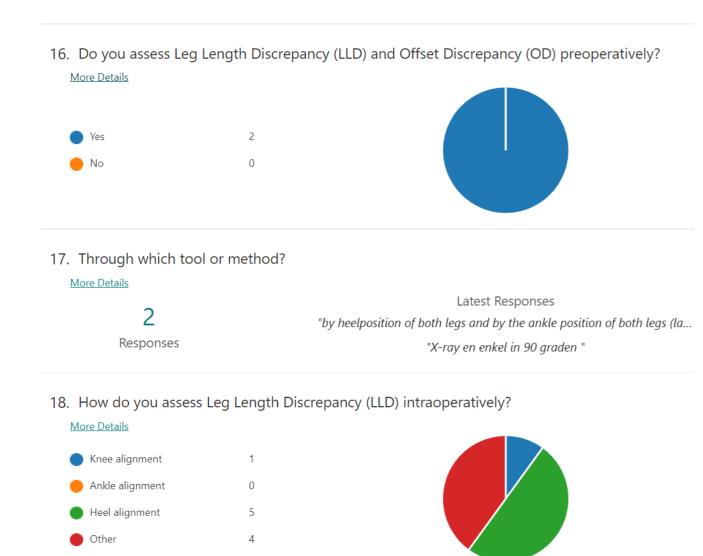
9 Responses

ID↑	Name	Responses
1	anonymous	Yes
2	anonymous	Yes
3	anonymous	Yes
4	anonymous	Yes
5	anonymous	Yes
6	anonymous	Offset templa
7	anonymous	Yes
8	anonymous	No
9	anonymous	Done by the





ate. Lld intra op		
runner nurse		



19. How do you assess Offset Discrepancy (OD) intraoperatively?

More Details by Landmarks (radiographically) Transverse rod method (radio... Other

18. How do you assess Leg Length Discrepancy (LLD) intraoperatively?

10 Responses

ID↑	Name	Responses
1	anonymous	Heel alignment
2	anonymous	All three above and tissue/ligament laxity
3	anonymous	Knee alignment
4	anonymous	Tip trochanter, centrum van rotatie
5	anonymous	Heel alignment
6	anonymous	Heel and telescoping
7	anonymous	Heel alignment
8	anonymous	Ankle and heel
9	anonymous	Heel alignment
10	anonymous	Heel alignment

19. How do you assess Offset Discrepancy (OD) intraoperatively?

10 Responses

ID↑	Name	Responses
1	anonymous	by Landmarks (radiographically)
2	anonymous	Rely on pre-op templated offset
3	anonymous	Inkt preopetatively
4	anonymous	by Landmarks (radiographically)
5	anonymous	by Landmarks (radiographically)
6	anonymous	None, template only
7	anonymous	by Landmarks (radiographically)
8	anonymous	by Landmarks (radiographically)
9	anonymous	by Landmarks (radiographically)
10	anonymous	by Landmarks (radiographically)

20. What factors may confuse your assessment of LLD or OD?

More Details

Latest Responses "Poisition pelvis" 10 "position of the patient on the OR table and the position of the OR ta... Responses "Stability "

20. What factors may confuse your assessment of LLD or OD?

10 Responses

ID↑	Name	Responses
1	anonymous	Rotation, total hip replacement or hip dysplasia on the other side
2	anonymous	Change of patiënt position during surgery
3	anonymous	Tilting of the pelvis intra operatively
4	anonymous	Ligging, cuppositie
5	anonymous	when the patient is lying on their left or right side
6	anonymous	Quality and leg position(rotation) on pre op pelvic X-ray
7	anonymous	Settings on xray
8	anonymous	Stability
9	anonymous	position of the patient on the OR table and the position of the OR table itsself
10	anonymous	Poisition pelvis

21. How often do you feel unsure about the assessment?

More	Details
	Dettano

Promoters	0
Passives	0
Detractors	10







23. Can you give examples?

More Details

4

Responses

23. Can you give examples?

4 Responses

ID↑	Name	Responses
1	anonymous	When there are
2	anonymous	Sterke varus of
3	anonymous	when the asser
4	anonymous	Unstable hip

24. How could more certainty be provided?

More Details

4

Responses

24. How could more certainty be provided?

4 Responses

ID↑	Name	Responses
1	anonymous	By having a sta
2	anonymous	Doirlichting
3	anonymous	?
4	anonymous	More anatomic





Latest Responses

are situations like dysplAsia of the other side

of valgus heupen

ement is not in line with my expectations

Latest Responses

tandardized reference tool

nic landmarks

25. Despite your confidence, how could even more certainty be provided? More Details

> 6 Responses

Latest Responses "Device" "x ray on the OR" "X"

25. Despite your confidence, how could even more certainty be provided?

6 Responses

ID↑	Name	Responses
1	anonymous	Хгау
2	anonymous	Don't know, May be with CAS of it is really surgeon friendly
3	anonymous	Knee measurement
4	anonymous	Х
5	anonymous	x ray on the OR
6	anonymous	Device

26. Do you assess Leg Length Discrepancy (LLD) and Offset Discrepancy (OD) postoperatively? More Details

Yes
 No
 2



27. Through which tool or method?

More Details

9 Responses Latest Responses "X-ray and patient perception" "Enkel methode"

27. Through which tool or method?

9 Responses

ID↑	Name	Responses
1	anonymous	Physical exam
2	anonymous	Manually and
3	anonymous	Weight bearin
4	anonymous	Foto
5	anonymous	heel aligneme
6	anonymous	LLB on table a op
7	anonymous	X-Ray
8	anonymous	Enkel method
9	anonymous	X-ray and pat

28. What is acceptable LLD to you?

More Details

11 Responses

1
post op ap pelvis xray
ng x-ray and boards
ent in bed and on postoperative x-ray
after removal of drapes Ofset post op X-ray compare to pre
le
tient perception

Latest Responses "5 mm" "10" "I'm not a doctor "

28. What is acceptable LLD to you?

11 Responses

ID↑	Name	Responses
1	anonymous	Up to 10 mm
2	anonymous	5
3	anonymous	1-1,5 cm
4	anonymous	0,5
5	anonymous	<1cm
6	anonymous	Line lesser trochanter
7	anonymous	0,5 mm
8	anonymous	5-10mm
9	anonymous	l'm not a doctor
10	anonymous	10
11	anonymous	5 mm

29. What is acceptable OD to you?

More Details

11 Responses Latest Responses "5mm" "5" "I'm not a doctor "

30. Would you like to participate in an online Brainstorm / Co-creation Session or follow-up survey?





29. What is acceptable OD to you?

11 Responses

ID↑	Name	Responses
1	anonymous	Up to 5 mm
2	anonymous	5
3	anonymous	0,5 1 cm
4	anonymous	0,5
5	anonymous	no cut off poi
6	anonymous	Never measu
7	anonymous	5 mm
8	anonymous	5mm
9	anonymous	l'm not a doc
10	anonymous	5
11	anonymous	5mm

32. Is there any final comment you would like to make?

9 Responses

ID↑	Name	Responses
1	anonymous	Good luck
2	anonymous	Clinical releva discrepancy. A
3	anonymous	No
4	anonymous	Hoop dat rele overschat zola
5	anonymous	good luck! loo
6	anonymous	Keep it simple
7	anonymous	Nice research
8	anonymous	Good luck
9	anonymous	Great survey

nt
e. When looks okay to me in happy
or

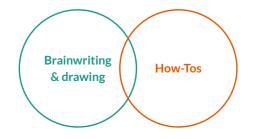
ance to be kept in mind. Perceived vs actual leg length And correlation with patiënt satisfaction
evantie LLD en OD literatuur meegenomen wordt. LLD belang ang het minder dan 1 cm is
oking forward to your conclusions
2



Co-Creation Session #1

Evaluating Leg Length Discrepancy during Total Hip Arthroplasty (THA) *Enhancing Conventional Surgical Workflows* Program

Methodology



- 1. Read your 'How-To...'
- 2. Write, draw, copy & paste... everything goes!
- 3. Time up? Finish last idea ...
- 4. Study next slide ...
- 5. Repeat!

Company Introduction

1. Introduction

- a. Company
- b. Context
- c. Current Market
- d. Surgical Protocol

2. Solution Criteria

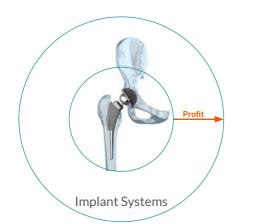
3. Co-Creation

- a. Set-up
- b. Sessions

4. Wrap-up

Introduction - Company

"Zimmer Biomet designs, develops, manufactures and markets **orthopaedics products**, including knee, hip, shoulder, elbow, foot and ankle <u>artificial joints</u> and dental prostheses."





Introduction - Context

"During THA the diseased ball and socket of the hip joint are completely removed and <u>replaced with artificial</u> <u>materials</u>. A femoral component (stem, neck & head) is inserted into the femur (thigh bone) and an acetabular cup is placed in the acetabulum socket of the pelvis."

Introduction - Context

Possible Unintended Consequences

1. Leg Length change

2. Offset change

Conclusion

Pre-, Intra & Postoperative evaluations of Leg Length and Offset are desirable.

Context Introduction

16

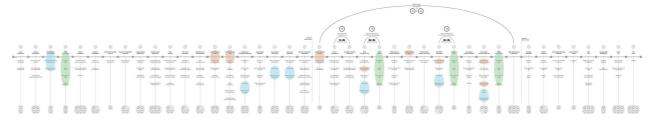




Market Introduction

Introduction - Surgical Protocol

Introduction



Introduction - Market

Mechanical Tools

- Iliac Fixation Pins
- Intraoperative Calipers
- PCA Limb Lengthening Gauge

Computer Assisted Systems

- Real-time Analysis Software
- Software Navigation Systems
- Tracking Systems

Robot Assisted Systems

- Robotic Arm System





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Solution Criteria

.

Co-Creation Set-up

Solution Criteria



- 1. Patient in supine position (on their back)
- 2. 1 min measurement (max.)
- 3. Non-invasive measurement
- 4. Symmetric measurement
- 5. Loaded measurement

Set-up

- 1 Problem Statement per slide
- 5 Slides = 6 rounds
- <u>2 min</u> per round
- <u>1 min</u> to drop ideas onto slide
- Repeat



Use

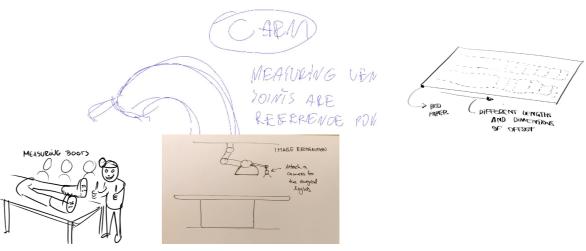
- A4 paper
- Drawing Tablet
- Google Images
- Text Box

Co-Creation Sessions

Round 1

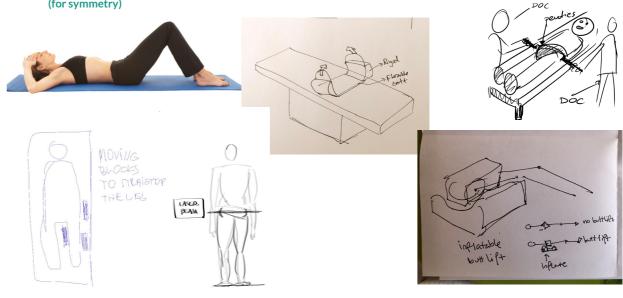
Slide 1

How to measure leg length or offset <u>non-invasively</u>? (asymmetric - single leg OR symmetric - both legs)



Slide 2

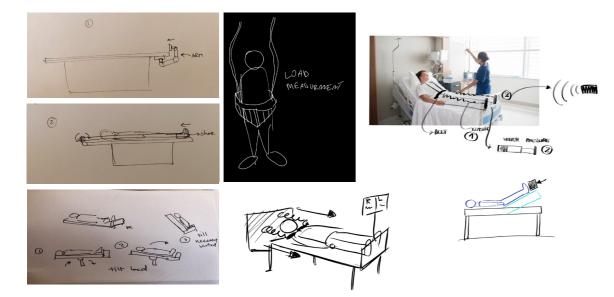
How to square up the pelvis before a measurement? (for symmetry)



Taking the data from CT to analyse

Slide 3

How to simulate (weight-bearing) loads on the patient's legs? (while in supine position)



Slide 5

How to give the user a sense of empowerment and control? (during a measurement)

BN

Feedback loop

Integrate different options of

measurement and ask for choice

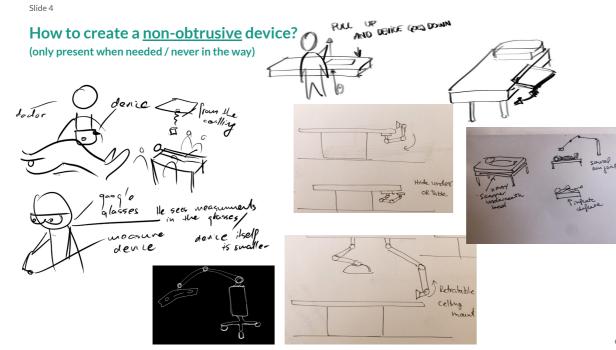
from medic between the methods

0

Triggers

00

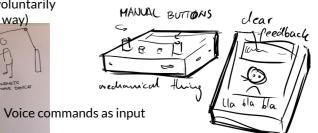
Create errors voluntarily (in a controlled way)



61

60





Auditory feedback after each step as beeps

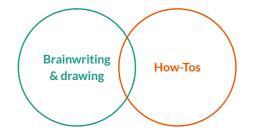
> Calculate but ask for evaluation

Ask for physical check aside from an automated measurement

Co-Creation Session #2

Evaluating Leg Length Discrepancy during Total Hip Arthroplasty (THA) *Enhancing Conventional Surgical Workflows* Program

Methodology



- 1. Read your 'How-To...'
- 2. Write, draw, copy & paste... everything goes!
- 3. Time up? Click a picture & send ...
- 4. Study next slide ...
- 5. Repeat!

Context Introduction

1. Introduction

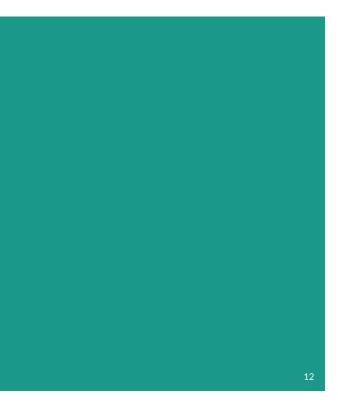
- a. Context
- b. OR
- c. Surgical Protocol

2. Solution Criteria

3. Co-Creation

- a. Set-up
- b. Sessions

4. Wrap-up



Introduction - Context

"During THA the **diseased ball and** socket of the hip joint are completely removed and replaced with artificial materials. A femoral component (stem, neck & head) is inserted into the femur (thigh bone) and **an acetabular cup is** placed in the acetabulum socket of the pelvis."



15

Surgical Protocol Introduction

Introduction - Context

Possible Unintended Consequences

- 1. Leg Length change
- 2. Offset change



Introduction - Surgical Protocol



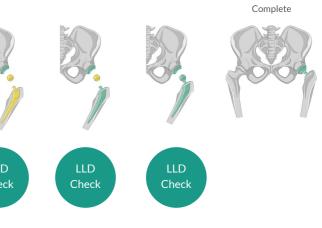




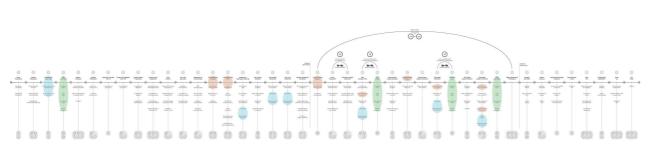
Check







Introduction - Surgical Protocol



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31

OR Introduction

Introduction - Context



Introduction - Context



OR Setup

- Surgical site (sterile zone) Feet
- Vertical Drape
- X-Ray 4. (on screen)
- 1. Surgical site (sterile zone) Feet 2. (sterile zone)
- Vertical Drape З. (non-transparent)
- Template 4. (on screen)

Preoperative

1. Line up Heels 2. Straighten Pelvis (move feet around) Centre Feet Apply pressure 5. Feel Difference

3. 4.

1.

2.

(via thur

Centre Feet (pointing out at 45°) Line up with Chin (straighten pelvis) 3. See difference



44

(non-sterile zone)



Introduction - Context





63

Solution Criteria

Solution Criteria



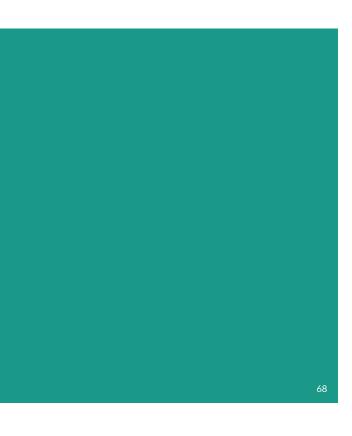
In case of Genius... Ignore!

1. Non-invasive

2. Non-disruptive to Workflow

3. Simplicity over complexity!

Co-Creation Set-up



Set-up

Use

- 1 Problem Statement per slide
- 7 Slides = 7 rounds
- <u>2 min</u> per round
- <u>1 min</u> to study next slide
- Repeat

- A4 paper

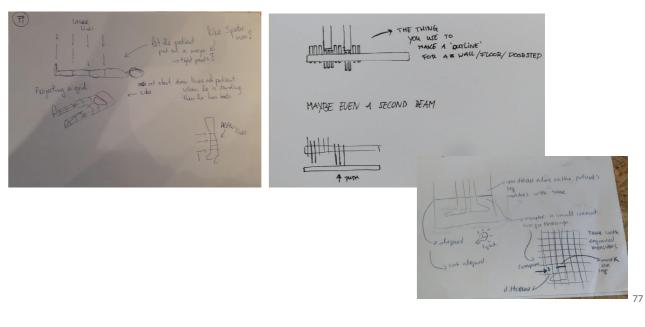
- Drawing Tablet
- Google Images
- Text Box

74

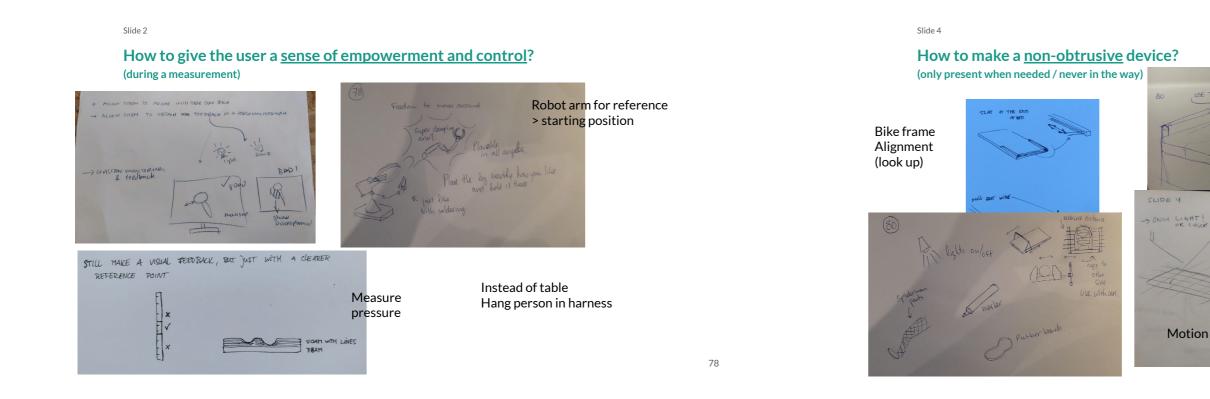
Round 1

Slide 1

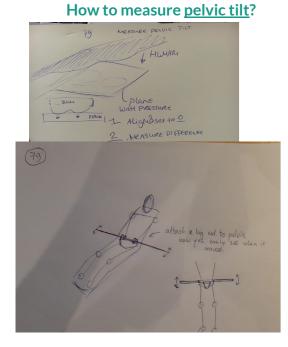
How to measure <u>leg length (discrepancy)</u>?

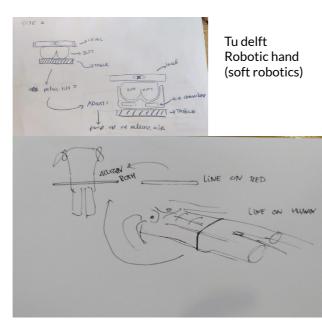


Co-Creation Sessions



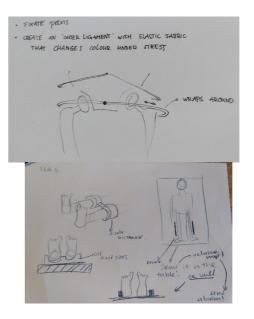
Slide 3

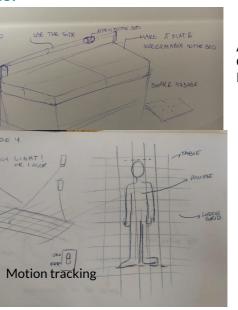




Slide 5

How to measure <u>leg offset (discrepancy)</u>?

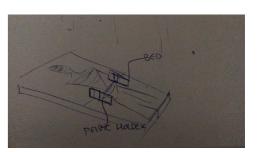




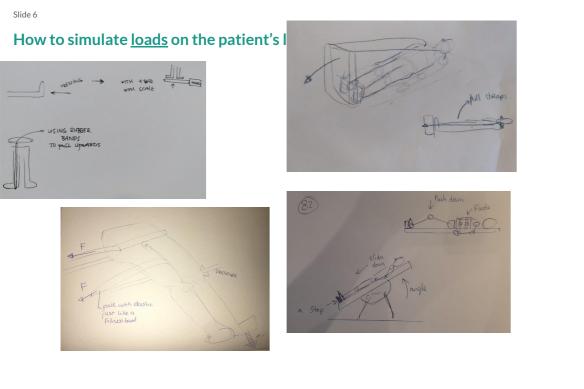
Automotive Clay modelling Rod measuring tool

Nemo ,museum Sand projection box





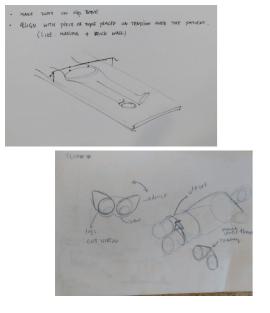


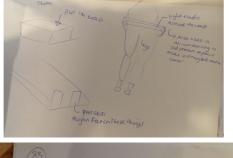


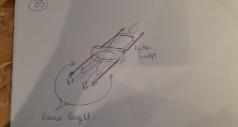
82

Slide 7

How to <u>straighten</u> the pelvis before a measurement?





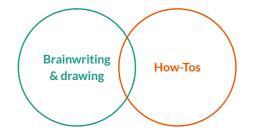


Appendix D | 63

Co-Creation Session #3

Evaluating Leg Length Discrepancy during Total Hip Arthroplasty (THA) *Enhancing Conventional Surgical Workflows* Program

Methodology



- 1. Read your 'How-To...'
- 2. Write, draw ... everything goes!
- 3. Time up? Click a picture & send ...
- 4. Study next slide ...
- 5. Repeat!

Problem Introduction

1. Introduction

- a. Problem
- b. Surgical Context
- c. Surgical Protocol
- d. OR Context

2. Solution Criteria

3. Co-Creation

- a. Set-up
- b. Sessions

4. Wrap-up

Introduction - Problem

"During THA the **diseased ball and socket of the hip joint are completely removed** and <u>replaced with artificial</u> <u>materials</u>. A femoral component (stem, neck & head) is inserted into the femur (thigh bone) and **an acetabular cup is placed in the acetabulum socket of the pelvis.**"



15

Surgical Context Introduction

Introduction - Problem

Possible Unintended Consequences

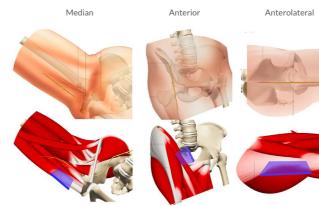
- 1. Leg Length change
- 2. Offset change

What are we looking for? A validation solution!



Introduction - Surgical Context

Approaches to the Hip Joint





20

Posterior

Direct Lateral

Introduction - Surgical Context

Approaches to the Hip Joint

Anterior



1. Least invasive (fastest recovery)

2. Supine Position (Patient lying on back)

Every Surgeon customises their workflow.. The solution <u>must not be disruptive</u> to any workflow! Introduction - Surgical Protocol





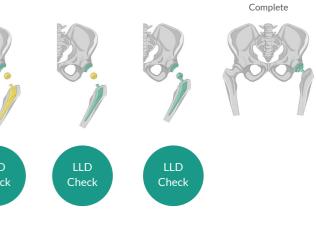


LLI Che

Surgical Protocol Introduction

OR Context Introduction

28





Introduction - Context





(via thumbs) 5. Feel Difference

1. Centre Feet (pointing out at 45°)

2. Line up with Chin (straighten pelvis)

C.

3. See difference



54

Introduction - Context



Introduction - Context



Intraoperative

- 1. Loaded check (horizontal) Feel difference
- (scrub nurse) 1. Aligned check
- 2. See / Feel difference
- (surgeon)
- 3. Tension test (muscles & ligaments)



Introduction - Surgical Protocol



- (sterile zone) Feet 2.
- (non-sterile zone) Vertical Drape 3. (transparent)
- 4. X-Ray (on screen)
- 1. Surgical site (sterile zone) Feet 2.
- (sterile zone) 3. Vertical Drape
- (non-transparent)
- 4. Template (on screen)

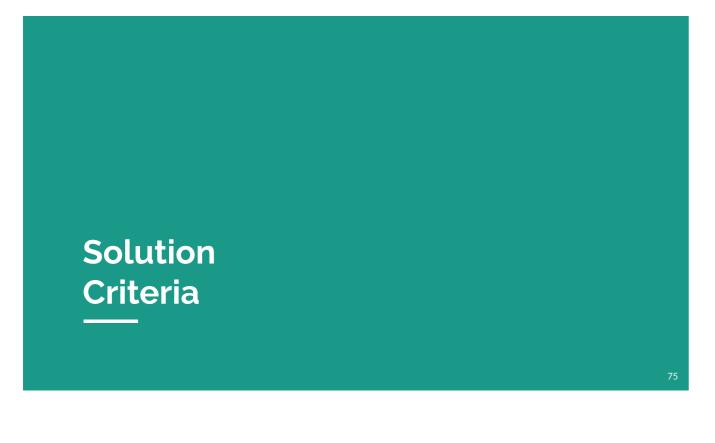
OR Setup

Surgical site



70

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Co-Creation Set-up

Solution Criteria

General Simplicity over Complexity!

- - 1. Non-invasive to patient
 - 2. Non-disruptive to Workflow
 - 3. Purely for validation

In case of Genius ... Ignore!

Set-up

- 1 Problem Statement per slide
- 7 Slides = 7 rounds
- <u>2 min</u> per round
- <u>1 min</u> to study next slide
- Repeat



80

Use

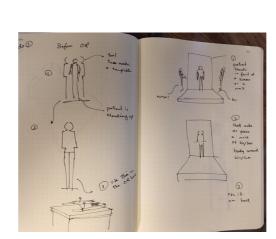
- A4 paper
- Drawing Tablet
- Text Box

Co-Creation Sessions



Slide 1

How to measure leg length (discrepancy)?





length.

body, we could be in exact measurements ...

Slide 2

How to give the user a sense of empowerment and control? (during a measurement)

Easy to control method , Humanized procedure

maybe using some special material that could be melt and be a part of the bone

virtual reality (user imagine s lie down in beach)

Like one of you projects... the resizable bag.., if the piece size could be changed and fixed after surgery...





smart scanner box for measurement

measurement pants



I assume it's the bed's duty to check legs

Or maybe in some specific positions of

Having something like SMART MIRRORS using in fitting rooms

Focus on pressure of the body Wight on some sensors after you made pelvic tilt straight more than measure of the length





This magic hat Controis Datient thought and make him full of hope!!!! :D





How to make a non-obtrusive device? (only present when needed / never in the way)

What if the drying process of the piece occurs after surgery, when the he could stand up and check his legs length. (During therapy)

The device should be on beneath the patient like a touch surface and interacted with a sensor or a camera on the top of the bed



tools that take shape of body or simulate force from out side

How to measure leg offset (discrepancy)?

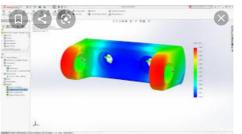
make perfect rectangle



Slide 6

How to simulate loads on the patient's legs?

We can measure it before the Surgery and use it in solidworks



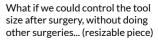


Virtual reality 😐😂



Do the surgery in a standing position

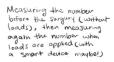










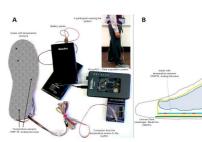


after

(0.001

before





How to straighten the pelvis before a measurement?

We can use the sensors that use in creating animation process.



A fixed piece on the bed can help the doctor to straighten the pelvic. The doctor can change the position of the pelvic until its position is right(it is straight). By that time that piece will alarms and notice the doctor that pelvice is straight

instead of normal operation clothing, patient wears a cloth like a wet suit that is tightly attached to the body, then (next photo) Maybe a smart scanner could check the position with the idealistic one

mark the body and

location of the hip

lines or dots are

. . .

10

1

، رحل برای بیمار به خانه لول و ششیم نگاه کن از تقیق هد آمد و معانق شکل خاصله وقیم سیل را مطلق اشکا

moving

خفرت ڈلیال نی

area, then by pushing the legs or moving it it is more evident how the

make a right position mold before surgery and install it on the bed. The patient must stay on his mold

Smart bed . If the position was false, the bed edit it

find the most bulge point of the hip from both sides and fixed it on the bed

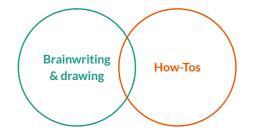
95

Appendix D | 79

Co-Creation Session #4

Evaluating Leg Length Discrepancy during Total Hip Arthroplasty (THA) *Enhancing Conventional Surgical Workflows* Program

Methodology



- 1. Read your 'How-To...'
- 2. Write, draw ... everything goes!
- 3. Time up? Click a picture & send ...
- 4. Study next slide ...
- 5. Repeat!

Problem Introduction

1. Introduction

- a. Problem
- b. Surgical Context
- c. Surgical Protocol
- d. OR Context

2. Solution Criteria

3. Co-Creation

- a. Set-up
- b. Sessions

4. Wrap-up

Introduction - Problem

Possible **Unintended Consequences**

- 1. Leg Length change
- 2. Offset change

What are we looking for? A validation solution!



Introduction - Surgical Context





Every Surgeon customises their workflow. The solution <u>must not be disruptive</u> to any workflow!

19

Surgical Context Introduction

Introduction - Surgical Context

Approaches to the Hip Joint

Anterior



1. Least invasive (fastest recovery) Supine Position 2.

- (Patient lying on back) 3. Growing in Popularity (offers opportunities)

The solution <u>must not be invasive</u> to the patient and should <u>utilise the supine position.</u>

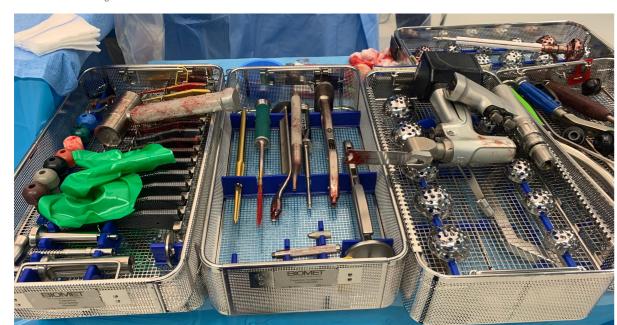




37

40

Introduction - Surgical Context



& Head ∖

Introduction - Surgical Context







LLD Check

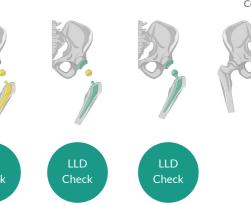
Introduction - Surgical Context







LLD Check



Complete

43





Place Final Stem, Neck &



OR Context Introduction

Introduction - Context



Fluoroscopy

Introduction - Context



OR Setup

- Surgical site (sterile zone) Feet
- (non-sterile zone) Vertical Drape
- X-Ray (on screen)
- 1. Surgical site (sterile zone) Feet 2
- (sterile zone) Vertical Drape 3.
- 4. Template (on screen)



Templating



Introduction - Context

Preoperative LLD Assessment

- 1. Line up Heels Straighten Pelvis 2.
- Centre Feet 3.
- 4 Apply pressure
- 5. Feel Difference
- 1. Centre Feet
- (pointing out at 45°)
- 3. See difference

Fluoroscopy

Preoperative LLD Assessment

1. Line up Heels Straighten Pelvis (move feet around) Centre Feet 4. Apply pressure 5. Feel Difference

2

3

Templating

69

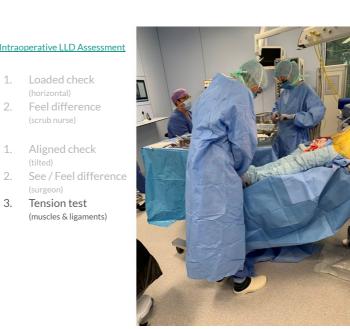
- (move feet around)
- Line up with Chin



Templating

Introduction - Context

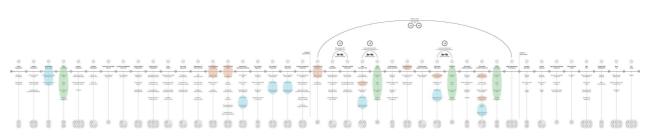




Templating

80

Introduction - Surgical Protocol



Surgical Protocol Introduction

Criteria

Solution

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Solution Criteria



Simplicity over Complexity!

- 1. Non-invasive to patient
- 2. Non-disruptive to Workflow
- 3. Purely for validation

In case of Genius ... Ignore!

Set-up

- 1 Problem Statement per slide
- 7 Slides = 7 rounds
- <u>2 min</u> per round
- <u>1 min</u> to study next slide

Co-Creation

Sessions

- Repeat

Co-Creation Set-up

88

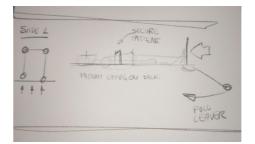
Use

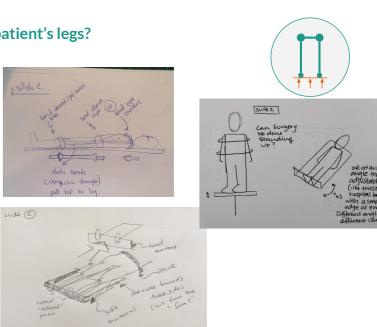
- A4 paper
- Drawing Tablet
- Text Box

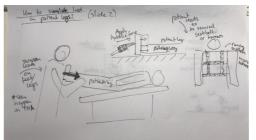




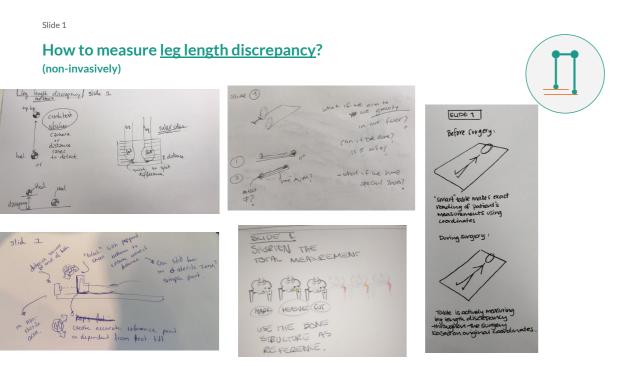
How to simulate <u>loads</u> on the patient's legs? (during a measurement)







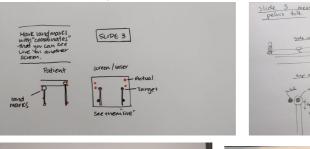






How to measure <u>pelvic tilt</u>?

(non-invasively)



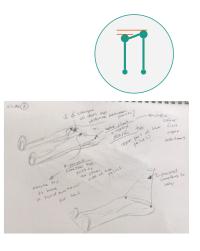




98

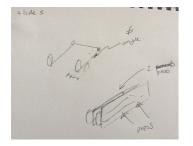
99

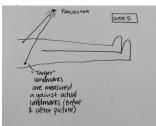


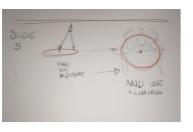


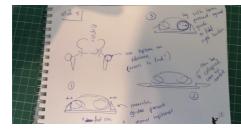


How to measure leg offset discrepancy? (non-invasively)





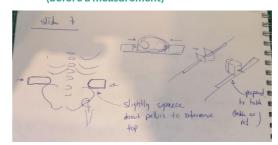


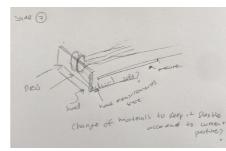




Slide 7

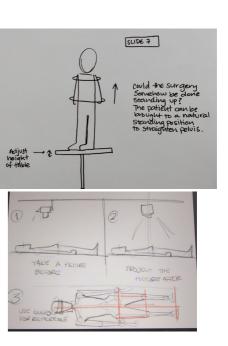
How to straighten the pelvis? (before a measurement)







103

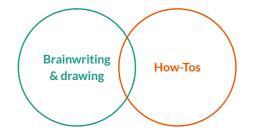




Co-Creation Session #5

Evaluating Leg Length Discrepancy during Total Hip Arthroplasty (THA) Enhancing Conventional Surgical Workflows Program

Methodology



- 1. Read your 'How-To...'
- 2. Write, draw ... everything goes!
- 3. Time up? Click a picture & send ...
- 4. Study next slide ...
- 5. Repeat!

Problem Introduction

1. Introduction

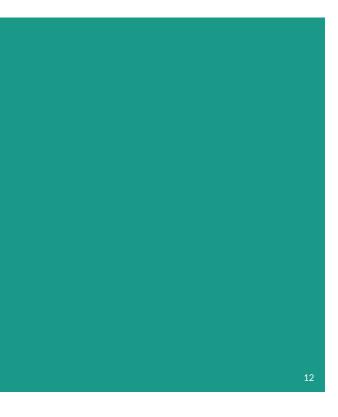
- a. Problem
- b. Surgical Context
- c. Fluoroscopy Timeline

2. Solution Criteria

3. Co-Creation

- a. Set-up
- b. Sessions

4. Wrap-up

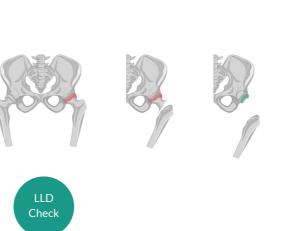


Introduction - Problem

"During THA the diseased ball and socket of the hip joint are completely removed and replaced with artificial materials. A femoral component (stem, neck & head) is inserted into the femur (thigh bone) and **an acetabular cup is** placed in the acetabulum socket of the pelvis."



Introduction - Problem



15

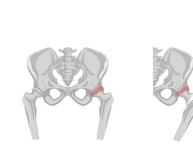
Introduction - Problem

Possible Unintended Consequences

- 1. Leg Length change
- 2. Offset change

How does that happen?





LLD Check

Introduction - Problem

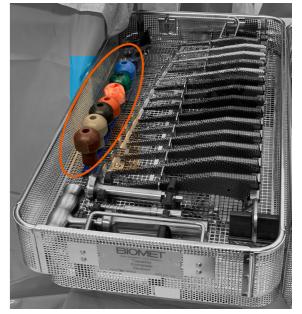






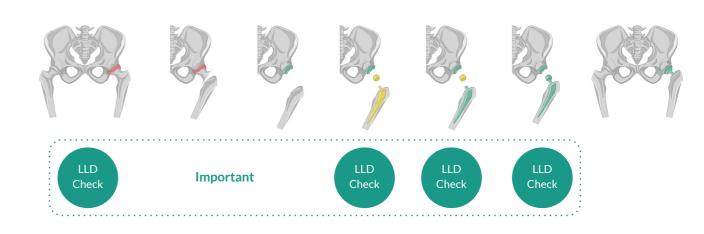




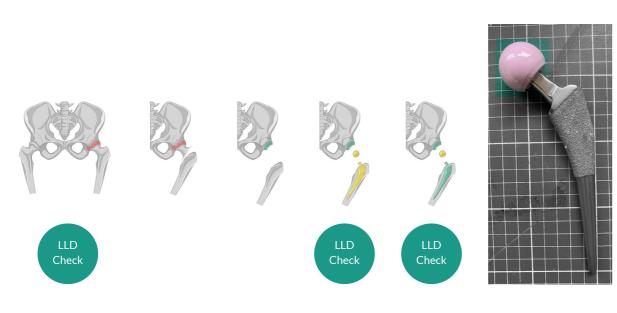


Introduction - Problem

Introduction - Problem

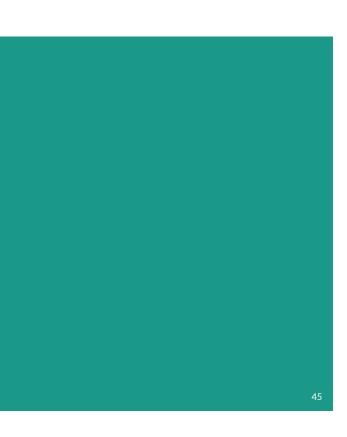


Introduction - Problem



Surgical Context Introduction

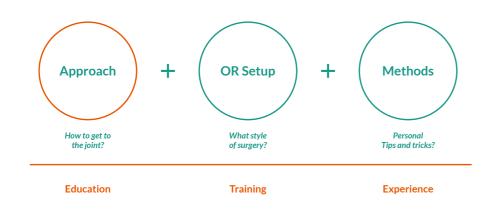
31

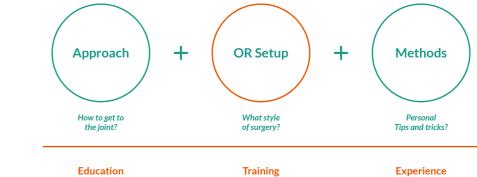


Workflow Customisation

Introduction - Surgical Context

Workflow Customisation

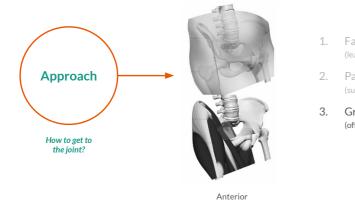




51

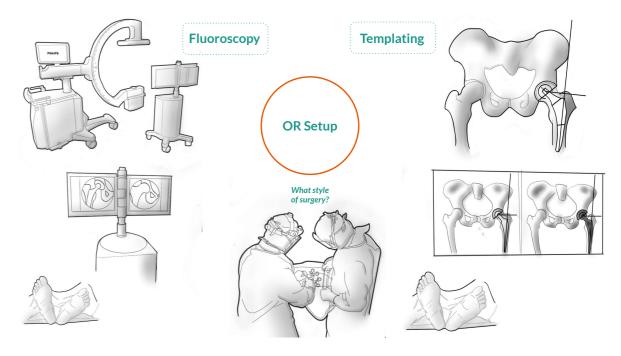
Introduction - Surgical Context

Workflow Customisation



- 1. Fastest Recovery (least invasive)
- 2. Patient lying on back (supine position)
- 3. Growing in Popularity (offers opportunities)





58

Introduction - Surgical Context





What style of surgery?

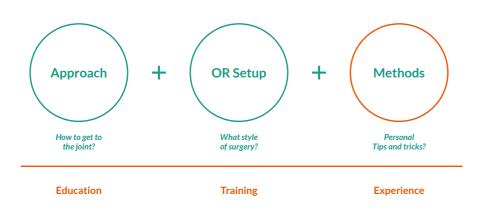




72

Introduction - Surgical Context

Workflow Customisation



Introduction - Context



1. Line up Heels

Centre Feet 3. 4.

2.

- 5. Feel Difference
- 1. Centre Feet
- (pointing out at 45°)
- 2.
- 3. See difference





77

Preoperative LLD Assessment

Straighten Pelvis (move feet around) Apply pressure

Line up with Chin



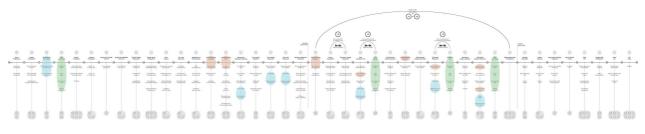
Introduction - Context







Introduction - Surgical Protocol

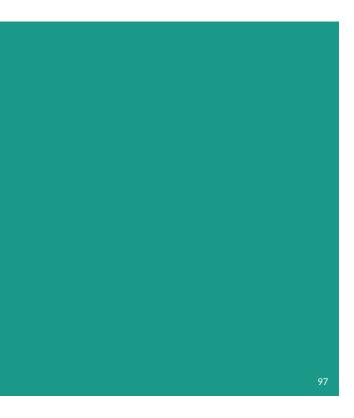


94

Fluoroscopy Timeline Introduction

Solution Criteria

https://prezi.com/1mvkmhw0gkno/untitled-prezi/?present=



Solution Criteria

General

Simplicity over Complexity!

- 1. Non-invasive to patient
- 2. Non-disruptive to Workflow
- 3. Purely validation

In case of Genius ... Ignore!

Set-up

- 1 Problem Statement per slide
- 7 Slides = 7 rounds
- <u>2 min</u> per round
- <u>1 min</u> to study next slide
- Repeat

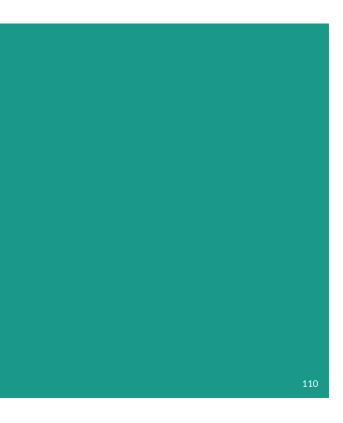
102

Co-Creation Set-up

Co-Creation Sessions Appendix D | 109

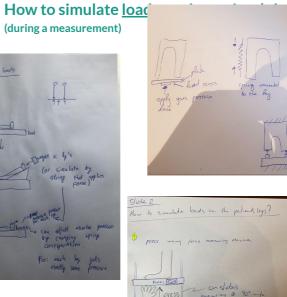
Use

- A4 paper
- Drawing Tablet
- Text Box







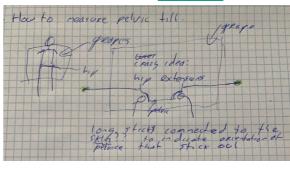


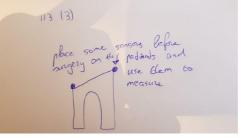
Slide 2

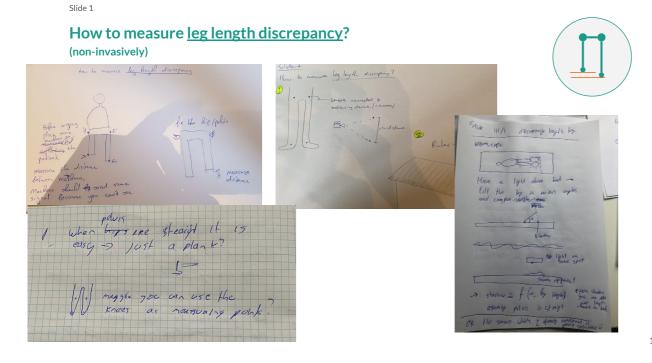
P9 112

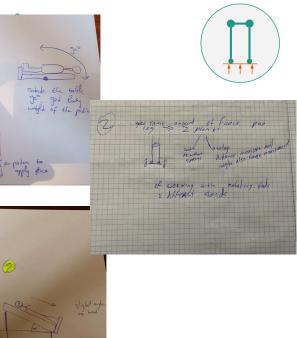
include loads

How to measure pelvic tilt?





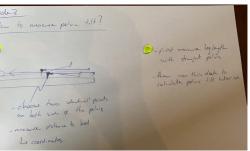


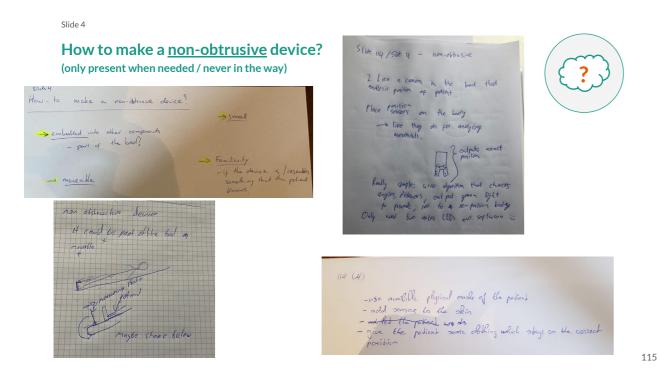


113

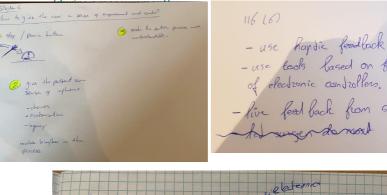


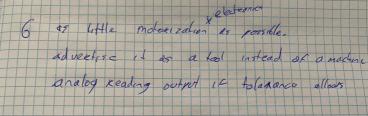






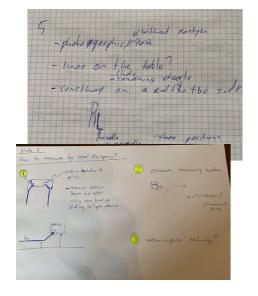
How to give the user a sense of empowerment and control?

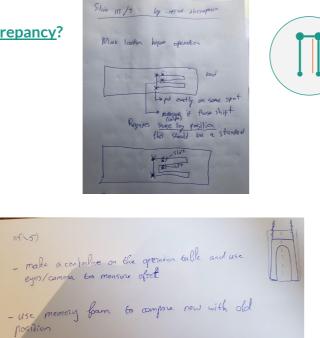




Slide 5

How to measure leg offset discrepancy? (non-invasively)





Slide 7



- use happie featback - use book lased on free inpud instead of electronic controllers. (surgey, can feel what he does) - live feat back from sensors - for gent back from sensors - Do know research -> show impr - We provide fraining should be very similar the ones they elready use adding technology/software. Mater 2 user-priendly, anger to use water it implementable in them surges in them sur handelingthen that sugeon reapp already portourns! Just a tool to check.



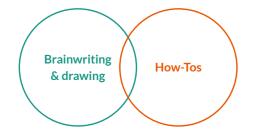




Co-Creation Session #6

Evaluating Leg Length Discrepancy during Total Hip Arthroplasty (THA) Enhancing Conventional Surgical Workflows Program

Methodology



- 1. Read your 'How-To...'
- 2. Write, draw ... everything goes!
- 3. Time up? Click a picture & send ...
- 4. Study next slide ...
- 5. Repeat!

Problem Introduction

1. Introduction

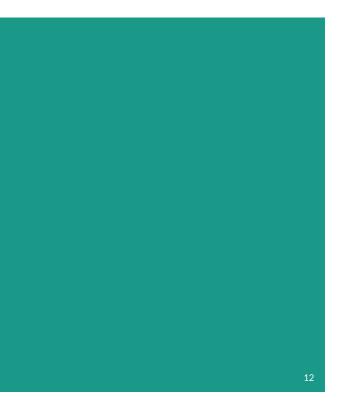
- a. Problem
- b. Surgical Context
- c. Fluoroscopy Timeline

2. Solution Criteria

3. Co-Creation

- a. Set-up
- b. Sessions

4. Wrap-up

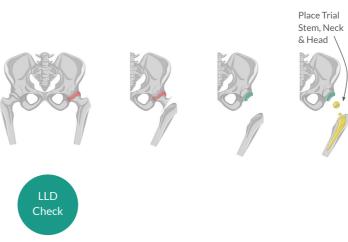


Introduction - Problem

"During THA the diseased ball and socket of the hip joint are completely removed and replaced with artificial materials. A femoral component (stem, neck & head) is inserted into the femur (thigh bone) and **an acetabular cup is** placed in the acetabulum socket of the pelvis."



Introduction - Problem



15

Introduction - Problem

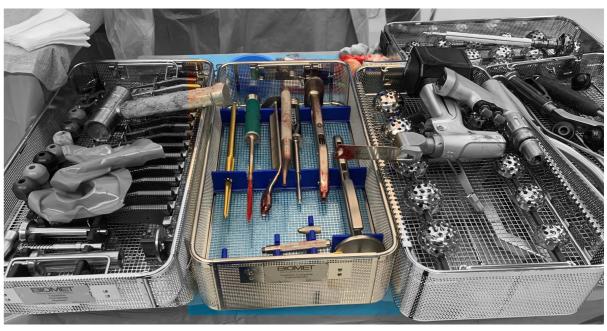
Possible Unintended Consequences

- 1. Leg Length change
- 2. Offset change

How does that happen?

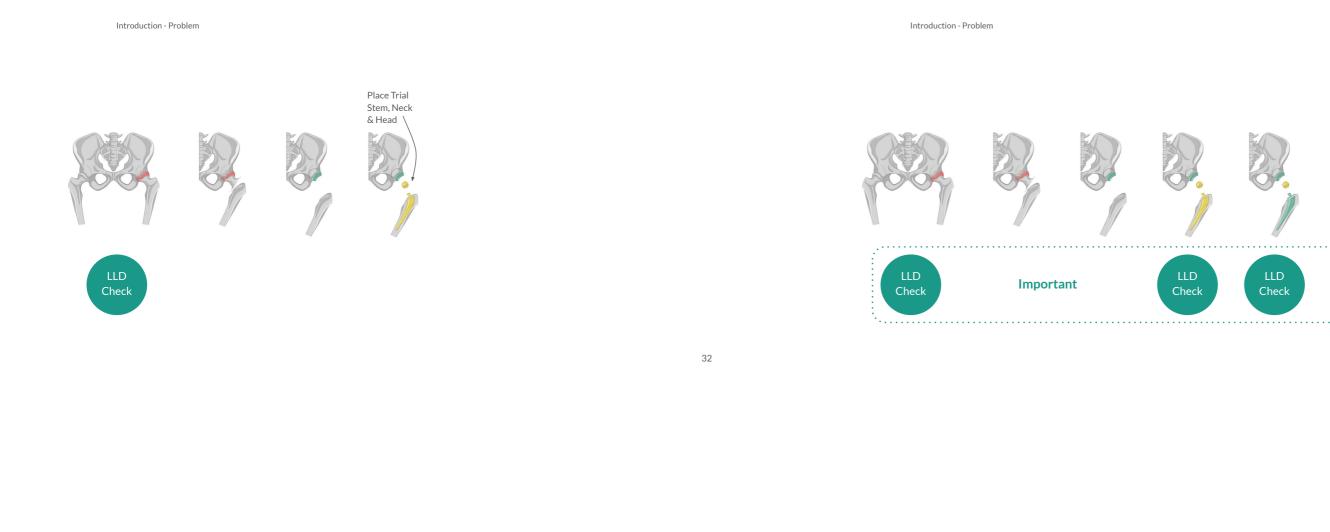


Introduction - Problem









Introduction - Problem

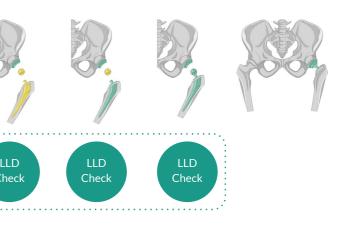
LLD Check

Place Final Stem, Neck & Trial Head P





Surgical Context Introduction

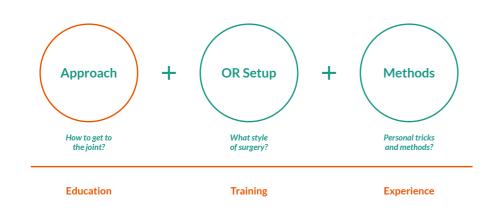


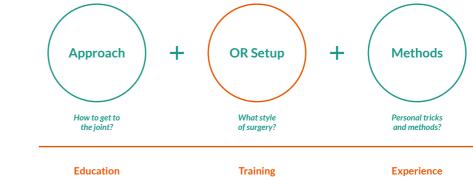


Workflow Customisation

Introduction - Surgical Context

Workflow Customisation

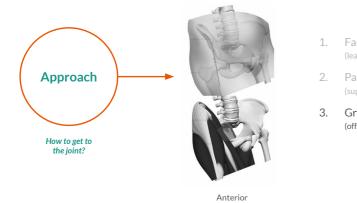




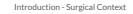
51

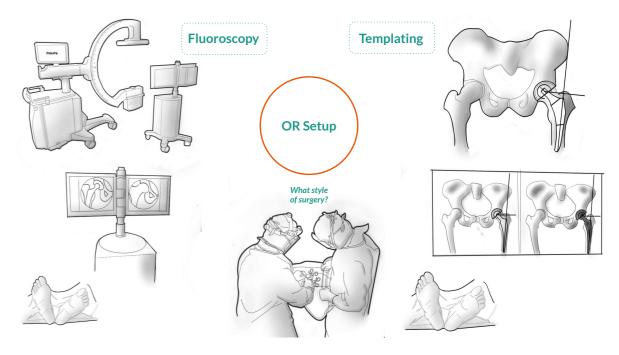
Introduction - Surgical Context

Workflow Customisation



- 1. Fastest Recovery (least invasive)
- 2. Patient lying on back (supine position)
- 3. Growing in Popularity (offers opportunities)





58

Introduction - Surgical Context

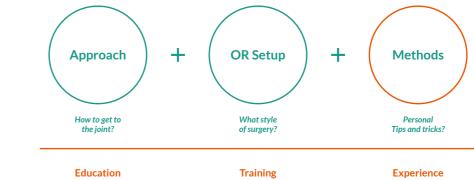


OR Setup

What style of surgery?



Workflow Customisation



72

Introduction - Context

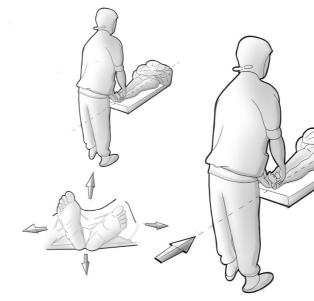
Fluoroscopy



Templating



Introduction - Surgical Context



76









84

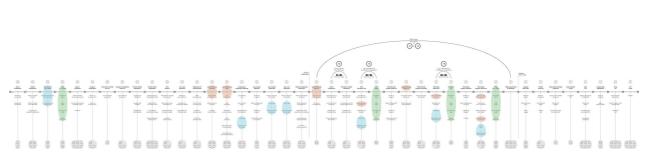
Fluoroscopy Timeline Introduction

Introduction - Surgical Context





Introduction - Surgical Protocol



https://prezi.com/1mvkmhw0gkno/untitled-prezi/?present=1

Solution Criteria

Co-Creation Set-up

Solution Criteria

General Simplicity over Complexity!

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In case of Genius ... Ignore!

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- <u>1 min</u> to study next slide
- Repeat



Use

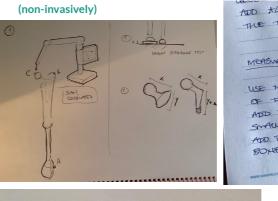
- A4 paper
- Drawing Tablet
- Text Box

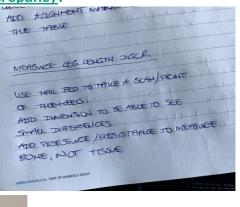
Co-Creation Sessions

Start!

Slide 1

How to measure <u>leg length discrepancy</u>?

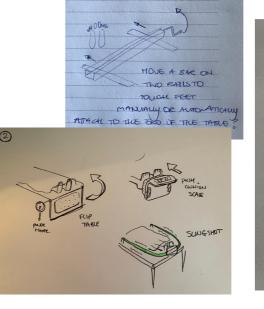






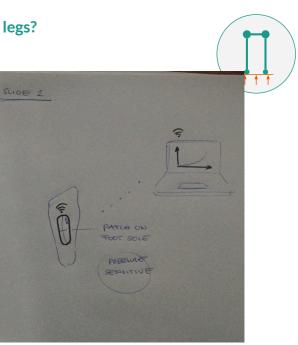
Slide 2

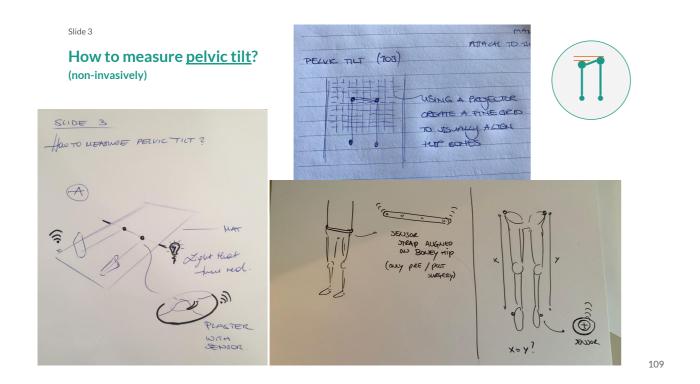
How to simulate <u>loads</u> on the patient's legs? (during a measurement)



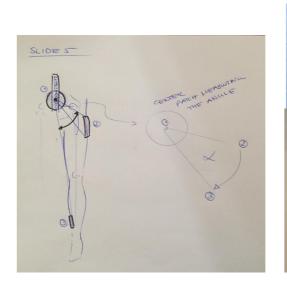


107





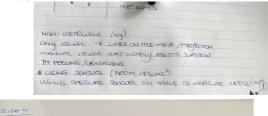
How to measure leg offset discrepancy? (non-invasively)

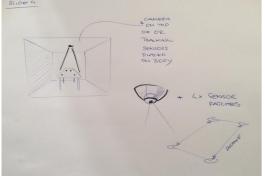


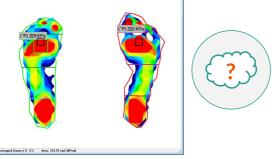


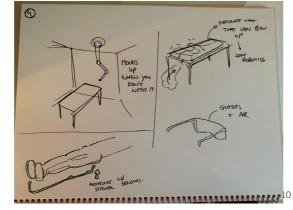
Slide 4

How to make a <u>non-obtrusive</u> device? (only present when needed / never in the way)

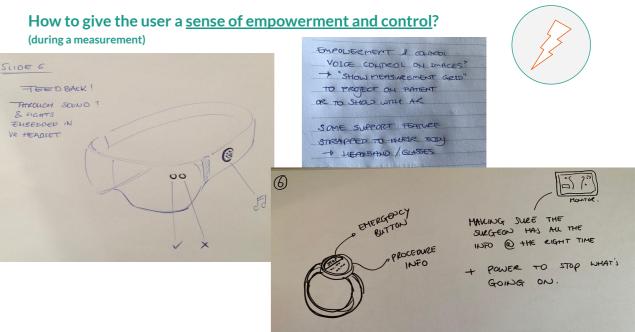


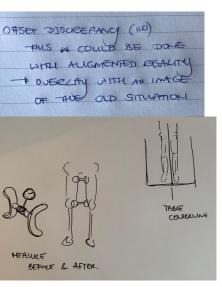






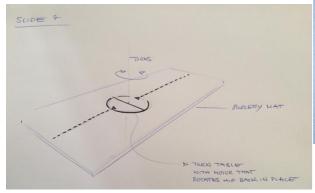
Slide 6



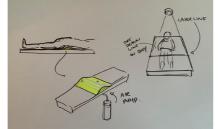




How to <u>straighten</u> the pelvis? (before a measurement)



and a superior
STRAIGTEN THE PELVIS
PLACE PATIENT ON A
MOUTHIG DISC / PLATEAU
THAT OWN BE FIXED OR
UNLOCKED TO ROTATE
ADD HAGHMENT MARKS TO
THE MABLE



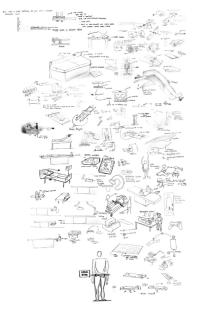
113

Appendix D |133





RECAP **CO-CREATION SESSIONS**



Warm-up Riddle \diamond

Last Steps

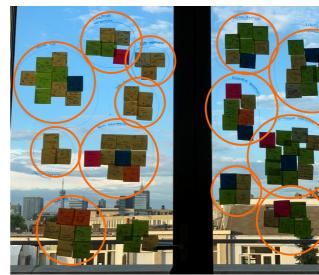
Warm-up Riddle

Compiling sketches

What would you do? 18.09.2020

RECAP

POST-IT-OLOGICAL CHART



6

RECAP BRAINSTORM



18.09.2020

Last Steps

- Warm-up Riddle
- Compiling sketches
- Put relevant ideas on Post-it

5

18.09.2020

Last Steps

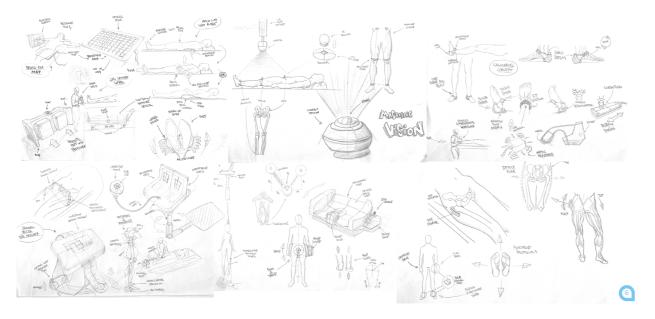
- Warm-up Riddle
- Compiling sketches
- Put relevant ideas on Post-it
- Sorting Ideas
 - Post-It ological Chart
 - LLD Assessment
 - Pelvic Tilt (PT)
 - OD Assessment
 - Pelvis Straightening

 - Pelvic Fixation
 LLD / PT / OD Triangulation Tracking
 - LLD / PT / OD Mechatronic
 - LLD / Tension Assessment Advanced Tech
 - Alignment Markers / Backgrops
 Small Ideas



RECAP **IDEATION SKETCHES**

18.09.2020



RECAP CONCEPT DIRECTIONS



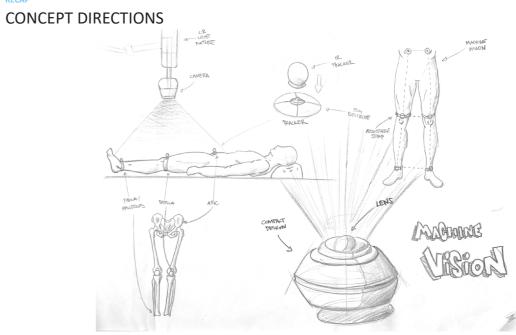
RECAP CONCEPT DIRECTIONS



Last Steps
Warm-up Riddle
Compiling sketches
Put relevant ideas on Post-it
Sorting Ideas
 Post-It ological Chart
LLD Assessment
 Pelvic Tilt (PT)
OD Assessment
Pelvis Straightening
Pelvic Fixation
LLD / PT / OD Triangulation Tracking
 LLD / PT / OD Mechatronic
LLD / Tension Assessment
Advanced Tech
Alignment Markers / Backgrops

18.09.2020

RECAP



0

18.09.2020

Last Steps

- Warm-up Riddle
- Compiling sketches
- · Put relevant ideas on Post-it
- Sorting Ideas
 Post-It ological Chart
 - LLD Assessment
 Pelvic Tilt (PT)

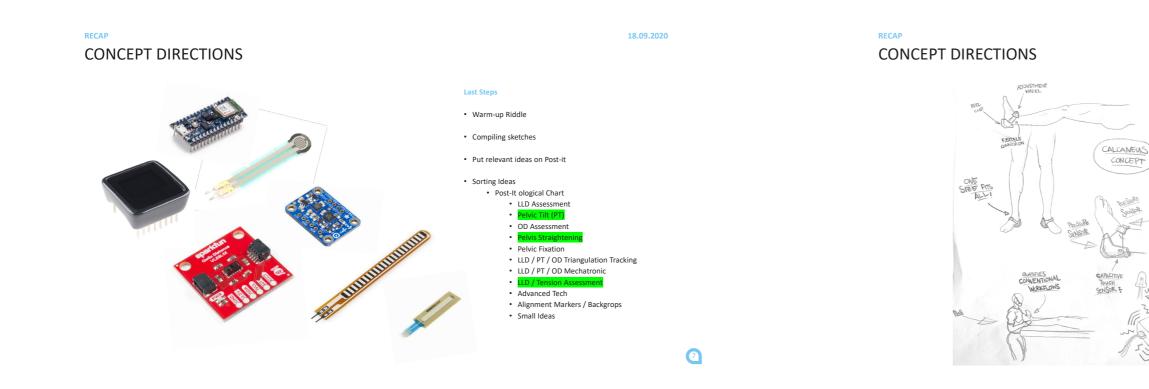
 - OD Assessment
 - Pelvis Straightening
 Pelvic Fixation

 - LLD / PT / OD Mechatronic
 LLD / Tension Assessment

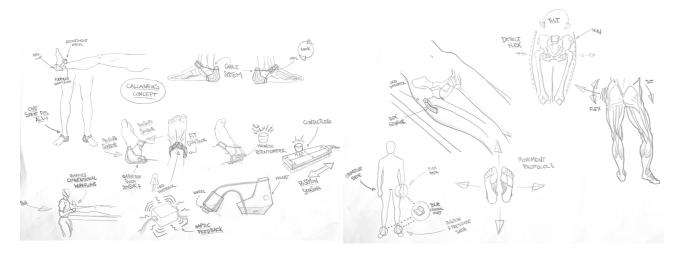
 - Advanced Tech
 Alignment Markers / Backgrops
 Small Ideas

18.09.2020

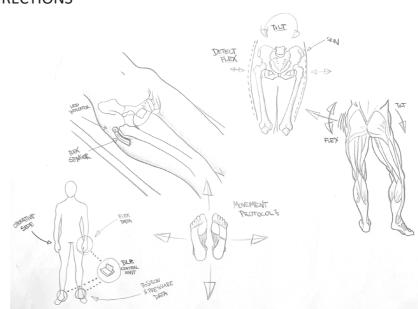






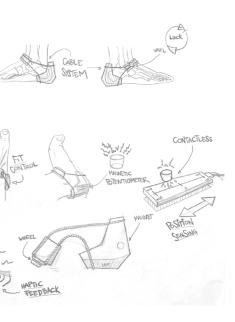


RECAP CONCEPT DIRECTIONS



18.09.2020

18.09.2020





18.09.2020

BI-WEEKLY MEETING

PROOF OF CONCEPTS

PoC #1 – Gesture Tracking

Facilitating Leap Motion
 Using diagnostic software

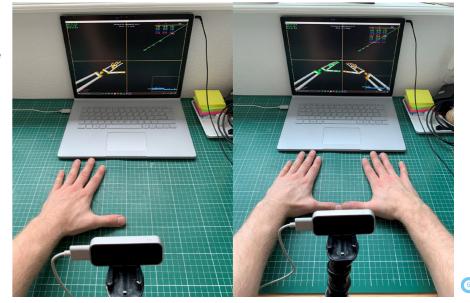


09.09.2020

BI-WEEKLY MEETING PROOF OF CONCEPTS

PoC #1 – Gesture Tracking

Facilitating Leap Motion
Using diagnostic software



BI-WEEKLY MEETING PROOF OF CONCEPTS



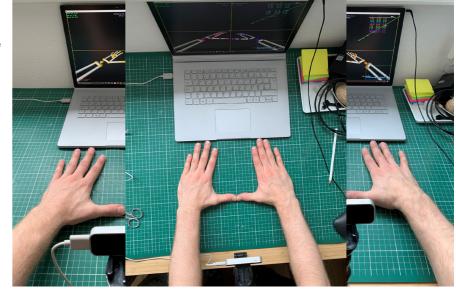
eap Motion Control Panel ieneral Troubleshooting About Device Status Show Software Log Diagnostic Visualizer Report Software Issue Restore Default Settings Low Res e Mode 4 Reduces performance and bandwidth of the Leap Motion Controller to improve on slower computers. Avoid Poor Performance Lighting Status: Automatically pause tracking when bad conditions are detected ecalibrate Device If the sensors on the Leap Motion controller are knocked out of their initial alignment, the device must be recalibrated. Poor calibration can cause: Persistent jumpiness Frequent discontinuities in the tracking data Aberrations in tracking data that occur only in certain areas of the field of view Poor tracking range Recalibrate Device Get Help with Recalibration OK Cancel Apply

18.09.2020

BI-WEEKLY MEETING PROOF OF CONCEPTS

PoC #1 – Gesture Tracking

Facilitating Leap Motion
 Using diagnostic software

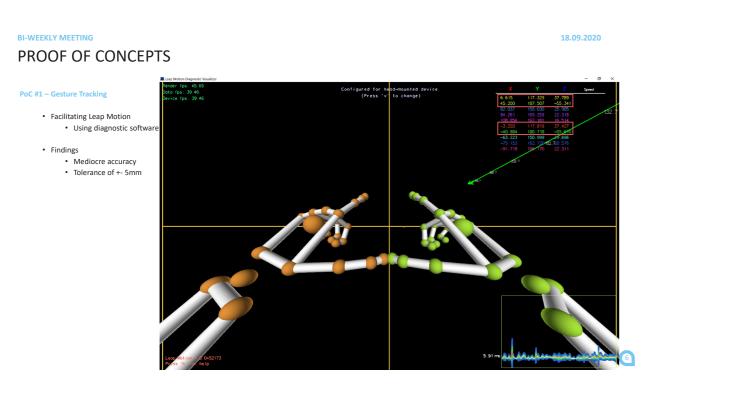


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18.09.2020





BI-WEEKLY MEETING PROOF OF CONCEPTS

PoC #1 – Gesture Tracking

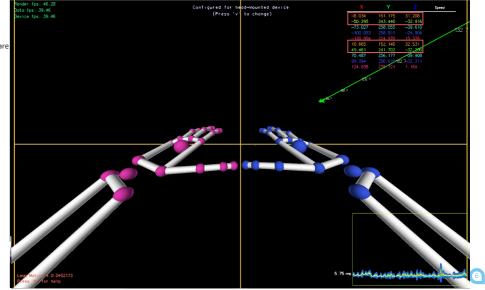
• Facilitating Leap Motion

• Using diagnostic software

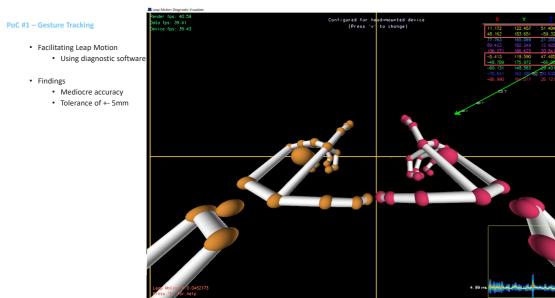
• Findings

• Mediocre accuracy

• Tolerance of +- 5mm



BI-WEEKLY MEETING PROOF OF CONCEPTS



BI-WEEKLY MEETING

18.09.2020

PROOF OF CONCEPTS

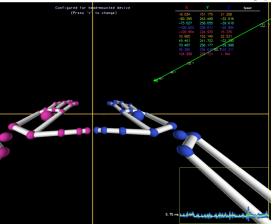
PoC #1 – Gesture Tracking

- Facilitating Leap Motion
 Using diagnostic software
- Findings
 Mediocre accuracy
- Tolerance of +- 5mm
- Conclusion
 Interesting but currently not feasible



18.09.2020

18.09.2020



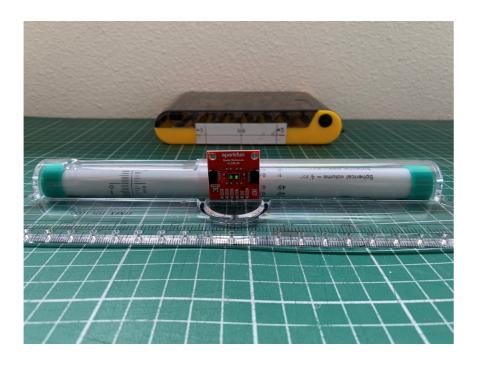


BI-WEEKLY MEETING

PROOF OF CONCEPTS

PoC #2 – VCSEL Sensor

Simple testing script
 Cutting mat
 Target surface

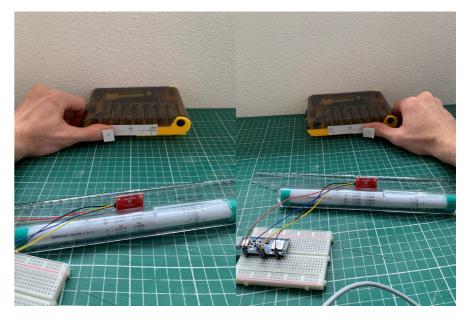


18.09.2020

BI-WEEKLY MEETING PROOF OF CONCEPTS

PoC #2 – VCSEL Sensor

Simple testing script
 Cutting mat
 Target surface



BI-WEEKLY MEETING PROOF OF CONCEPTS

PoC #2 – VCSEL Sensor

Simple testing script
 Cutting mat
 Target surface

18.09.2020

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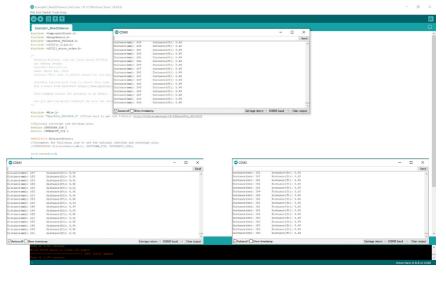
BI-WEEKLY MEETING PROOF OF CONCEPTS

PoC #2 – VCSEL Sensor

Simple testing script
 Cutting mat
 Target surface

Findings
Good accuracy
Tolerance of +- 3mm

Conclusion
Feasible
Complex setup required



Appendix E | 147

18.09.2020

18.09.2020

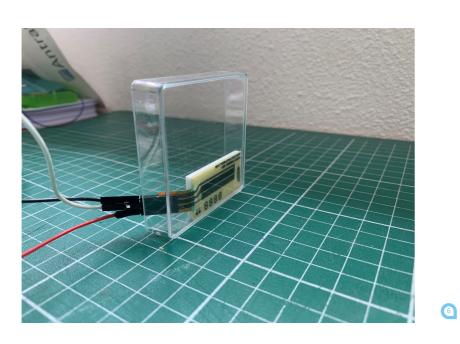
6

BI-WEEKLY MEETING

PROOF OF CONCEPTS

PoC #3 – MagnetoPot

 Simple testing script
 Magnet
 Caliper (for displacement measurement)



18.09.2020

BI-WEEKLY MEETING PROOF OF CONCEPTS

PoC #3 – MagnetoPot

 Simple testing script
 Magnet
 Caliper (for displacement measurement)

BI-WEEKLY MEETING PROOF OF CONCEPTS

PoC #3 – MagnetoPot

 Simple testing script
 Magnet
 Caliper (for displacement measurement)



18.09.2020

BI-WEEKLY MEETING PROOF OF CONCEPTS

FROOT OF CONCEFT

PoC #3 – MagnetoPot

Simple testing script Magnet Caliper

(for displacement measurement)

Findings

Good accuracy
Tolerance of +- 1mm

- Conclusion
 Feasible
 - Reduction of tolerance possible



18.09.2020



6

18.09.2020

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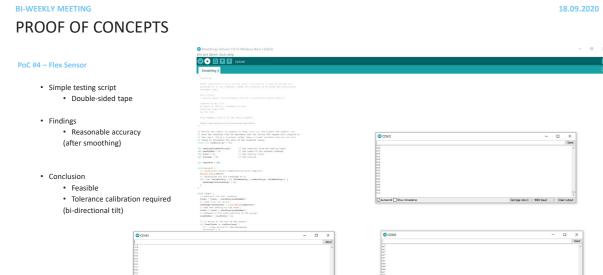
6

BI-WEEKLY MEETING PROOF OF CONCEPTS

PoC #5 – OpenMV

 Delayed Arrival 2 days ago





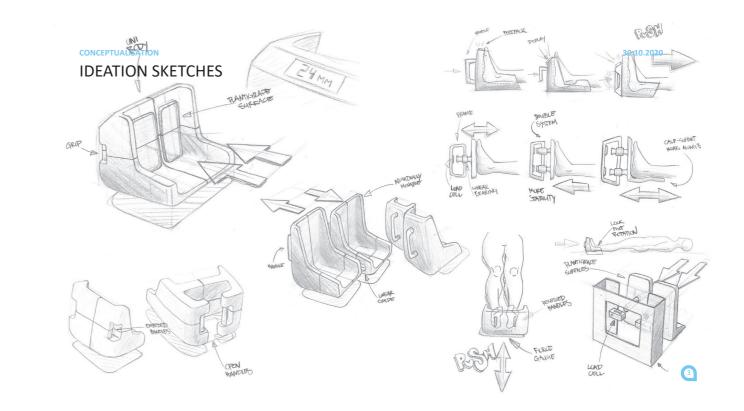
Carriage return v 9600 baud v Ci

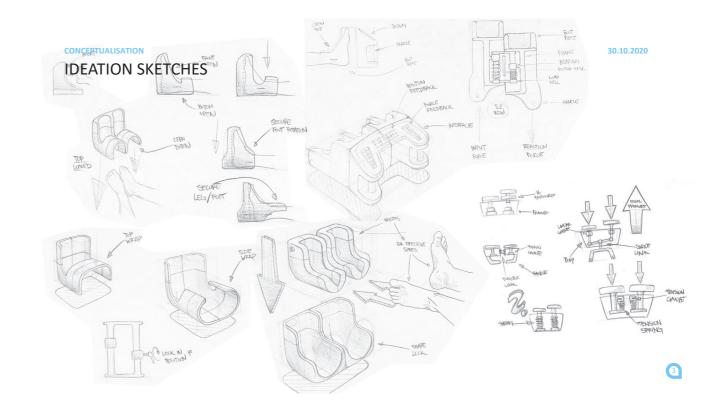
Questions?

18.09.2020









Agenda

Concept
 Updates & Next Steps
 Planning
 Trello

• Ideation Sketches

Ergonomics Study

ERGONOMICS STUDY

Overview

- 5x cardboard plastic mockup
 2x unibody
 3x splitbody
- 2x converted luggage scale

30.10.2020

ERGONOMICS STUDY

Unibody 2

Top Loaded

CONCEPTUALISATION

- Feet weight down device
- Still difficult to load feet (fidly)
- Heel locks nicely
- Easy to apply force



CONCEPTUALISATION ERGONOMICS STUDY

Unibody 1

- Bottom Loaded
- Feet weight down device
- Difficult to load feet (fidly)
- Easy to apply force



30.10.2020

4

CONCEPTUALISATION ERGONOMICS STUDY

Splitbody 1

- Bottom Loaded
- Feet weight down device
- Easy to load feet (individual)
- Easy to apply force
- Easy to slide in parallel
- Flat horizontal surfaces help orientation



30.10.2020

4



ERGONOMICS STUDY

Splitbody 2

- Bottom Loaded
- Feet weight down device
- Easy to load feet (individual)
- Easy to apply force
- Easy to slide in parallel
- Difficult to orientate



4

30.10.2020

CONCEPTUALISATION ERGONOMICS STUDY

Splitbody 3

- Bottom Loaded
- Feet weight down device
- Easy to load feet (individual)
- Heel locks nicely
- Easy to apply force
- Easy to slide in parallel
- Difficult to orientate



30.10.2020

CONCEPTUALISATION ERGONOMICS STUDY

Luggage Scale Handle

'Embracing grab'

- Verified: Different Loads applied
- Handle is not ergonomic for pushing
- Limited control when pulling / pushing
- User should grab the device fully
- Shape of device should be ergonomic



CONCEPTUALISATION ERGONOMICS STUDY

Luggage Scale Handle

- Verified: Different Loads applied
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- 'Embracing grab'



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30.10.2020



4



ERGONOMICS STUDY

Luggage Scale Handle

- Verified: Different Loads applied
- Handle is not ergonomic for pushing
- Limited control when pulling / pushing
- User should grab the device fully
- Shape of device should be ergonomic
- 'Embracing grab'



4

CONCEPTUALISATION **ERGONOMICS STUDY**

Luggage Scale Handle

- Verified: Different Loads applied
- Handle is not ergonomic for pushing
- Limited control when pulling / pushing
- User should grab the device fully
- Shape of device should be ergonomic
- 'Embracing grab'

30.10.2020



30.10.2020

CONCEPTUALISATION CONCEPT

Overview

Load sensors

• Wired into a Wheatstone Bridge For better precision

CONCEPTUALISATION

CONCEPT

Overview

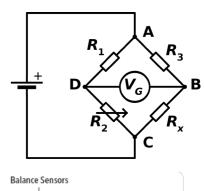
 Load sensors Wired into a Wheatstone Bridge For better precision

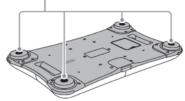
• Wii Balance Board / Smart Scale Split in two

Introduce flexible link

4

30.10.2020





5



CONCEPTUALISATION	30.10.2020	CONCEPTUALISATION
 Overview I cond sensors Wired into a Wheatstone Bridge For better precision Will Balance Board / Smart Scale Split in two Introduce flexible link Magnetopot for position sensing Shape design for position sensing 'complete the shape' 		Overview 4. Load sensors 4. Wired into a Wheatstone Bridge 5. For better precision 4. Wii Balance Board / Smart Scale 5. Split in two 6. Introduce flexible link 5. Magnetopot for position sensing 6. Shape design for position sensing 6. Yomplete the shape' 5. Magnets for connecting two halfs 6. Completely enclose system 6. Sterile cleaning 7. Wireless charging?
	6	

CONCEPT

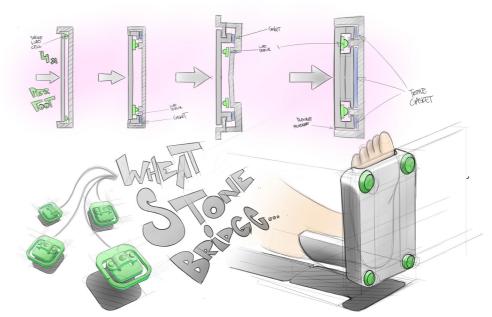
Overview

- Load sensors
 Wired into a Wheatstone Bridge
 For better precision
- Wii Balance Board / Smart Scale
 Split in two
 Introduce flexible link
- Magnetopot for position sensing
 Shape design for position sensing
 'complete the shape'
- Magnets for connecting two halfs
 Completely enclose system
 Sterile cleaning

30.10.2020



CONCEPTUALISATION



30.10.2020

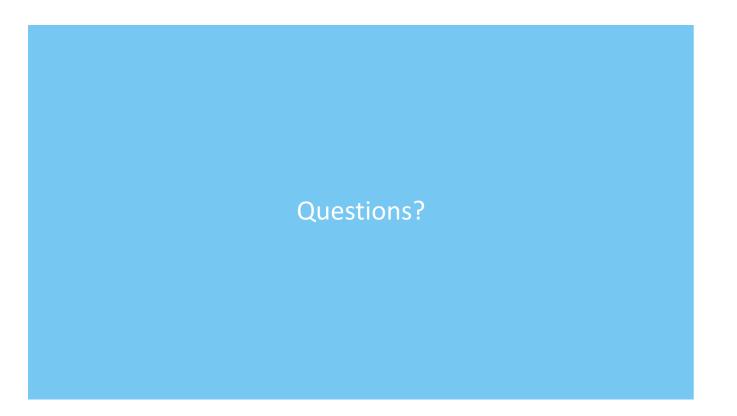






5





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CONCEPTUALISATION ERGONOMICS STUDY

Overview

5x cardboard plastic mockup
2x unibody
3x splitbody

2x converted luggage scale



CONCEPTUALISATION

CONCEPT

Overview

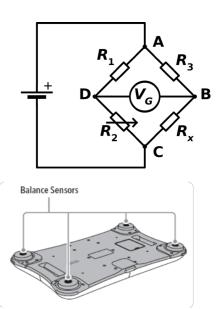
Load sensors
 Wired into a Wheatstone Bridge
 For better precision

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30.10.2020



3





CONCEPTUALISATION CONCEPTUALISATION 30.10.2020 CONCEPT CONCEPT Overview Overview Load sensors Load sensors Wired into a Wheatstone Bridge For better precision For better precision • Wii Balance Board / Smart Scale • Wii Balance Board / Smart Scale Split in two Split in two Introduce flexible link Introduce flexible link

4

CONCEPTUALISATION

CONCEPT

Overview

- Load sensors Wired into a Wheatstone Bridge For better precision
- Wii Balance Board / Smart Scale Split in two Introduce flexible link
- Magnetopot for position sensing Shape design for position sensing 'complete the shape'

30.10.2020



Wired into a Wheatstone Bridge

 Magnetopot for position sensing Shape design for position sensing 'complete the shape'

 Magnets for connecting two halfs Completely enclose system
 Sterile cleaning

CONCEPTUALISATION

CONCEPT

Overview

 Load sensors Wired into a Wheatstone Bridge For better precision

• Wii Balance Board / Smart Scale Split in two Introduce flexible link

 Magnetopot for position sensing Shape design for position sensing 'complete the shape'

 Magnets for connecting two halfs Completely enclose system Sterile cleaning

Wireless charging?

30.10.2020







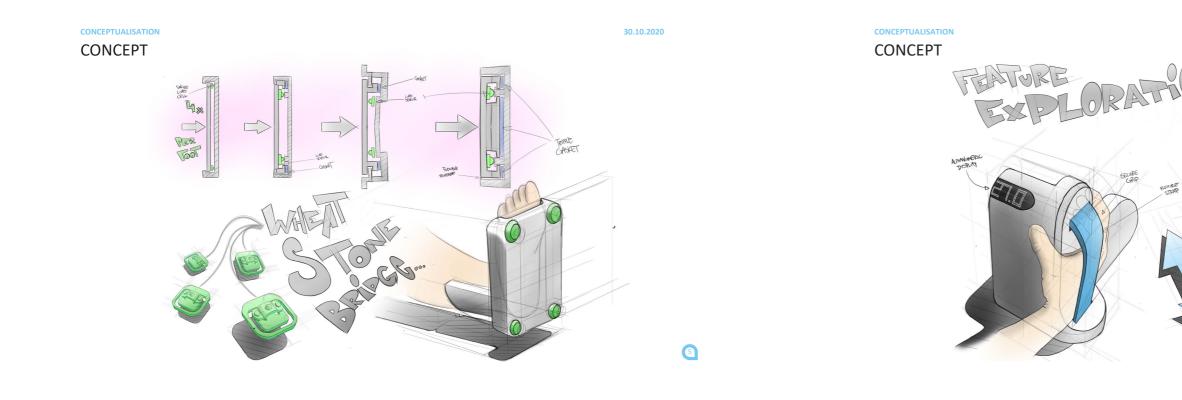
30.10.2020

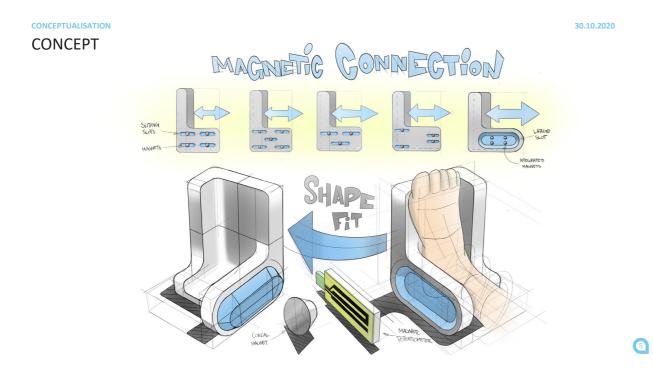






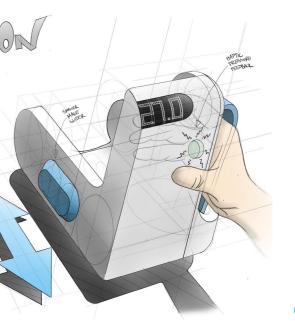






Questions?

30.10.2020





magnetoPot_Smoothing

Smoothing

Reads repeatedly from an analog input, calculating a running average and printing it to the computer. Keeps ten readings in an array and continually averages them.

The circuit: - analog sensor (potentiometer will do) attached to analog input 0

created 22 Apr 2007 by David A. Mellis <dam@mellis.org> modified 9 Apr 2012 by Tom Igoe

This example code is in the public domain.

http://www.arduino.cc/en/Tutorial/Smoothing */

// Define the number of samples to keep track of. The higher the number, the // more the readings will be smoothed, but the slower the output will respond to // the input. Using a constant rather than a normal variable lets us use this // value to determine the size of the readings array. const int numReadings = 10;

int	readings[numReadings];	11	the	readings from the analog input
int	readIndex = 0;	//	the	index of the current reading
int	total = 0;	//	the	running total
int	average = 0;	11	the	average

int inputPin = A0;

```
void setup() {
 // initialize serial communication with computer:
 Serial.begin(9600);
 // initialize all the readings to 0:
 for (int thisReading = 0; thisReading < numReadings; thisReading++) {</pre>
   readings[thisReading] = 0;
```

}

void loop() {

// subtract the last reading: total = total - readings[readIndex]; // read from the sensor: readings[readIndex] = analogRead(inputPin); // add the reading to the total: total = total + readings[readIndex]; // advance to the next position in the array: readIndex = readIndex + 1;

// if we're at the end of the array... if (readIndex >= numReadings) { // ...wrap around to the beginning:

readIndex = 0; ł

// calculate the average: //average = total / numReadings; // send it to the computer as ASCII digits //Serial.println(average); //int distance = map (average, 20 , 990 , -290 , 210); //float distance2 = distance / 10; const float distance1 = -25.00; const float distance2 = 25.00; float distance3 = distance1 + ((distance2 - distance1)* analogRead(inputPin) /1024); Serial.println (String(distance3) + "mm"); //Serial.println(readings[readIndex]); delav(100); // delay in between reads for stability

double magnetoPot Smoothing

Smoothing

Reads repeatedly from an analog input, calculating a running average and printing it to the computer. Keeps ten readings in an array and continually averages them.

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// Define the number of samples to keep track of. The higher the number, the // more the readings will be smoothed, but the slower the output will respond to // the input. Using a constant rather than a normal variable lets us use this // value to determine the size of the readings array. const int numReadings1 = 10; const int numReadings2 = 10;

int readings1[numReadings1]; int readIndex1 = 0; int total1 = 0; int average1 = 0; int readings2[numReadings2]; int readIndex2 = 0; int total2 = 0; int average2 = 0;

// the index of the current reading // the running total // the average // the readings from the analog input // the index of the current reading // the running total // the average

// the readings from the analog input

int inputPin1 = A0; int inputPin2 = A1;

```
void setup() {
 // initialize serial communication with computer:
 Serial.begin(9600);
 // initialize all the readings to 0:
 for (int thisReading1 = 0; thisReading1 < numReadings1; thisReading1++) {</pre>
   readings1[thisReading1] = 0;
```

for (int thisReading2 = 0; thisReading2 < numReadings2; thisReading2++) {</pre> readings2[thisReading2] = 0;

```
}
```

}

ł

void loop() { // subtract the last reading: total1 = total1 - readings1[readIndex1]; // read from the sensor: readings1[readIndex1] = analogRead(inputPin1); // add the reading to the total: total1 = total1 + readings1[readIndex1]; // advance to the next position in the array: readIndex1 = readIndex1 + 1;

// if we're at the end of the array... if (readIndex1 >= numReadings1) { // ...wrap around to the beginning: readIndex1 = 0;

// subtract the last reading: total2 = total2 - readings2[readIndex2];

// subtract the last reading: total2 = total2 - readings2[readIndex2]; // read from the sensor:

```
readings2[readIndex2] = analogRead(inputPin2);
 // add the reading to the total:
 total2 = total2 + readings2[readIndex2];
 // advance to the next position in the array:
 readIndex2 = readIndex2 + 1;
 // if we're at the end of the array...
 if (readIndex2 >= numReadings2) {
  // ...wrap around to the beginning:
   readIndex2 = 0;
 // calculate the average:
 average1 = total1 / numReadings1;
 // send it to the computer as ASCII digits
 //Serial.println(average1);
 int distance1 = map (average1, 20 , 990 , 0 , 25);
 Serial.println (String(distance1) + "mm");
//Serial.println(readings1[readIndex1]);
// calculate the average:
average2 = total2 / numReadings2;
// send it to the computer as ASCII digits
 //Serial.println(average2);
 int distance2 = map (average2, 20 , 990 , 0 , 25);
 Serial.println (String(distance2) + "mm");
//Serial.println(readings2[readIndex2]);
 delay(100);
                   // delay in between reads for stability
```

Pelvic_tilt_device_code__1 #include <Adafruit_NeoPixel.h> const int flexPin = A0; #define LED_PIN 6 // How many NeoPixels are attached to the Arduino? #define LED_COUNT 7 // NeoPixel brightness, 0 (min) to 255 (max) #define BRIGHTNESS 255 // Declare our NeoPixel strip object: Adafruit_NeoPixel strip(LED_COUNT, LED_PIN, NEO_GRB + NEO_KHZ800); void setup() { Serial.begin(9600);

<pre>strip.begin();</pre>	// INITIALIZE NeoPixel strip object	(REQUIRED)
<pre>strip.show();</pre>	// Turn OFF all pixels ASAP	
<pre>strip.setBrightness(5);</pre>	<pre>// Set BRIGHTNESS to about 1/5 (max =</pre>	= 255)

, 50); // Blue

}

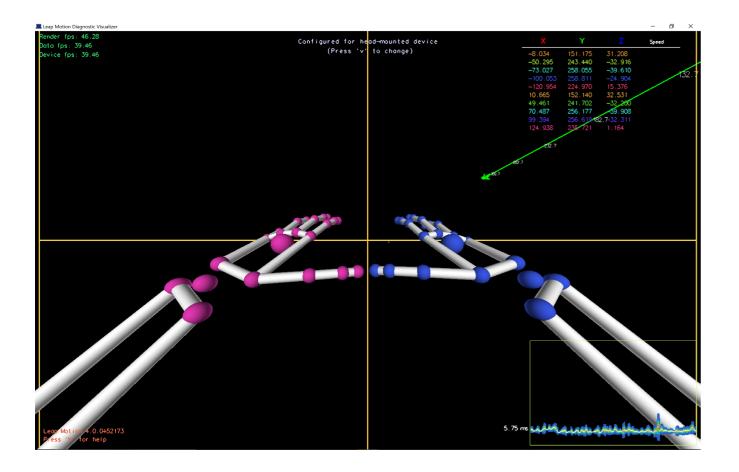
void loop() { int flexValue; flexValue = analogRead(flexPin); Serial.print("sensor: "); Serial.println(flexValue); //colorWipe(strip.Color(0, 0, 255) // pulseBlue(5);

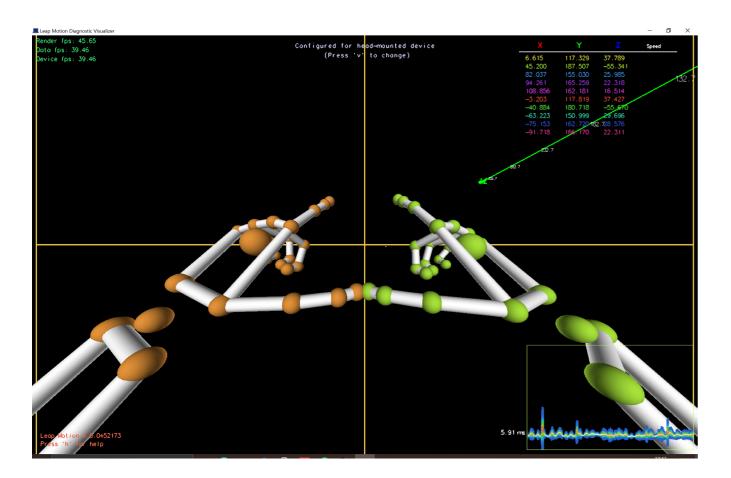
```
if (flexValue >= 740) {
   colorWipe(strip.Color( 255, 0, 0) , 50); // Red
   pulseRed(5);
}
else {if (flexValue < 709) {
   colorWipe(strip.Color( 255, 0, 0) , 50); // Blue
   pulseRed(5);
}
else {
</pre>
```

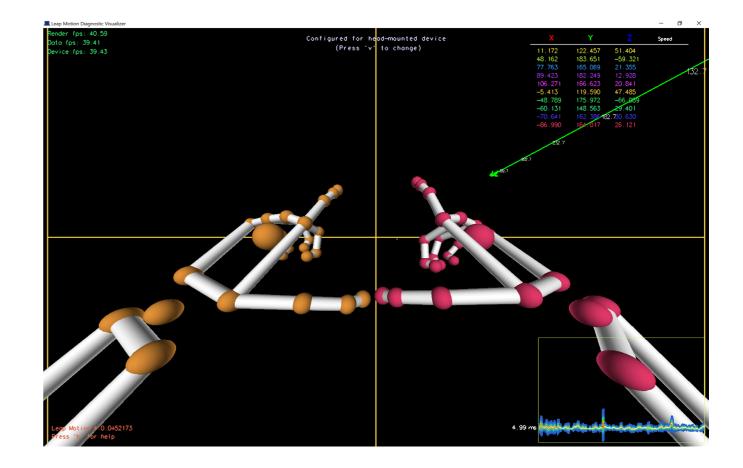
```
else {
  colorWipe(strip.Color( 0, 255, 0) , 50); // Green
}
```

L	_ine: 1, Col: 1	
king using the OpenMV Cam.		
hite light from IR.		
reshold" and more area than "area_threshold threshold" and "area_threshold" if you chan lapping blobs in the image.		
ls_threshold=1000, area_threshold=1000, mer	ge=True)	:
ilter out non-squarish blobs =(255,255,255))		









Example1 ReadDistance | Arduino 1.8.13 (Windows Store 1.8.42.0)

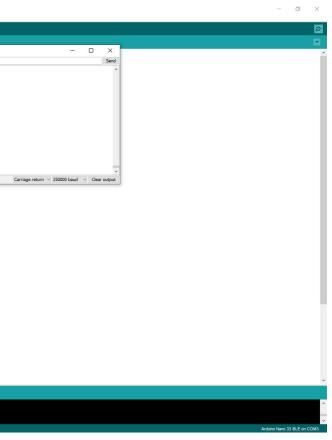
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Are you getting weird readings? Be sure the voce '/ finclude dwire.ho finclude dwir	This example prints the distance to an object			
Are you getting weid readings? Be sure the vect Distance(m): 146 Distance(ft): 0.48 */ #include dwire.b> #include "sparkTwn VL53LIX.b" //Click here to get the library: http://librarymanager/All4SparkTwn_VL53LIX //Optional interrupt and shotdown pins. #define SWTTOWNF_PIN 3 WTVN53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and interrupt pins. //SWTV53LIX distanceSensor(#intervection of the optional shotdown and intervection of the optional shotdown and	This example prints the distance to an object.			
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<pre>include "SparkFum_VLSJLIX.h" //Click here to get the library: http://librarymanager/All4SparkFum_VLSJLIX //Optional interrupt and shutdown pins. fdefine SWTDROWT_PIN 3 SWTUAJLIX distanceGensor(//Document the following line to use the optional shutdown and interrupt pins. //SWTUAJLIX distanceGensor(Bire, SWTUAME_PIN); wold setup(vrsia) { Kire.hegin(); Serial.begin(li5200); </pre>	tinclude (Wire.b)	Autoscroll Show times	stamp	
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<pre>STFULSJLIX distanceSensor; //Document the following line to use the optional shutdown and interrupt pins. //STFULSJLIX distanceSensor(Wire, SHOTDOWL_FIN, INTERSUPT_FIN); wold setup(void) (Wire.begin(); Serial.begin(115200);</pre>				
<pre>//Mocoment the following line to use the optional abordown and interrupt pins, //SFEWLSALIX distancedemoor(Wire, SHOTDOWN_FIN, INTERSUPT_FIN); wold setup(void) { Wire.begin(); Serial.begin(115200);</pre>	_			
<pre>//SFEVL53LLX distanceSensor(Wire, SHUTDOWE_PIN, INTERSUPT_PIN); void setup(void) { Wire.begin(); Serial.begin(115200);</pre>	SFEVLS3L1X distanceSensor;			
<pre>//SFEVL53LLX distanceSensor(Wire, SHUTDOWE_PIN, INTERSUPT_PIN); void setup(void) { Wire.begin(); Serial.begin(115200);</pre>	//Uncomment the following line to use the optional	shutdown and interru	pt pins.	
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(Wire.begin(); Serial.begin(115200);		-		
(Wire.begin(); Serial.begin(115200);	void setup(void)			
Serial.begin (115200);	1			
Serial.begin (115200);	Wire.begin();			
Serial.println("VL53L1X Qwiic Test");	Serial.begin(115200);			
	Serial.println("VL53L1X Qwiic Test");			

stanceSensor.begin() != 0) //Begin returns 0 on a good init al.println("Sensor failed to begin. Please check wiring. Freezing..."); ie (1) .println("Sensor online!");

1 loop (vold)

aintancesensor.startanging(); //write conjugation pytes to initiate measurement while (distancesensor.checkForDataReady()) { delay(1);

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<pre>ude "SparkYun_VL53L1K.h" //Click here to ional interrupt and shutdown pins. ne SWTTOWR_UPIN 2 SSILX distanceSensor; moment the following line to use the opti /JSJLX distanceSensor(Wire, SWTTOWN_PIN moment the following line setup(void) e.hegin(); ial.println("VL53L1K Qwire Test"); ial.println("VL53L1K Qwire Test"); ial.println("Gensor failed to begin. Fi nile (D)</pre>	get the library: http://libra onal sbutdown and interrupt p , INTERNUPT_PIN); uurns 0 on a good init	rymanager/All4SparkFun_VL53L1X	Carriage return ∨ (250000 baud ∨	Char oxput	
<pre>wdw "SparkYun_VL53LIX.h" //Click here to tooal interrupt and shutdown pins. the SWTTOWR_PIN 2 is INTERRUPT_PIN 3 is INTERUPT_PIN 3 is INTERRUPT_PIN 3 is INTERRU</pre>	get the library: http://libra onal sbutdown and interrupt p , INTERNUPT_PIN); uurns 0 on a good init	rymanager/All4SparkFun_VL53L1X	(Carriage return ∨ 250000 baud ∨	Char output	
<pre>de "SpackFun_VLS3LLX.h" //Click here to onal interrupt and shutdown pins. e SUTTOMM_PIN 2 e INTERMOT_PIN 3 3LLX distanceSensor; ment the following line to use the opti LS3LLX distanceSensor(Wire, SHUTDOM_PIN etup(void) .begin(): al.println("MLS3LLX Qwiic Test"); distanceSensor.begin() != 0) //Regin ret rial.println("Sensor failed to begin. F) ile (1);</pre>	get the library: http://libra onal sbutdown and interrupt p , INTERNUPT_PIN); uurns 0 on a good init	rymanager/All4SparkFun_VL53L1X	Carriage return ∨ (250000 baud ∨	Char output	
<pre>wdw "SparkYun_VL53LIX.h" //Click here to tooal interrupt and shutdown pins. the SWTTOWR_PIN 2 is INTERRUPT_PIN 3 is INTERUPT_PIN 3 is INTERRUPT_PIN 3 is INTERRU</pre>	get the library: http://libra onal sbutdown and interrupt p , INTERNUPT_PIN); uurns 0 on a good init	rymanager/All4SparkFun_VL53L1X	(Carriage return ∨ 250000 baud ∨	Char output	
<pre>ude "SparkPum_Vt53L1X.h" //Click here to ional interrupt and shotdown pins. me SWUTOWE_VTN 3 53L1X distanceSensor; omment the following line to use the opti Vt53L1X distanceSensor(Wire, SWUTUOWE_VTS satup(void) e.ebgin(); iai.println('Vt53L1X Qwire Test"); distanceSensor.begin() != 0) //Begin ret erial.println("Sensor failed to begin. P) hile (1) ; iai.println("Sensor failed to begin. P) hile (1); ; iai.println("Sensor online!");</pre>	get the library: http://libra onal sbutdown and interrupt p , INTERNUPT_PIN); uurns 0 on a good init	rymanager/All4SparkFun_VL53L1X	(Carriage return ∨ 250000 baud ∨	Char odput	
<pre>lude "Wire.b> lude "SparKPun_VLSSLIX.h" //Click here to tional interrupt and shutdown pins. ins NUTTOME PIN 3 LSSLIX distanceSensor; Outself distanceSensor; South (the following line to use the opti VLSSLIX distanceSensor; Self, SUTTOME_PIN setup(vois) rial.begin(1)2200); rial.begin(1)2200); rial.begin(1)2200); rial.begin(1)2200); rial.begin(1)2200); rial.peintln("VLSSLIX Quire Test"); (distanceSensor.begin() != 0) //Begin ret Secial.println("Sensor failed to begin. PI shile (1) ; rial.println("Sensor failed to begin. PI shile (1) ; rial.println("Sensor failed to begin. PI shile (1) ; rial.println("Sensor failed to begin. PI shile (1) ;</pre>	<pre>get the library: http://libra onal shutdown and interrupt p , INTERMOPT_PIN; ; urns 0 on a good init ease check wiring. Freezing</pre>	rymanager/All4SparkFun_VL53L1X ins.	Carriage return ∨ (250000 baud ∨	Char output	
<pre>ude *SparkPum_Vt53LLX.h* //Click here to cloan1 interrupt and shutdown pins. ne SMUTOOM PIN 2 </pre>	<pre>get the library: http://libra onal shutdown and interrupt p , INTERMOPT_PIN; ; urns 0 on a good init ease check wiring. Freezing</pre>	rymanager/All4SparkFun_VL53L1X ins.	(Carriage return ∨ 250000 baud ∨	Char odput	
<pre>ude "SparkPum_Vt53L1X.h" //Click here to ional interrupt and shutdown pins. ne SUUTOME_VT9 2 ne INTENDUT_FT9 3 STLI distanceSensori omment the following line to use the opti vt53L1X distanceSensor(Wire, SUUTOWN_FT9 exbegin();</pre>	<pre>get the library: http://libra onal shutdown and interrupt p , INTERMOPT_PIN; ; urns 0 on a good init ease check wiring. Freezing</pre>	rymanager/All4SparkFun_VL53L1X ins.	Carriage return ∨ (250000 baud ∨	Char output	

Example1_ReadDistance | Arduino 1.8.13 (Windows Store 1.8.42.0)

Example1_ReadDistance include <componentobject.h></componentobject.h>	СОМ3		
include <rangesensor.h></rangesensor.h>			
include <sparkfun vl53l1x.h=""></sparkfun>	1		
include <v15311x class.h=""></v15311x>	Distance(mm): 151	Distance(ft): 0.50	
include <v15311 codes.h="" error=""></v15311>	Distance(mm): 157	Distance(ft): 0.52	
inoran	Distance(mm): 151	Distance(ft): 0.50	
*	Distance(mm): 152	Distance(ft): 0.50	
Reading distance from the laser based VL53L1	Distance(mm): 151	Distance(ft): 0.50	
By: Nathan Seidle	Distance (mm): 159	Distance(ft): 0.52	
	Distance (mm): 152	Distance(ft): 0.50	
	Distance(mm): 152	Distance(ft): 0.50	
License: This code is public domain but you	Distance(mm): 151	Distance(ft): 0.50	
License. This code is public domain buc you	· Distance(mm): 151	Distance(ft): 0.50	
SparkFun labored with love to create this co	Distance(mm): 151	Distance(ft): 0.50	
sparkrun labored with love to create this co	Distance(mm): 153	Distance(ft): 0.50	
Buy a board from SparkFun! https://www.spark	Distance(mm): 150	Distance(ft): 0.49	
This example prints the distance to an object	Distance(mm): 150	Distance(ft): 0.49	
	Distance(mm): 150	Distance(ft): 0.49	
	Distance(mm): 150	Distance(ft): 0.49	
Are you getting weird readings? Be sure the /	Distance (mm): 150	Distance(ft): 0.49	

//Optional interrupt and shutdown pins. #define SHUTDOWN_PIN 2 #define INTERRUPT_PIN 3

SFEVL53LLX distanceSensor; //Uncomment the following line to use the optional shutdown and interrupt pins. //SFEVL53LLX distanceSensor(Wire, SHUTDOWN_PIN, INTERRUPT_PIN);

void setup(void)

Wire.begin();

Serial.begin(115200);
Serial.println("VL53L1X Qwiic Test");

if (distanceSensor.begin() !- 0) //Begin returns 0 on a good init

{
 Serial.println("Sensor failed to begin. Please check wiring. Freezing...");
 while (1)

}
Serial.println("Sensor online!");

void loop (void)

distanceSensor.startRanging(); //Write configuration bytes to initiate measurement
while (!distanceSensor.checkForDataReady())

elay(1);

 magnetopot_test | Arduino 1.8.13 (Windows Store 1.8.42.0)
File Edit Sketch Tools Help magnetopot_test сомз
 • Construction
 (701)

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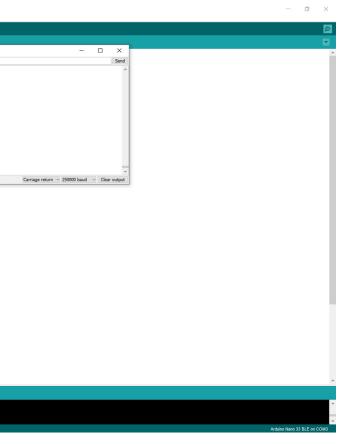
 • Construction
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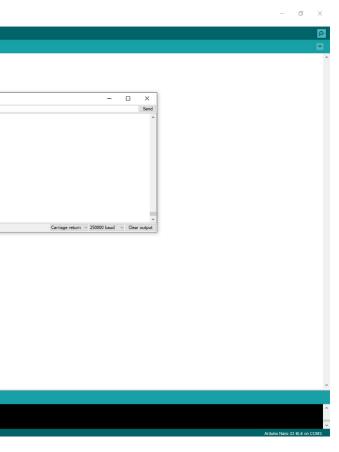
 • Construction
 (685)

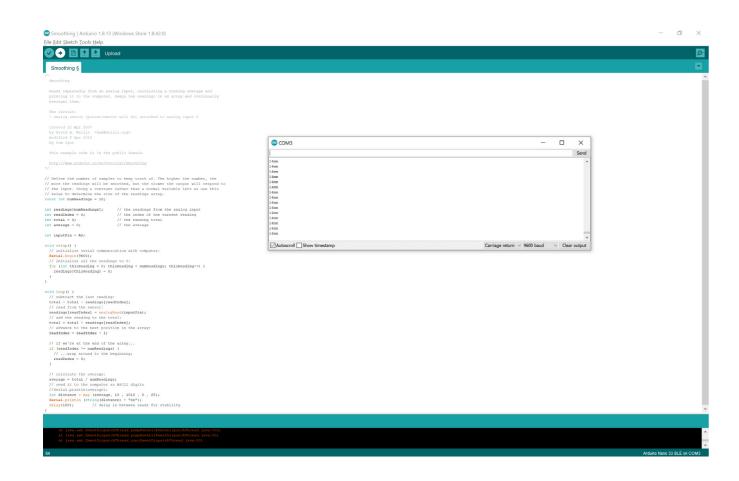
 • Construction
 const int SOFT_FOT_PIN = A0; // Pin connected to softpot wiper const int GRAPH_LENGTH = 50; // Length of line graph void setup() {
 Serial.begin(9600);
 pinMode(SOFT_POT_PIN, INPUT);
} void loop() Autoscroll Show timestamp (// Read in the soft pot's ADC value int softPotADC - analogNed GOOT POT PIN; // Map the -0.1033 value to 0.-40 int softPotPosition - map(softPotADC, 400, 1000, 0, GRAFH_LEBOTH); // Print a line graph: Serial.print("<"); // Starting end for (int i=0; i<GRAPH_LENGTH; i++) { {
 if (i == softPotPosition) Serial.print("!");
 else Serial.print("-");

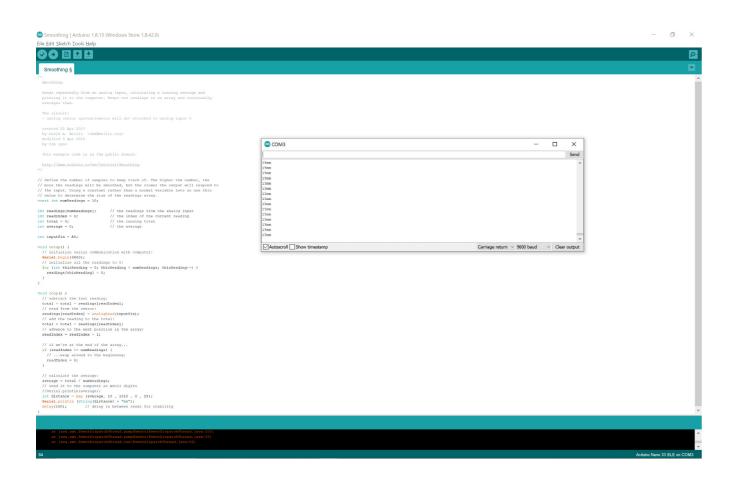
}
Serial.println("> (" + String(softPotADC) + ")");

delay(100);









Eile Edit Sketch Tools Help	
magnetopot_test	
/**************************************	
SoftPot_Example.ino	
Example sketch for SparkFun's soft membrane potentiometer	
(https://www.sparkfum.com/products/8680) Jim Lindblom # SparkFum Electronics	
April 28, 2016	
Ayees sv, svev	
- Connect the softpot's outside pins to 5V and GND (the outer pin with an arrow	
indicator should be connected to (ND) .	
- Connect the middle pin to A0.	
As the woltage output of the softpot changes, a line graph printed to the	
	COM3
Development environment specifics:	-
Arduino 1.6.7	
	Distance: 14 mm
const int SOFT_POT_PIN = A0; // Pin connected to softpot wiper	Distance: 14 mm
	Distance: 15 mm
const int GRAPH_LENOTH = 25; // Length of line graph	Distance: 14 mm
void setup()	Distance: 14 mm
	Distance: 14 mm
Serial.begin(9600);	Distance: 15 mm
pinMode (SOFT POT PIN, INPUT);	Distance: 14 mm
1	Distance: 14 mm Distance: 14 mm
	Distance: 14 mm Distance: 15 mm
void loop()	Distance: 15 mm
	Distance: 15 mm
// Read in the soft pot's ADC value	Distance: 15 mm
<pre>int softPotADC = analogRead(SOFT_POT_PIN);</pre>	Distance: 14 mm
<pre>// Map the 0-1023 value to 0-40 int softPotPosition = map(softPotADC, 300, 1020, 0, GBAPH LENGTH);</pre>	
<pre>//float pos = softPotPosition / 25;</pre>	Autoscroll Show timestamp

Smoothing §		
Smoothing		
Reads repeatedly from an a	analog input, calculating a running average and	
printing it to the compute averages them.	er. Heeps ten readings in an array and continually	
The circuit:		
- analog sensor (potention	meter will do) attached to analog input 0	
created 22 Apr 2007 by David A. Mellis <dam@< td=""><td></td><td></td></dam@<>		
modified 9 Apr 2012		
by Tom Igoe		COM3
This example code is in th	he public domain.	1
http://www.arduino.cc/en/		16mm
/		16mm
		1 6mm 1 6mm
	ples to keep track of. The higher the number, the	16mm
	e smoothed, but the slower the output will respond to ant rather than a normal variable lets us use this	1 Gran
<pre>/ the input. Using a const. / value to determine the s.</pre>		1.6mm
onst int numReadings = 10;		1.6mm
		16mm
nt readings[numReadings];	// the readings from the analog input	1.6mm 1.6mm
nt readIndex = 0;	// the index of the current reading	1 ferm
nt total = 0; nt average = 0;	// the running total // the average	1.6mm
ne average - 0,	// the average	1.6mm
nt inputPin - A0;		1.6mm
		Autoscroll Show timestamp
nid setun() (
oid setup() { // initialize serial comm	unication with computer:	L
<pre>// initialize serial comm Serial.begin(9600);</pre>		
<pre>// initialize serial comm Serial.begin(9600); // initialize all the read </pre>	dings to 0:	·
<pre>// initialize serial comm Serial.begin(9600); // initialize all the rea for (int thisReading = 0;</pre>	dings to 0: thisNeading < numNeadings; thisNeading++) (
<pre>// initialize serial comm Serial.begin(9600); // initialize all the read for (int thisReading = 0; readings[thisReading] =</pre>	dings to 0: thisNeading < numNeadings; thisNeading++) (
<pre>// initialize serial comm Serial.begin(9600); // initialize all the rea for (int thisReading = 0;</pre>	dings to 0: thisNeading < numNeadings; thisNeading++) (
<pre>// initialize serial comm Serial.begin(9600); // initialize all the read for (int this@eading = 0; readings[this@eading] = }</pre>	dings to 0: thisNeading < numNeadings; thisNeading++) (1
<pre>// initialize serial comm Berial.begin(9600); // initialize all the rea- for (int thisReading = 0; readings[thisReading] = } } oid loop() {</pre>	dings to 0: this heading < mumbers dings; this heading++) ($0_{\rm f}$	
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<pre>// initialize serial com Serial.begin9600; // initialize all the rea for (int thisReading = 0; readings[thisReading] = } oid loop() { // subtract the last read total = total = readings[// readfine the sensor:</pre>	dings to 0: thisBeading < numbeadings; thisBeading) (0; ing: readIndes];	
<pre>// initialize serial com Serial.begin(9600); // initialize all the res- for (int thisReading = 0; readings[thisReading] =) oid loop() { // subtract the last read total = total - readings[// read from the sensor: readings[readIndex] = ons readings[readIndex] = ons</pre>	<pre>timp to 0: thiskeading < numbershipp; thiskeading++) (0; ing; readTades); readTades); readTades;; readTade</pre>	
<pre>// initialize serial coum Serial.begin(9600); // initialize all the rea for (int thisseading = 0) readings[thisseading] =)) oid loop() { // subtract the last read total = total - readings[// read from the sensor: readings[readIndex] = ona // add the reading to the // add the reading to the sensor:</pre>	ilnys to 0: thismeading < maskeadings; thiskeading++) (og: neg: meadIndeal; Jugdeed(genetRn); total:	
<pre>// initialize serial comm Serial.begin(9600); // initialize all the res for (int thisReading =)) old loop() { // motract the last read total = total - readings(// read from the sensor: readings(Total - reading) // add the reading to the total = total + reading()</pre>	<pre>timp to 0: thismeading < numberedings; thismeading**) (0; ing: readTable(); teah1 teah1</pre>	
<pre>// initialize serial coum Serial.begin(9600); // initialize all the rea for (int thisseading = 0) readings[thisseading] =)) oid loop() { // subtract the last read total = total - readings[// read from the sensor: readings[readIndex] = ona // add the reading to the // add the reading to the sensor:</pre>	<pre>dinp: to 0: thismeading < numberedings; thismeading++) (0; immailment;; immailment;; implement(imputPin); medTaing;; into in: the array;</pre>	
<pre>// initialize serial come Serial begins(9600) // initialize all the ree for (int thiseading = 0; reeding(thiseading = 0; // static the last read total = total = readings[// reading(reading(s) = ase // static serial = readings(// static serial = readings(// advance to the next po reedinder = readinder + 1</pre>	<pre>dimp to 0: thismeading < masteadings; thismeading++) (0; institute ins</pre>	
<pre>// initialite serial come Serial begine(900); // initialite all the res for [in: thiseadday = 0) recollected and the series of [in: thiseadday = 0) recollected and the series // series the last read- ing (read from the sense; resing(readTodes) = an () advance to the sense to resing(readTodes) = an () advance to the sense to resing(readTode</pre>	<pre>dings to 0: thismeeding < masheadings; thisheading++) (0; measingles(); logicad(logentin); testif readingl; itim is the array; ; the array</pre>	
<pre>// initialize serial come Serial beging(900); // initialize all the res for [ist thisedulys] = 0; reading(thiseduly) = 0; // series the last read format is the last read format is the last read format is the last read reading(readTode) = as // advance to the next po readIndex = readInder + readIndex = readInder + // if we're at the sent po readIndex = readInder + // if we're at the sent po // if we're at the sent po // if we're at the sent po //</pre>	<pre>slop to 0; thiseeding+; thiseeding+; (0; ing: readInden1; todal: total: to the array; the array; the array;</pre>	
<pre>// initiality serial come fortal begin (900); // initiality all the res res (initiality all the res res (initiality all the res res); // support (initiality); // supp</pre>	<pre>slop to 0; thiseeding+; thiseeding+; (0; ing: readInden1; todal: total: to the array; the array; the array;</pre>	
<pre>// initialize serial come Serial beging(900); // initialize all the res for [ist thisedulys] = 0; reading(thiseduly) = 0; // series the last read format is the last read format is the last read format is the last read reading(readTode) = as // advance to the next po readIndex = readInder + readIndex = readInder + // if we're at the sent po readIndex = readInder + // if we're at the sent po // if we're at the sent po // if we're at the sent po //</pre>	<pre>slop to 0; thiseeding+; thiseeding+; (0; ing: readInden1; todal: total: to the array; the array; the array;</pre>	
<pre>// initiality serial come fortal beginetable fortal beginetable // initiality all the rew readings (1) initiality and object (1) initiality (1) and forth is easily // satirate the last read fortal - total - readings(1) // satirate the second reading(readTode) = sati // satirate the second // satirate the second // satirate is readings(1) // satirate is readings(1) // satirate is a satirate // satirate is a satirate in treadTode = satirate // closelate the average; // calculate the average;</pre>	<pre>disp to 0: thismealing < masheadings; thisheading++) (ing: readInden1; logics(ingestRa); tead1 readInden2; readInden3; readInden3; readInden3; r</pre>	
<pre>// initiality serial come Benial beginted to the serial perial beginted to the series readings (thisteading) -) set loop 0 (// sobtract the last read focal - total - reading(// sobtract the last read focal - total - reading(reading(reading) - as // add the reading to the reading(reading) - as // idd the reading to the readings - readings - to // idd the reading to the // idd ways at the add of // idd ways at the add of readings - readings - to readings - come and // idd ways at the add of readings - come add of readings - come add of readings - come add of readings - come add of readings - to the series // come add of the series // come add of the series // come add of the series // come add of the ser</pre>	<pre>dimp: to 0: thismealing < mamteading;; thismeading++) (0; ing: contention(); ingtead(inguetPin); contention(); ingtead(inguetPin); contention(); ingtead(inguetPin); contention(); ingtead(inguetPin); contention(); ingtead(inguetPin); ingtead</pre>	
<pre>// initiality serial communications of the serial begin (Secience Series) and the series of the</pre>	<pre>dings to 0: thismeding < maskeadings; thiskeading++) (on; reseffedds]; reseffedd; itics is the array: tetal: tetal: tetal: tetal: tetal: tetal: teta: tetal: teta: tetal: tetal: teta: tet</pre>	
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at java.avt.EventDispatchThread.pumpEvents(EventDispatchThread.java:93 at java.avt.EventDispatchThread.run(EventDispatchThread.java:82)

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magnetopot test							
Antonio de la construcción de la							^
- Connect the softpot's outside pins to 5V and GND (the outer pin with an arrow indicator should be connected to GND connect the middle pin to Δc							
As the voltage output of the softpot changes, a line graph printed to the serial monitor should match the wiper's position.	(com3)			x			
Development environment specifics: Arduino 1.6.7				end			
<pre>const int SOFT_POT_PIN = A0; // Pin connected to softpot wiper</pre>	Distance: 14 mm Distance: 13 mm			^			
const int GRAPH_LENGTH = 25; // Length of line graph	Distance: 13 mm Distance: 14 mm Distance: 14 mm						
<pre>void setup() (Serial.begin(9600);</pre>	Distance: 13 mm Distance: 14 mm						
<pre>pinMode(SOFT_FOT_PIN, INFUT); }</pre>	Distance: 13 mm Distance: 13 mm Distance: 13 mm						
<pre>void loop() { // Read in the soft pot's ADC value int softworksc - analogemad(sort_pot_PIN); </pre>	Oistance: 13 mm Distance: 14 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm			J.			
<pre>// Map the 0-1023 value to 0-40 int softPotPosition = map(softPotADC, 380, 1020, 0, GRAPH_LENGTH); //float pos = softPotPosition / 25;</pre>	Autoscroll Show timestamp	Carriage return $$	Clear out	put			
<pre>Serial.println("Distance: * + String(softPotPosition) + " sm"); delay(500); }</pre>	-						

<pre>// Votes the number of angule to key track of. The Support the weeks, the // Delres the number of angule to key track of. The Support the week to the // Delres the number of the support to key the support to the support // Delres the number of the support to key the support to the support for adding the support to key the support to key the support is intervent to key the support to key the support // Delres the support to key the support to key the support // Delres the support to key the support // Support to key to key the support // Support to key the support to key the support // Support to key the support to key the support // Support to key the s</pre>	<pre>https:// intermediations// intermediations/</pre>	Verity		
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<pre>- and/present (proteilenery iii (a) attached to and/print 0 Write Compared 24 print 24 p</pre>	<pre>- and/operation/control/c</pre>	printing it to the computer. Keeps		
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<pre>The sample which is its the public famile. transformer shows and any of angle to have brack at the higher the mother, the '/' '/ Define the made of angle to have brack at the higher the mother, the '/' Define the index of angle to have brack at the higher the mother, the '/' Define the index of angle to have brack at the higher the mother, the '/' Define the index of the public famile. '/' Define the index of the index of the public famile. '/' Define the index of the public famile. '/' Define the index of the in</pre>	<pre>The emaphy to the is is the public densit. that/Jose redukes control/theris/Josenthal reduces the redukes of the public densit. The is a state of the reduke of the redukes the space of the subject the same the state reduces the redukes of the redukes resp. is a state of the redukes of the redukes the state of the subject the state of the redukes the state of the redukes of the reduke</pre>	by David A. Mellis <dam@mellis.org modified 9 Apr 2012</dam@mellis.org 		
<pre>by addition and addition of a sequence to have your that have the addition of the additio</pre>	<pre>trans //www.schicks.nch/schuzzi/limenting Parise the scalary of sequence to have years of the scheme to be sequence will request to the input. Scalary of sequence that input willing its uses that the input. Scalary of the sca</pre>			
<pre>// Jobs the makes of sampler to keep track of. The higher the makes, the // more the makes of sampler to keep track of. The higher the makes, the // more the makes prime tracks the makes the sample will respond to // bas higher. This manufacture is a more vertice mark is the makes in a more vertice is makes in a more vertice is makes in a more vertice // the isode of the mark in a more vertice // the isode of the isode in the isode in</pre>	<pre>clica the number of pargise to keep trach of. The higher the number, the many the readings will be anomal variable for a number will argond to the space. This a number variable for an anomal variable for a number of the n</pre>			
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<pre>// value to attend to be attended by a resp. int a summary int of the reading range. int a summary int of the reading range. int a summary int of the reading range is a reading reading</pre>	<pre>value to determine the size of the readings range, if a maximum problem is a size of the reading range of the sailing input if a sailing problem is a size of the reading range of the sailing input if a sailing problem is a size of the reading range of the sailing input if a sailing of the same range if a sailing of the same range if a sailing of the same range if a same range of the same range of the same range if a same range of the same</pre>	// more the readings will be smoothed	but the slower the output will respond to	СОМЗ
<pre>int manipulsions: int man</pre>	<pre>static static stat</pre>	// value to determine the size of the	readings array.	1
<pre>int reactions ************************************</pre>	<pre>: matched = 0; /// // the index of the nurrent reading</pre>			1
<pre>int test = 0 // the restarg is test = 0 // the restarg is restarg = 0 // the restarg is restarg = 0 // the restarg is restarg = 0 // the restarg // is test = 0 // the restarg // is test = 0 // the restarg // is test = 0 // the restarg is restarg = 0 // the restarg is restarg = 0 // the restarg // restarg = 0 // restarg = 0 // the restarg // restarg = 0 // restarg // restarg = 0 // restarg = 0 // restarg // restarg = 0 // restarg = 0 // restarg // restarg = 0 // restarg = 0 // restarg // restarg = 0 // restarg = 0 // restarg = 0 // restarg // restarg = 0 // restarg</pre>	<pre>t table 0; // the meaning vtail = 0; //</pre>			
<pre>is impacts = Ms/ inf impacts = Ms/ inf impacts = Ms/ if initiality = nonmaliating with empoter: // initiality = nonmaliating with empoters: // initiality = nonmaliating with empoters:</pre>	<pre>impedia = M/</pre>	int total = 0; // th	running total	
<pre>ide seque() { if a seque() { if a seque() {</pre>	<pre>intervalues into the sense int</pre>	int average = 0; // th	avezage	
<pre>media sergio 1 // initialize and in manufaction with empoter; // initialize series // in</pre>	<pre>id sectory (</pre>	int inputPin = A0/		
<pre>// initiality and a manufacture with compares: #44 #11.inity:(1000) #1000 *000 #re (iso thatheading = 0 ministrating iso that and ministry iso the ministry iso ministry iso the ministry iso the ministry iso the ministry iso the ministry iso ministry iso the ministry iso the ministry iso ministry iso the ministry iso theminiter iso miniso miniso minis</pre>	<pre>// isitizis series and is communication with computer: ##11astications #11astications #11astications #11astications #11astications #11astications #11astications #11astications #11astications #11astications #11astications #11asticatio</pre>			
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<pre>// initialisal the readings to 5(for (its this/mathing is withinkating) thinkating() { for (its this/mathing is withinkating) thinkating() {</pre>	<pre>// initialize all the readings to 0: for (i) this discussion of the initialized (i) this discussion of the initialized (i) this discussion of the initialized (i) the initialized</pre>	Serial.begin(9600);	ith computer:	047
<pre>resting(thinfacting) = 0;</pre>	<pre>masting tisknasting := 67 ;</pre>	// initialize all the readings to 0		
<pre>is into long() { // entroit is used in entropy // entropy // entroit is used in entropy // ent</pre>	<pre>idi loop 0 { // addit is addit seeding: // addit</pre>		og < numBeadings: thisBeading++) {	
<pre>ind boph 1 // setTos to the set reading: // setTos to the set reading: // setTos to the setTos</pre>	<pre>it is and the init reading:: // units is and the init president is and the init preside</pre>			
<pre>medi logg ! /** /** /** /** /** /** /** /** /** /** /*</pre>	<pre>id loop 1</pre>			847
<pre>// redinist the next semigric trail = trail = redining remainson (redining remainson (remainson (remain</pre>	<pre>// matrixe the iss reading: // matrixe the iss reading: // mat from the sense: // mat from the sense: // mat the reading (reading) // mat the reading to the total // did the reading to the total // did the reading to the integra- readings - reading from the integrational // is we're at the end of the array: // is we're at the end of the array is we're // is we're at the end of the array is we're // is we're at the end of the array is we're // is we're at the end of the array is we're // is we're at the end of the array is we're // is we're at the end of the array is we're // is we're at the end of the array is we're // is we're at the end of the array is we're // is we're at the end of the array is we're // is we're at the end of the array is we're // is we're at the array is we're // is we're at the array is we're // is we're at the array is we're at</pre>			
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<pre>total = realing/treatments/ // if we realing the total array: // if we real to main the error // if we real to the main the error // comparison to the beginning: // contained to the beginning: // contained to the beginning // contained to the massions/ // endowed to the</pre>	<pre>total - total + reading(reading(reading)) ///orders to the surple pointing is the strapy setTotar - readings - 1; ///order to the strapy ///order to the surple pointing: setTotar - reading - readi</pre>		utPin);	
<pre>// advance to the max particle in the array advance = setup (in the array) // if were at the well of the array if treadforts = manufactury (// excluse = for // excluse = for // excluse = for // excluse to the measure // exclusion to a meraps exclusion to to the immediate // exclusion to a meraps exclusion to a meraps // exclusion to a</pre>	<pre>// absence to the sext position in the arrays and the array of th</pre>	total = total + readings[readIndex]		
<pre>// if wip at the end of the error, // if wip at the end of the region //</pre>	<pre>// if seven is the end of the ansay // if seven is the ansay //</pre>	// advance to the next position in :	he arrayi	
<pre>if (reaching := contracting) (//rouge arrows to the hepining: readTables = 0; // contracts the average: // contracts the average:</pre>	if freatBooks >= muthatings (//tong struct to basginite: //arthouse = 0; //arthouse = to: //arthouse = to: //arthouse = to: //arthouse = to: //arthouse = to: //arthouse = to:	readIndex = readIndex + 1;		
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reatTooks = 67 // calculates = 67 // sametage = total / numerations // samet is to the composed and the same same and the sametage of the s	readDate = 0; // clubulate the serverse // clubulate the serverse // security = total, 'security description // security in the computer as ANGII digits description to the serverse pion	if (readIndex >= numReadings) {		
) // calculate the strenge: // calculate the strenge: // calculate the strenge: // calculate the strenge: // calculate the strenge the str) versage - total / manheedings: / mean total / manheedings:	<pre>//wrap around to the beginnin readIndex = 0;</pre>		
<pre>average total / madwadings: // end it to the computer as AADIT digits Aerial printl(everage): disd(000) / // shivy in between reads for wrability</pre>	average = total / mumRedings; // send it to the computer as ABCII digits Senial_println(werage);			
average * total / manWasdingu: // end its the computes as AACIT digits Serial_println(average): diadg(00): // elays in between reads for stability	average = total / mumRedings; // send it to the computer as ABCII digits Senial_println(werage);			
<pre>// seed it to the computer as ARCII digits Secial_println(average): deleg@d001: // delay in between reads for stability</pre>	<pre>// send it to the computer as ASCII digits Serial.println(average);</pre>			
Serial.println(average); delay(100); // delay in between reads for stability	Serial.println(average);	// send it to the computer as ASCII	digits	
	minggoos; // ming is between reads for stability	Serial.println(average);		
		delay(100); // delay in betw	en reads for stability	



magnetopot_test Arduino 1.8.13 (Windows Store 1.8.42.0)		
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magnetopot_test		
tPot_Example.ino		
mple sketch for SparkFun's soft membrane potentiometer		
https://www.sparkfun.com/products/8680)		
Lindblom @ SparkFun Electronics		
1 28, 2016		
nnect the softpot's outside pins to SV and GND (the outer pin with an arrow		
onnect the middle pin to A0.		
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monitor should match the wiper's position.	Сомз	- 🗆 X
l monitor should match the wiper's position. opment environment specifics:	СОМЗ	- 🗆 X Send
<pre>il monitor should match the wiper's position. opment environment specifics: no 1.6.7</pre>	1	
<pre>l monitor should match the wiper's position. opment environment specifics: no 1.4.7</pre>) Distance: 12 mm	
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<pre>l monitor should match the wiper's position. opposit environment specifics: ao 1.6.7 int SoTT_FOT_FIN = A0; // Fin connected to softpot wiper int GATM_LEMOTE = 25; // Length of line graph</pre>	Distance: 12 mm Distance: 12 mm Distance: 13 mm Distance: 12 mm Distance: 12 mm Distance: 12 mm	
<pre>l monitor should match the viper's position. oppent environment specificm: no 1.6.7 int DOT_rem_JIM = A0; // Fin commetted to softpor viper i ant GRAM_LENDTH = 25; // Length of line graph SetUp()</pre>	Distance: 12 mm Distance: 12 mm Distance: 12 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm	
<pre>number should match the viper's position. pressed sevel constant appendix of the seven sev</pre>	Listance: 12 mm Distance: 12 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm	
<pre>1 monitor should match the wiper's position. ignate monitormeant specifics: </pre>	Distance: 12 mm Distance: 12 mm Distance: 12 mm Distance: 12 mm Distance: 12 mm Distance: 12 mm Distance: 13 mm Distance: 13 mm	
<pre>number should match the viper's position. pressed sevel constant appendix of the seven sev</pre>	- Distance: 12 mm Distance: 12 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm	
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<pre>immits whold match the viper's position. quark swyloamast specifics: n LLT_TOT_INF #0; // Fin connected to softpot viper int CDATM_LEDITM = 25; // Length of line graph stdp() kal.hegin(9600); how(bOT_TOT_FIN, INVT);</pre>	Distance: 12 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm	
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<pre>i molice about match the viper's position. opens devicement specifics: molic. int SOTY_FOR_THE + AP; // He connected to softpot viper int GARM_LEMENT = 25; // Length of line graph setup 0 Mail.begin(M600); mode (SOTY_FOR_THE, INNUT); Loop 0 mead in the soft pot's ADC value</pre>	C Distance: 12 mm Distance: 12 mm Distance: 12 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm Distance: 14 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm	
<pre>matter should match the viper's position. pmant surjenness question: in: Sorr_For_FIN = A0; // Fin connected to softpot viper in: GMAN_LEMENT = 29; // Length of line graph setup 0 delbolin(9600); delbolin(9600); desd in the soft pot's ADC vipes softpote = maloghask(DOT_yor_FID); desd in the soft pot's ADC vipes softpote = maloghask(DOT_yor_FID);</pre>	- Distance: 12 mm Distance: 12 mm Distance: 13 mm	
<pre>il monitor should match the wiper's position. (means movies specification) into 1.0. i fit GOT_FOT_FIT = AD; // Fin connected to softpot wiper i int GOT_FOT_FOT_FIT = AD; // Length of line graph setup0 fil.hegin(9600); mode GOT_FOT_FIT, INTOT); length mode for T_at ADT pot's ADD value; reforemance = amalogement(port, FOT_FIT); mode to Tat ADT pot's ADD value; reforemance = amalogement(port, FOT_FIT); mode to Tat ADT pot's ADD value; reforemance = amalogement(port, FOT_FIT); </pre>	C Distance: 12 mm Distance: 12 mm Distance: 12 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm Distance: 14 mm Distance: 13 mm Distance: 13 mm Distance: 13 mm	
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Serial.println("Distance:	+	String (softPotPosition)	
delay(500);			
}			

Reads repeatedly from an an	
	. Keeps ten readings in an array and continually
averages them.	
The circuit:	
	ter will do) attached to analog input 0
created 22 Apr 2007	
by David A. Mellis (dam@mel	
modified 9 Apr 2012	
by Tom Igoe	
http://www.ardsino.cc/en/Tu	
*/	
	es to keep track of. The higher the number, the
	smoothed, but the slower the output will respond to
	t rather than a normal variable lets us use this
// value to determine the size	e of the readings array.
const int numReadings = 10;	
int readings[numReadings];	// the readings from the analog input
int readIndex = 0/	// the index of the current reading
int total = 0r	// the running total
int average = 0;	// the average
int inputPin = A0y	
and angestran - May	
) () quies biov	
// initialize serial communi	ication with computer:
Serial.begin(9600);	
// initialize all the reading	
// initialize all the reading	ng= to 0: hisDeading < numDeadings; thisDeading++) (
// initialize all the reading	hisReading < numReadings; thisReading++) (
<pre>// initialize all the reading for (int thisReading = 0; t)</pre>	hisReading < numReadings; thisReading++) (
<pre>// initialize all the reading for (int thisReading = 0; th readings[thisReading] = 0;</pre>	hisReading < numReadings; thisReading++) (
<pre>// initialize all the readi for (int thisDeading = 0; ti readings[thisDeading] = 0; }</pre>	hisReading < numReadings; thisReading++) (
<pre>// initialize all the readi for (int thisPeading = 0; t) readings[thisPeading] = 0, } youd loop() {</pre>	influeting < muntheadinger thisflueding++) (
<pre>// initialize all the readin for (int thisPeading = 0; ti readings[thisPeading] = 0; } void loop() { // subtract the last readin</pre>	infeading (numbeadings: thisbeadings:) (;
<pre>// initialize all the readin for (int thisPeeding = 0; th readings(thisPeeding) = 0; } void loop() { // subtract the last reading total = total - readings[re.</pre>	infeading (numbeadings: thisbeadings:) (;
<pre>// initialize all the readi for (int thisReading = 0; ti readings[thisReading] = 0 }) void loop() { // subtract the last reading total = total = reading[te: // read from the sensor:</pre>	sismading < unitarity (///////////////////////////////////
<pre>// initialize all the reading for (int thinPacking = 0; t readings(thinPacking) = 0;) void loop() { // subtract the last readin total = total - readings[re // read from the sensor: readings(readInders) = enalog </pre>	iinnadig (mathaning); thinhaning)) (/ /////////////////////////////////
<pre>// initialize all the reading for (init thisPacing = 0; the readings(thisPacing) = 0; } void loop() (// subtract the last reading total = total - readings(re- // read from the sensor: readings[readIndex] = analo; // add the reading to the to // add the reading to the to</pre>	iionadig < muthaatigy (tiithaatigy) (/ / ////////////////////////////////
<pre>// initialize all the reading for (ins thisReading = 0; the readings(thisReading) = 0;) void loop() { // read to loo last reading/re- total = total = readings/re- // read from the sensor: readings/readIndersellowers // add the readings to the 0 total = total = readings[re- total = total = readings[re-)</pre>	inimeding < uniteratings; thisteeding;;) (; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ; ;
<pre>// initialize all the reading for (init thisPacing = 0; the readings(thisPacing) = 0; } void loop() (// subtract the last reading total = total - readings(re- // read from the sensor: readings[readIndex] = analo; // add the reading to the to // add the reading to the to</pre>	ninnedig (understopp (tristeretiop)) (/ / / / / / / / / / / / / / / / / /
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<pre>// initialize all the readi for (in thisMeding = 0 to readings(thisMeding) = 0)) vidi loop({ // solutant the last reading/the readings(the last reading) / add the reading to the to total = total = readings[the // advants reading to the total = total = readings[the // advants the set point readings = the set head of to / advants at the set of to / if wires at the set of to // if</pre>	innacing (mathaningur thintacingur) (r f film
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<pre>// initialize all the readi for (int thisReading = 0 u) readings(thisReading) = 0)) vidi loop() { // subtract the last reading total = total - reading(the // add the total - reading(the // add = total + readings(the // add = total + readings(the) + readings(t</pre>	inimating < university visitseting++) (/ / fiftheny/ infine()// infine()/ i
<pre>// initialize all the readi for (in thireading = 0.1 reading(thireading = 0.1)))))))))))))))))))</pre>	inimating < university visitseting++) (/ / fiftheny/ infine()// infine()/ i
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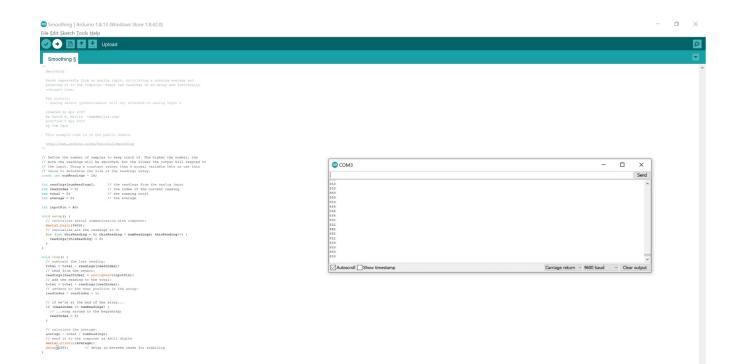
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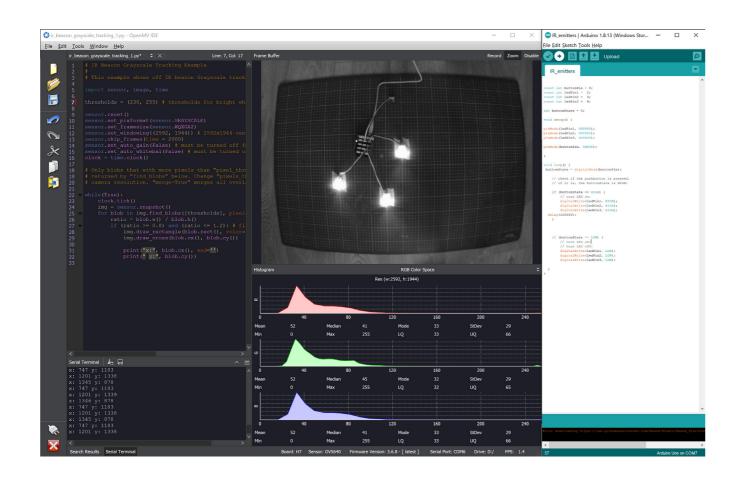
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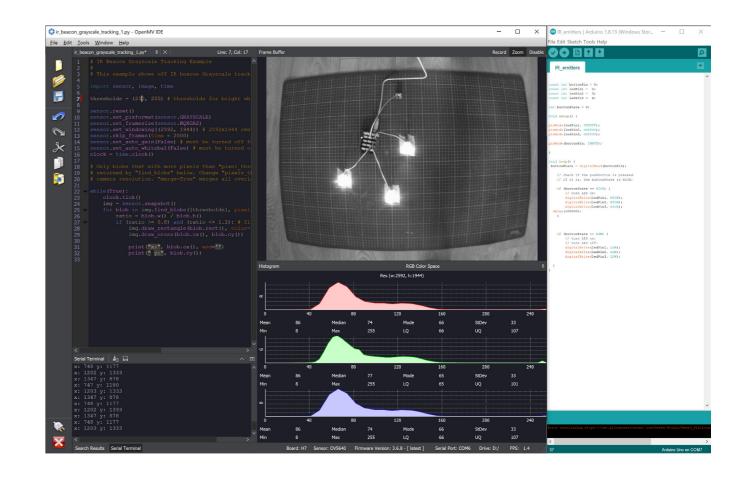
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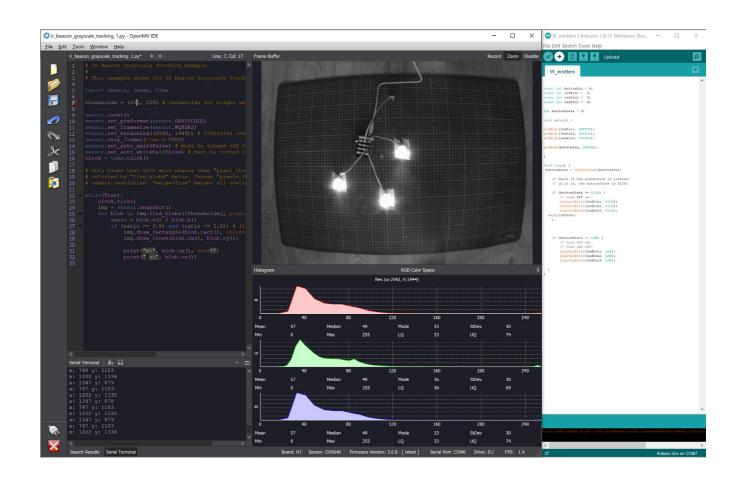
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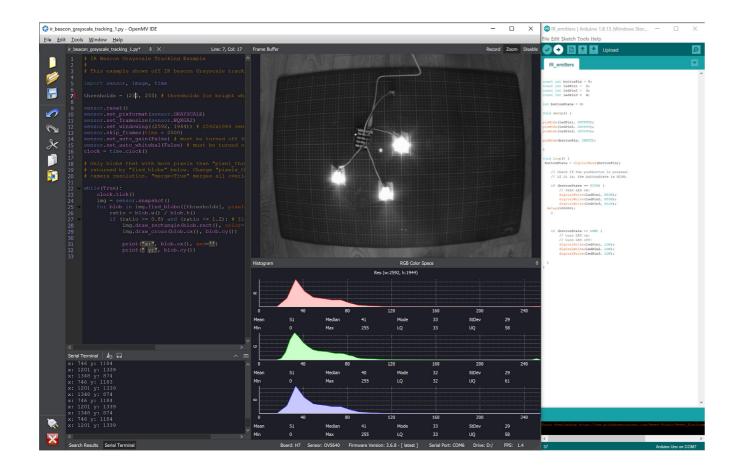


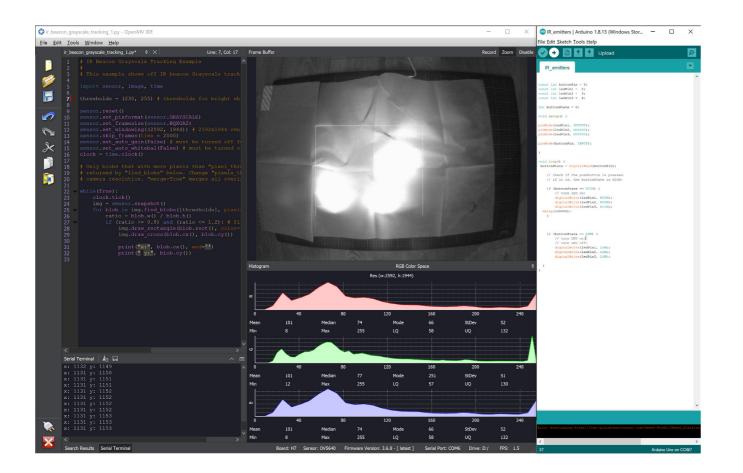
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at processing.app.Serial.dispose(Serial.java:168)
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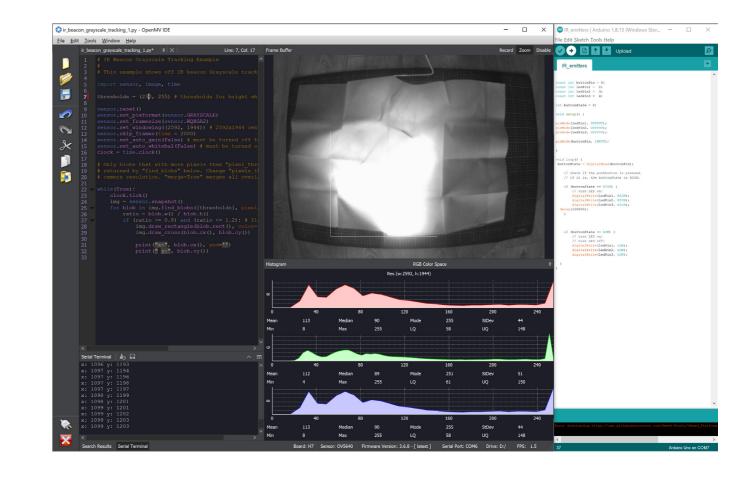


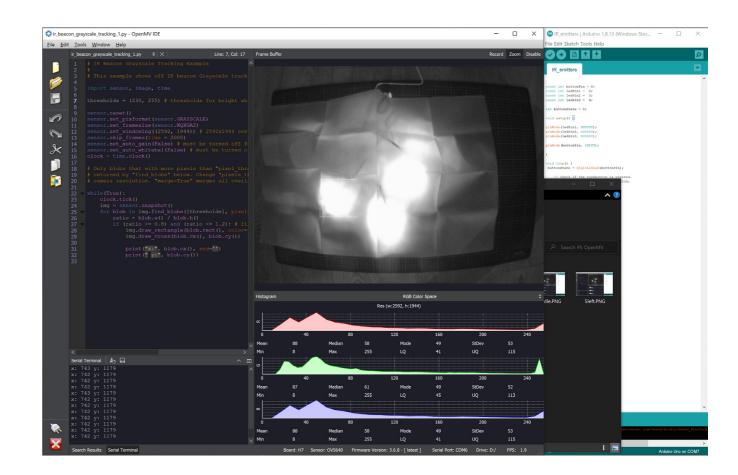


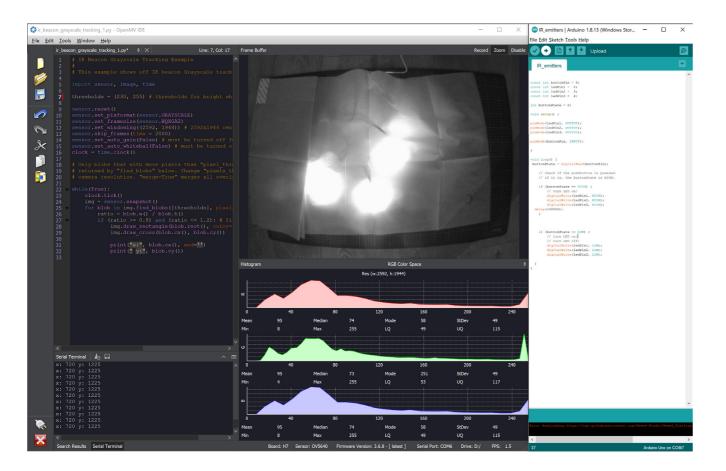






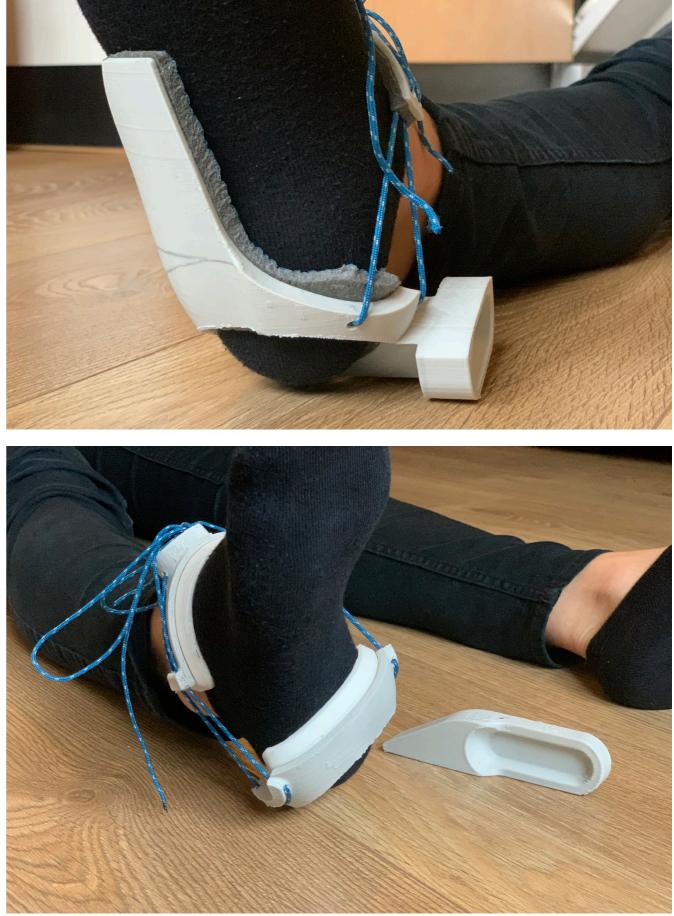




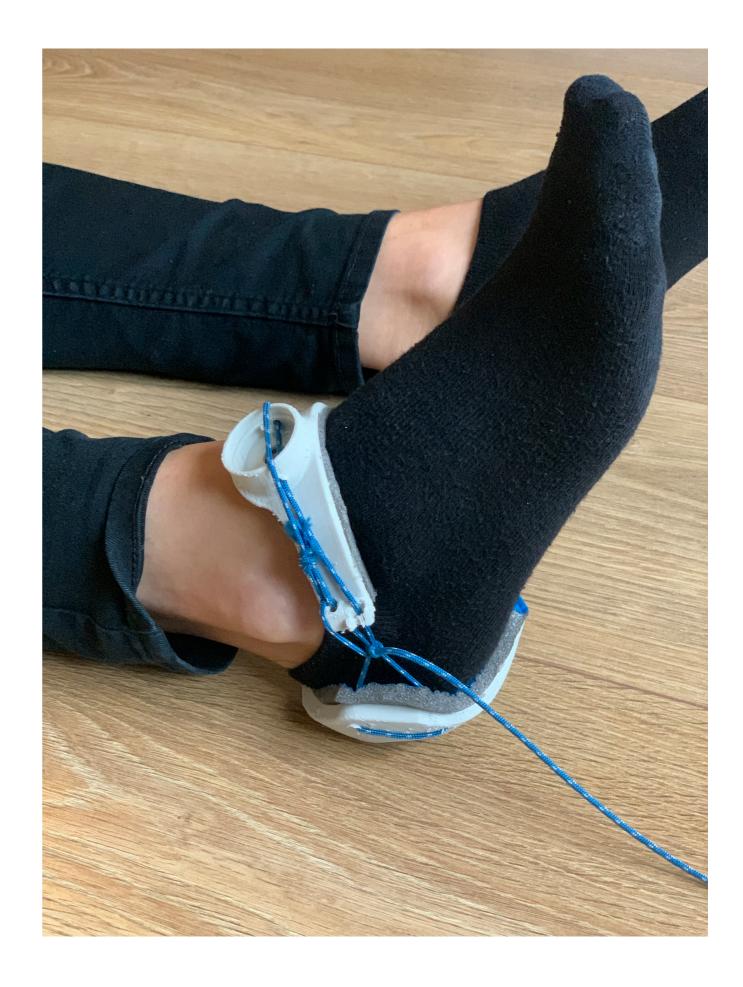


















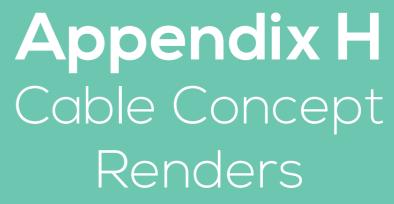


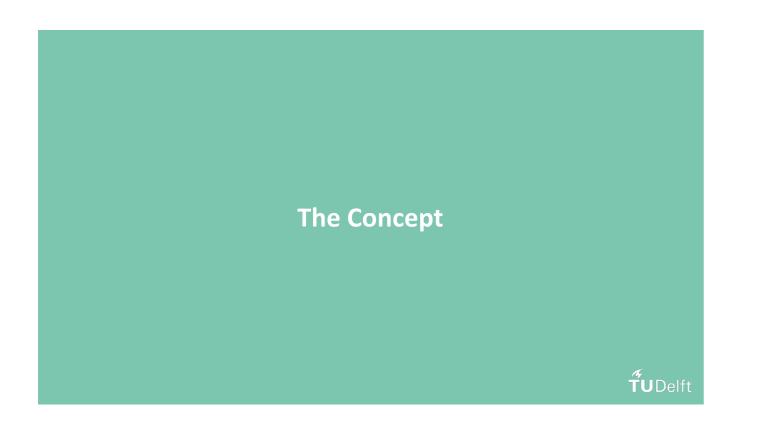












Concept Introduction

Wearable design

 Waterproof
 Sterilisable

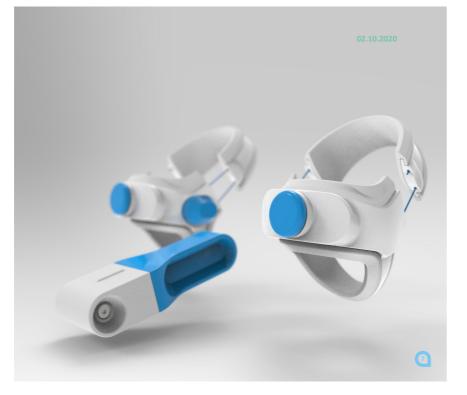
- Minimal surfaces fit



GREEN LIGHT MEETING

Concept Introduction

Wearable design
 Waterproof
 Sterilisable





Concept Introduction

Wearable design
 Waterproof
 Sterilisable

- Minimal surfaces fit

- Maximum workflow flexibility

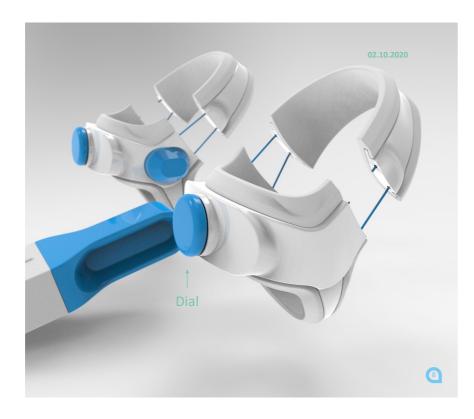






Cup Breakdown

- Cable closure system



GREEN LIGHT MEETING

Cup Breakdown

- Cable closure system

- Arduino Nano 33 BLE

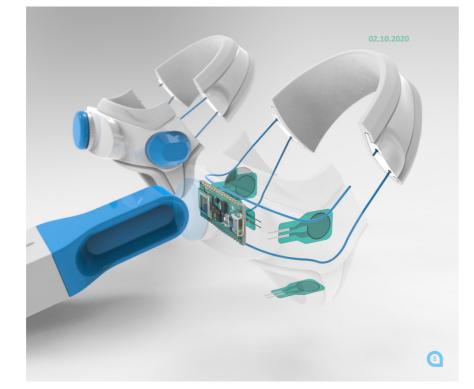
Pressure sensors
 3x Fit control
 1x Heel pressure control

GREEN LIGHT MEETING

CURRENT

Cup Breakdown

- Cable closure system
- Arduino Nano 33 BLE
- Pressure sensors



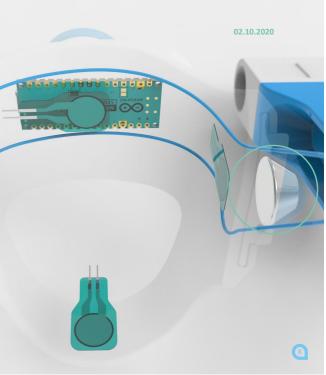
GREEN LIGHT MEETING

Cup Breakdown

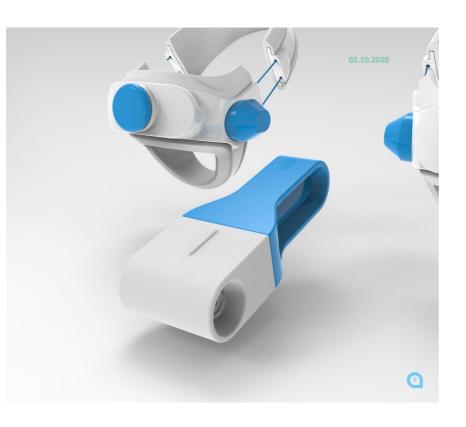
- Cable closure system
- Arduino Nano 33 BLE
- Pressure sensors
 3x Fit control
 - 1x Heel pressure control
- Positioning Magnet







Key Breakdown



GREEN LIGHT MEETING

Key Breakdown

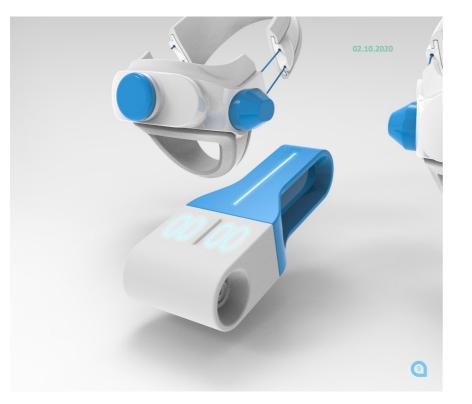
Oled Screens
 Grayscale Oled
 Blue Oled

- Arduino Nano 33 BLE

GREEN LIGHT MEETING

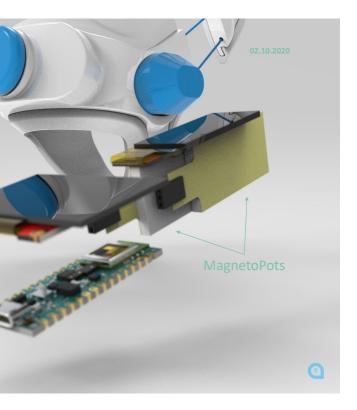
CURRENT

Key Breakdown









CURRENT

Key Breakdown

- Oled Screens
 Grayscale Oled
 Blue Oled
- Arduino Nano 33 BLE
- MagnetoPot Position Sensing
 Independent heel positioning
 Visual communication
- Magnet Activation



GREEN LIGHT MEETING

Usage Breakdown

Shape embodied intelligence
 Self aligning

GREEN LIGHT MEETING

CURRENT

Key Breakdown

- Oled Screens
 Grayscale Oled
 Blue Oled
- Arduino Nano 33 BLE
- MagnetoPot Position Sensing

 Independent heel positioning
 Visual communication
- Magnet Activation



GREEN LIGHT MEETING

Usage Breakdown

Shape embodied intelligence
 Self aligning
 Perpendicularity ensured

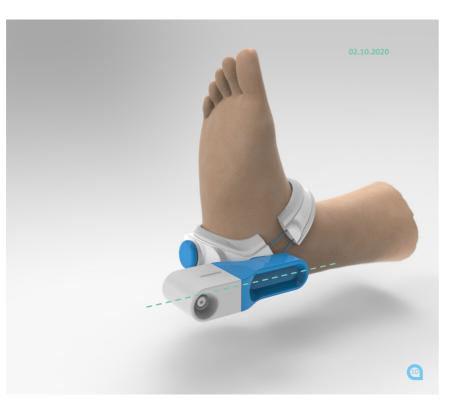




CURRENT

Usage Breakdown

- Shape embodied intelligence Self aligning
 Perpendicularity ensured



GREEN LIGHT MEETING CURRENT

Usage Breakdown

Shape embodied intelligence
 Self aligning
 Perpendicularity ensured

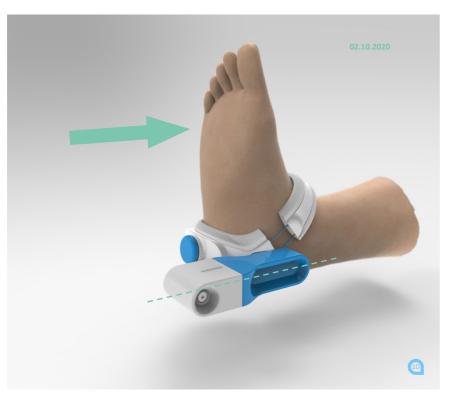
- Precision Mode - Activated by sliding

GREEN LIGHT MEETING

CURRENT

Usage Breakdown

Shape embodied intelligence
 Self aligning
 Perpendicularity ensured



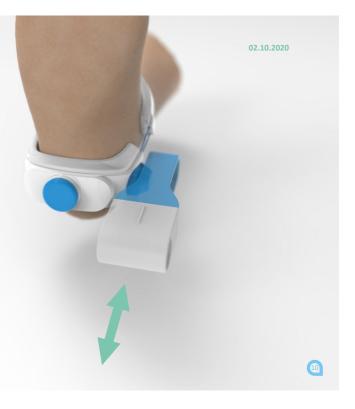
GREEN LIGHT MEETING CURRENT

Usage Breakdown

Shape embodied intelligence
 Self aligning
 Perpendicularity ensured

- Precision Mode - Activated by sliding





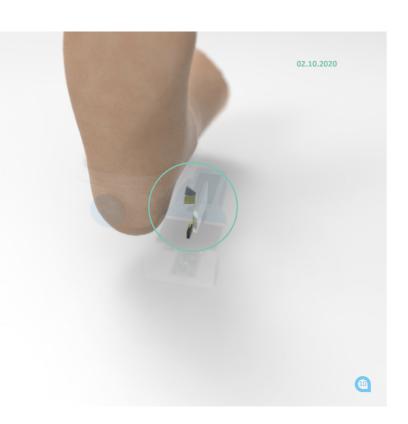
CURRENT

Usage Breakdown

- Shape embodied intelligence
 Self aligning
 Perpendicularity ensured
- Precision Mode

 Activated by sliding
- MagnetoPot Position Sensing

 Independent heel positioning
 - Visual communication



GREEN LIGHT MEETING

To be done

- 3D Modelling (!)
- Final Prototype
- Testing & Evaluating

GREEN LIGHT MEETING

CURRENT

Usage Breakdown

- Shape embodied intelligence
 Self aligning
 Perpendicularity ensured
- Precision Mode

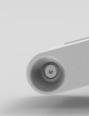
 Activated by sliding
- MagnetoPot Position Sensing
 Independent heel positioning
 - Visual communication

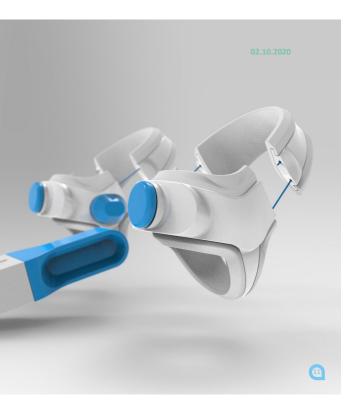


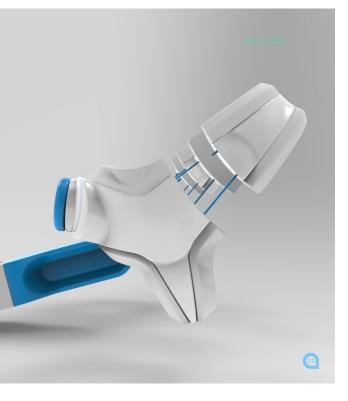
GREEN LIGHT MEETING

To be done

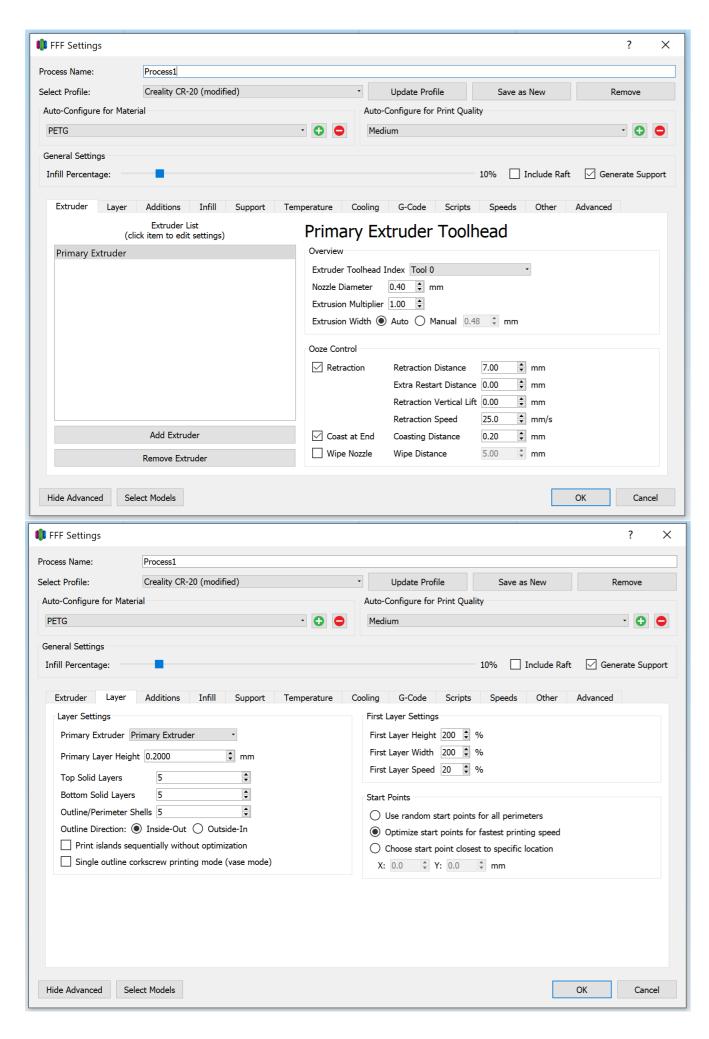
- 3D Modelling (!)
- Final Prototype
- Testing & Evaluating
- Report
- Report Visuals
- Appendix
- Video











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		Remove Setpoint	Fan Overrides		
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		Fan Speed 60 🗘 %	Maximum cooling fan spee	ed 100 🗘 %	
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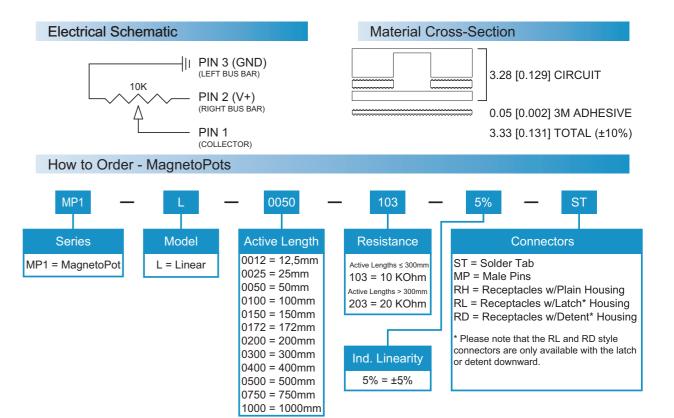




MAGNETOPOT MP1

Features

- Contactless Linear Sensor
- IP64 Debris Proof, Splash Proof
- Ideal for Hydraulic and Pneumatic Position Sensina
- Liquid Level Capability
- Upon request
- Male or Female Nicomatic Connectors
- Corresponding Exterior Magnet



Mechanical Specifications

-Life Cycle: >1 million -Height: ≤3.50mm (0.138") -Actuation Force: 18 grams pull force from

exterior magnet or ferromagnet

Environmental Specifications

-Operating Temperature: up to +85°C -IP Rating of Active Area: IP64

Dimensional Diagram - Stock Linear MagnetoPots

Electrical Specifications

-Resistance - Standard: 10k Ohms (lengths >300mm = 20k Ohms) -Resistance - Custom: 5k to 500k Ohms -Resistance Tolerance: ±20% -Effective Electrical Travel: 8 to 1200mm -Resolution: Depends on the exterior magnet strength and distance to the MagnetoPot -Power Rating: 0.50 Watt continuous, 1 Watt Peak -Dielectric Value: No affect @ 500VAC for 1 minute -Independant Linearity: ±5% (±1% available) -Hysteresis: 3mm*

*Please note that the hysteresis is directly affected by the drive magnet size, strength, and distance from the internal magnet.

 \triangleright

15.748"

16.373" 20.310"

19.685"

100.00mm 150.00mm 171.89mm 200.00mm 300.00mm 400.00mm 500.00mm 750.00mm 1000.00mm 11.811"

12.436"



Crimpflex Solder Tab (ST)









spectrasymbol.com

12.70mm

0.500"

20.32 [0.800]

12.50mm 25.00mm

0.492"

28.36mm

1.117"

D

3.81 [0.150]

ACTIVE WIDTH

0.984"

40.86mm

1.609"

50.00mm

1.969"

65.86mm

2.593"

3.937"

115.86mm

4.562"

5.906"

6.531"



8.24 [0.325]

7.93 [0.312] -

7.874"

8.499"

165.86mm 185.86mm 215.86mm 315.86mm 415.86mm 515.86mm

24.89mn

0.980

6.768"

7.318"

PART LENGTH [P] ACTIVE LENGTH [A]

(888) 795-2283

765.86mm 1015.86mm

39.370"

39.995"

10.16 [0.400] TAIL WIDTH

- PIN 1

TAIL LENGTH [T]

29.528"

30.153"

Crimpflex Short Male Pins (MP)

Crimpflex Female Receptacles with a Plain Housing (RH)

> Crimpflex Female Receptacles with a Latch Housing (RL) *only available with the latch oriented downward

> > **Crimpflex Female Receptacles** with a Detent Housing (RD) *only available with the detent oriented downward

Customization

Customize the size and shape. Such custom requests, for example, can be: custom lengths 10mm-1200mm; custom rotary diameters, etc. Spectra Symbol would be glad to quote your custom application, just contact us at sales@spectrasymbol.com or (888)795-2283.

How It Works

The MagnetoPot is simple, yet elegant in its ability to track motion in a contactless manner. A magnet on the inside of a cylinder, or a magnet on the opposing side of a motion device will guide the built-in magnetics of the MagnetoPot for position location through a potentiometric output.

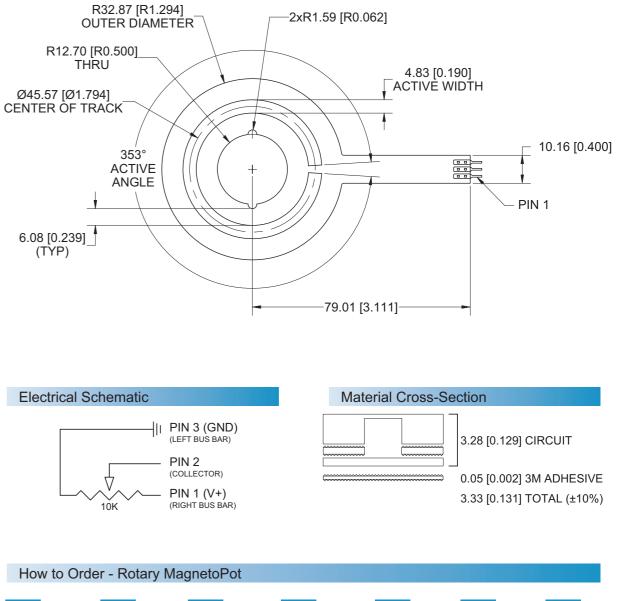
The MagnetoPot is a sealed potentiometer, in the membrane potentiometer tradition, yet it does not require a wiper/actuator to connect the collector and the resistor. Instead, the MagnetoPot is controlled by an outside magnet, which attracts the magnetic forces within the MagnetoPot to connect to the linear resistor and give linear potentiometer feedback.

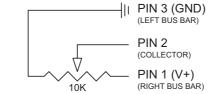
The wiper inside the sealed pot is magnetic or ferromagnetic, and will only perform if connected with an exterior magnet.

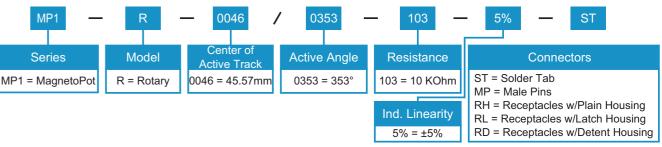
As opposed to a magnetically-based Reed Switch, which gives simply "open" or "close" signals, the MagnetoPot gives the full linear travel of a hydraulic or pneumatic cylinder.

In liquid level applications, the MagnetoPot can attach to the outside of a liquid tank and give position of the magnet inside the float. No water ingress, no wearing of the part by environment, because the MagnetoPot is outside of the tank.

Diagram - Stock Rotary MagnetoPot







Design and Contruction

The MagnetoPot is made of polyester, fiberglass and kapton, depending on the specification required. It functions as a voltage divider, a resistor or rheostat, as desired by the end-user. By bringing the exterior magnet into a proximity necessary to connect with the internal magnetic attractors, the operator can obtain linear position sensing based on the location of the exterior magnet. As the exterior magnet moves, so does the electrical output of the MagnetoPot.

The MagnetoPot should not be mounted to a ferromagnetic surface.

Page 4



Left_unit_user_Button_start_combine___load_cell___motor_small #include "Arduino.h" #include <Wire.h> #include <Adafruit_GFX.h> #include "Adafruit_LEDBackpack.h" #include "Adafruit_DRV2605.h" Adafruit_DRV2605 drv; #include "SparkFun_Qwiic_Scale_NAU7802_Arduino_Library.h" // Click here to get the library: <u>http://librarymanager/All#SparkFun_NAU7802</u> NAU7802 myScale; //Create instance of the NAU7802 class //LED DEFINITION #define LED_MODE 1 const int ledPin = 5; // the number of the LED pin, D3 const int buttonPin = 3; // the number of the pushbutton pin, D4 const boolean breathMode = true; // if or not the led lights as breath mode when it's on // Variables will change: int ledState = HIGH; // the current state of the output pin int ledFadeValue = 0; int ledFadeStep = 10; int ledFadeInterval = 100; //milliseconds int buttonState; // the current reading from the input pin int lastButtonState = 0; // the previous reading from the input pin unsigned long lastDebounceTime = 0; // the last time the output pin was toggled unsigned long debounceDelay = 70; // the debounce time; increase if the output flickers unsigned long lastLedFadeTime = 0; //DISPLAY DEFINITION Adafruit_AlphaNum4 alpha4 = Adafruit_AlphaNum4(); //MAGNETOPOT DEFINITION const int numReadings = 10; // the readings from the analog input int readings[numReadings]; // the index of the current reading int readIndex = 0; int total = 0; // the running total int average = 0; // the average int inputPin = A0; void setup() { //BUTTON SETUP // initialize the LED pin as an output: pinMode(ledPin, OUTPUT); // initialize the pushbutton pin as an input: pinMode(buttonPin, INPUT); //MAGNETOPOT SETUP for (int thisReading = 0; thisReading < numReadings; thisReading++) {</pre> readings[thisReading] = 0; //DISPLAY SETUP alpha4.begin(0x70); // pass in the address alpha4.writeDigitRaw(3, 0x0); alpha4.writeDigitAscii(3, '+'); alpha4.writeDisplay(); delay(200); alpha4.writeDigitRaw(3, 0x0); alpha4.writeDigitAscii(2, '+');

alpha4.writeDigitAscii(3, 'P'); alpha4.writeDisplay(); delay(200);

alpha4.writeDigitRaw(3, 0x0); alpha4.writeDigitAscii(1, '+'); alpha4.writeDigitAscii(2, 'P'); alpha4.writeDigitAscii(3, 'L'); alpha4.writeDisplay(); delay(200);

alpha4.writeDigitRaw(3, 0x0); alpha4.writeDigitAscii(0, '+'); alpha4.writeDigitAscii(1, 'P'); alpha4.writeDigitAscii(2, 'L'); alpha4.writeDigitAscii(3, 'U'); alpha4.writeDisplay(); delay(3000);

alpha4.clear(); alpha4.writeDisplay();

//CELL SETUP Serial.begin(9600); Serial.println("Qwiic Scale Example");

Wire.begin();

if (myScale.begin() == false)

Serial.println("Scale not detected. Please check wiring. Freezing..."); while (1);

Serial.println("Scale detected!");

//MOTOR SETUP

}

drv.begin(); // I2C trigger by sending 'go' command drv.setMode(DRV2605_MODE_INTTRIG); // default, internal trigger when sending GO command

drv.selectLibrary(1); drv.setWaveform(0, 119); // Smooth hum 1 - 50% drv.go(); delay(100);

char displaybuffer[4] = {' ', ' ', ' ', ' '};

void loop() { // read the state of the pushbutton value: buttonState = digitalRead(buttonPin);

// check if the pushbutton is pressed. If it is, the buttonState is HIGH: if (buttonState == LOW) { // turn LED on:

digitalWrite(ledPin, HIGH);

```
//turn MAGNETOPOT on:
// subtract the last reading:
 total = total - readings[readIndex];
// read from the sensor:
 readings[readIndex] = analogRead(inputPin);
// add the reading to the total:
 total = total + readings[readIndex];
// advance to the next position in the array:
 readIndex = readIndex + 1;
// if we're at the end of the array...
 if (readIndex >= numReadings) {
// ...wrap around to the beginning:
   readIndex = 0;
// calculate the average:
 average = total / numReadings;
// send it to the computer as ASCII digits
//Serial.println(average);
 int distance = map (average, 20 , 990 , -290 , +210);
// float distance2 = distance / 10;
// Serial.println(distance);
 const float distance1 = -25;
 const float distance2 = 300;
 float distance3 = distance1 + ((distance2 - distance1)* average /1024);
//Serial.println (String(distance3) + "mm");
//Serial.println(readings[readIndex]);
 int distance4 = distance3;
 if (distance4 <= 0) {
 distance4 = distance3 * 0;
int thousands = (distance4 % 10000) / 1000;
int hundreds = (distance4 % 1000) / 100;
int tens = (distance4 % 100) / 10;
int ones = distance4 % 10;
 //turn DISPLAY on
// display MAGNETOPOT readings,
// alpha4.writeDigitAscii(0, thousands + '0');
// alpha4.writeDigitAscii(1, hundreds + '0');
// alpha4.writeDigitAscii(2, tens + '0', true);
// alpha4.writeDigitAscii(3, ones + '0');
   alpha4.writeDigitAscii(0, hundreds + '0');
   alpha4.writeDigitAscii(1, tens + '0', true);
   alpha4.writeDigitAscii(2, ones + '0');
   alpha4.writeDigitAscii(3, '+');
   alpha4.writeDisplay();
 delay(100);
                    // delay in between reads for stability
```

```
//turn LOAD SYSTEM on
   long currentReading = myScale.getReading();
 int tareReading = ((-132000)-(-123000))/435;
 int weightReading = (currentReading-(-122000))/tareReading;
 if (weightReading > 4000) {
   Serial.print("Weight Reading: ");
   Serial.println(weightReading);
```

ł

```
else{
Serial.print("Weight Reading: ");
Serial.println(weightReading);
drv.selectLibrary(1);
drv.setWaveform(0, 106); // transition ramp up long smooth 1 - 0 to 50%
drv.go();
```

```
}
```

