PROSthesis

An open source parametric prosthesis design
for digital fabrication

Task Clarification

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20278241

DEFINING DISABILITY

Giving form to the visual language of disability

“Disabilities is an umbrella term, covering impairments, activity limitations, and participation restrictions. An impairment is a problem in body function or structure; an activity limitation is a difficulty encountered by an individual in executing a task or action; while a participation restriction is a problem experienced by an individual in involvement in life situations.

Thus disability is a complex phenomenon, reflecting an interaction between features of a person’s body and features of the society in which he or she lives.”

UN World Health Organisation

Simplified, as I understand it, this definition states that disability exists as a spectrum. One that we all experience, and exist upon, to some degree. And our experiences of these disabling effects are a result of the interaction between the features of our body, and that of our environment.

For example; even for those of us with ‘good’ hearing can suffer disability of hearing in a noisy environment such as a bar. It is interesting to approach an understanding of disability aids from this perspective. That of inclusion, and not impart the ‘problem’ onto those with the impairment.

In reading this definition by the WHO I am struck by how careful the language is crafted to articulate an inclusive and nuanced definition of the experience of disability.

I am interested in exploring what the aesthetic and visual form language of prosthetic devices is communicating about the experience of physical impairment. And how this same care can be taken to more accurately reflect this experience.

What does a skin coloured prosthesis communicate about the wearers relationship to their impairment?

Homes for “Wounded Warriors”, IDEO

THE SOCIAL MODEL

Moving away from the Medical and Commercial Models of design.

Through this project I hope to challenge the medical and engineering model of prosthesis design. Through introducing design through the social non commercial model of design I hope to create a prosthetic that does not ignore the role that the aesthetics and form of a wearers prosthesis has in defining the wearers disability. To themselves and to others.

To explore how to adapt a social design and fashion aesthetic into medical design. And explore how the user themselves can be involved in the process through automated user defined design. Enabling them to have ownership over this intimate part of their body.

“YOU CANT LOOK AT ME WITH A STRAIGHT FACE AND LABEL ME AS DISABLED. I HAPPEN TO HAVE THIS MINOR CONDITION OF LIMB AMPUTATION... I CLIMB MOUNTAINS FOR GODSAKE.

Hugh Herr, Director of the Biomechanics Group, MIT Media Lab.

Hugh Herr, Director of the Biomechanics Group, MIT Media Lab.

“WHO IS TO SAY THAT PLEASURE IS NOT USEFUL

Charles Eames

“CARING BEYOND THE FUNCTIONAL IMPERATIVE

Jonathan Ive, VP of Industrial Design, Apple

WWII Leg Splint, Charles and Ray Eames

STATISTICS

How many people rely on prosthesis technology to overcome their impairment.

30-54million

WHO estimate of worldwide amputees.

1.7million

amputees in the United States of America.

1 in 200 people

in the United States of America.

185thousand

new amputees in the US each year.

50percent

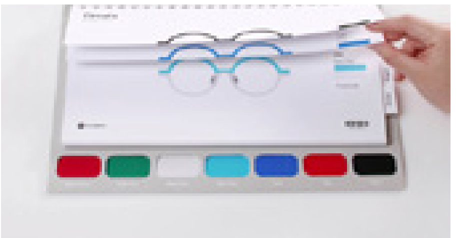
of all amputations are lower limb, below the knee.

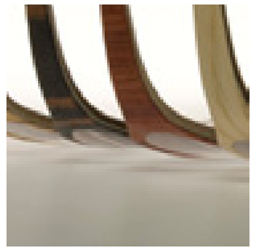
EVERY 3-5 years

a new prosthesis is needed.

> **“ THE NHS BELIEVED THAT PEOPLE WOULD WANT DISCRETION IN THEIR VISION CORRECTION ... THAT NO-ONE WOULD WANT THEIR GLASSES TO STAND OUT. SO THERE WAS ONE FORM OF GLASSES MADE FOR EVERYONE. TODAY, THAT SOUNDS LUDICROUS.** Aimee Mullins

1930’s National Health Service (England) issued glasses. One ‘medical device’ choice for all users. In a problematic ‘flesh’ colour.





Now choice in materials, forms & details is something we take for granted as glasses have moved to an item of fashion.

Augmentation of height, or shock absorption for injury prevention.

Augment memory, vocal ability, sense of direction etc.

MAINSTREAM PROSTHESIS

How did eyewear move from the medical model to the social model of design?

Now seen as a vision impairment. Not a disability. And the assistive technologies that go along with it are now seen as desirable, even for people without vision impairment. In fact 20% of eyewear sold in the United States is sold without prescription lenses. This persists even though perfectly discreet options exist (contact lenses, laser eye surgery).

How can this transition be learned from, and lower limb prosthesis moved away from an aesthetic of tact and discretion. And to one of celebration, expression and fashion.

We use many accessories in our daily lives that augment our physical and mental abilities. That acknowledge and adhere to impairments we may have or perceive to have. We augment our height with high heels, our memory with smart phones, our terrible handwriting with type.

It would be interesting to explore how the styling of these objects can be reflected back into the design of lower limb prosthesis. Recognizing the spectrum of ability to we all live within and seek to augment to some degree.

And perhaps if any technologies and materials can be integrated together. Allowing advances in one area to inform advances in another.

JAIDPUR FOOT ASSEMBLY


Prefabricated vulcanized rubber feet are cut to size by hand to fit in different shoe size moulds.

Various parts of the moulding are painted with rubber sealant.

Different part are taped together and assembled as one.

The sole is assembled in the die .

This is then assembled together with the foot assembly.

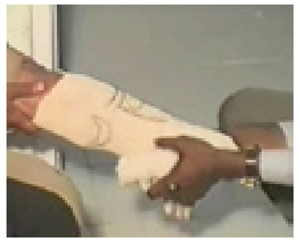
The assembly is then covered with skin coloured rubber.

It is then placed in a die, which is tightened and placed in a vulcanizer for 20min.

The foot assembly is complete.

JAIDPUR LEG ASSEMBLY

Key areas are marked by a trained technician.

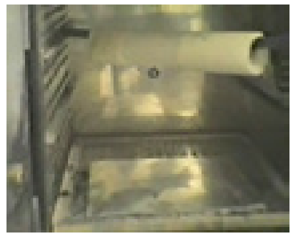


Then wrapped in plaster bandage.

The plaster mold is removed.

The mold is filled with a casting compound. To harden it.

Then carved to the marked specifications made earlier.



A standard PVC pipe is heated.

It is then stretched over the mold to be formed.

Once cooled the mold is knocked loose.

The foot and leg are then fitted on the patient.

PRODUCTION MODEL

How can prosthesis fabrication can fit into the emerging production model of digital design and fabrication? In particular how 3D scanning, 3D printing and generative/parametric form development be used to create better prosthesis.

PROPOSED PROCESS

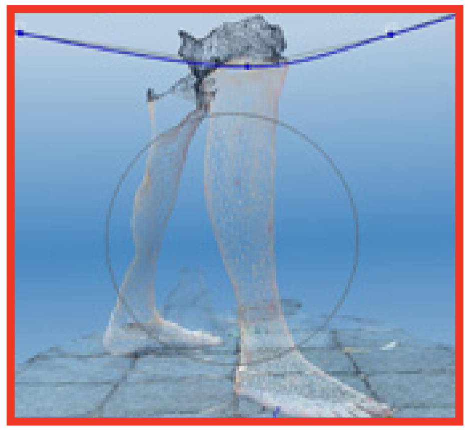
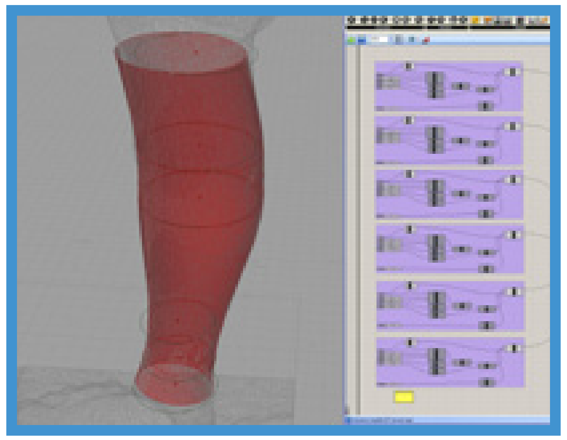
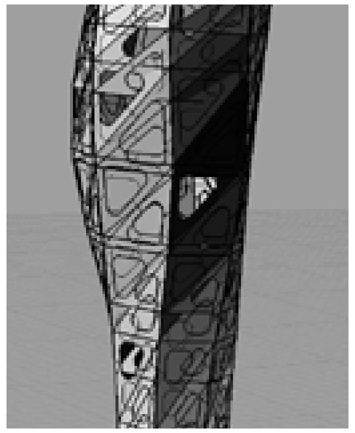


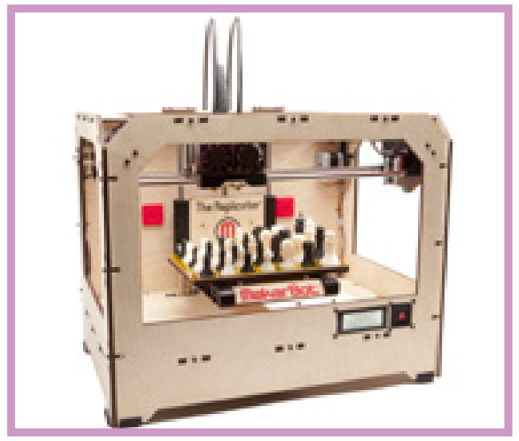
Image based 3d scan of both intact and residual limb is collected.



A parametric model of the new leg is automatically generated to match the cloud scan in key points. This is checked by the trained technician.



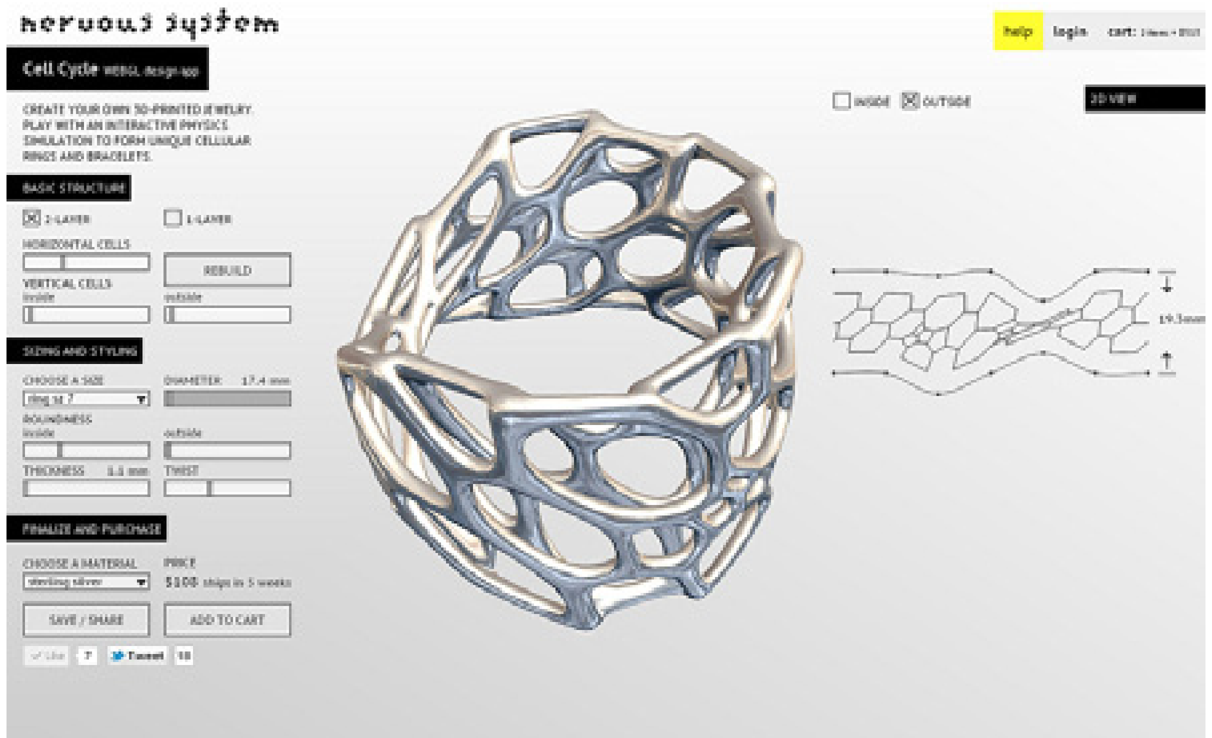
The user is consulted over various parametric surface finish options, as well as material finish options.



Parts are 3d printed from the parametric model.

DESIGNER AS CURATOR

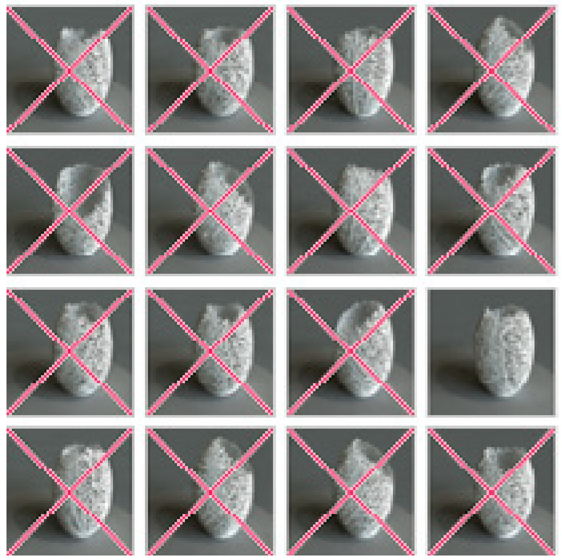
Explore how the user can be involved in the creation of a completely individual object, without the designer.



Nervous Systems, Cell Cycle Ring

A generative system that allows ring type forms to be constructed for 3D printing. A web interface allows the user to define the parameters of the final item. In this system the designer sets up some initial scripting that will give the object form, but leaves many parameters open, relinquishing control of the final form.

I am interested in how forms generated by emergent and generative systems can have a form that is simultaneously biological and digital. A kind of digital machine beauty, an artificial biology. I fell this form language is perfectly placed for medical and assistive technology.



While variation is not determined by the user in this case, the variations are emergent of their own rules. forms differ in infinite ways. Mimicking biological systems.

The Open Prosthetics Project is an online forum attempting to develop and share improvements to components for upper arm prosthesis.

The designer hopes that the growing accessibility of high end open sources fabrication technology such as 3D printers and scanners, the growing access to a worldwide network of information through the internet, and a growing access to shared resources through a worldwide network of fab las, will lead to a more open and global network of knowledge share. Enabling a designer in one part of the world to collaborate with a user anywhere else in the world to develop and change their prosthesis to suit their needs.

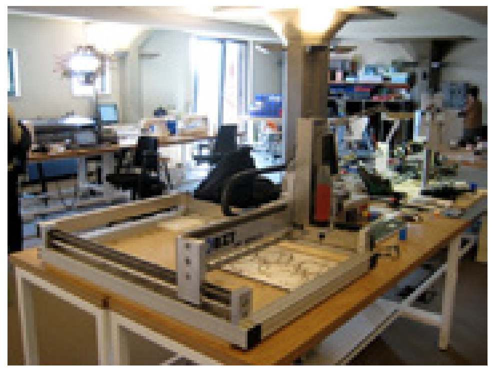
The difficulty of sourcing and transporting parts could also be greatly reduced when the raw material is shipped in efficient bundles and fabricated on site into all the various parts needed. This would be especially useful for travelling prosthesis labs in remote areas. Having parts in stock would no longer be an issue.

A constantly developing model, with huge varieties of change and personalization would give users many options for upgrading and specialising their own prosthesis over time. Currently a completely separate prosthetic must be purchased if the user wishes to wear high heels. The designer imagines that in the near future a high heel foot module could be downloaded in the users specific shoe size, specific to the pitch of the shoe and added to the prosthesis. Enabling the user to wear whatever shoes they wish. Or a separate module for cycling, swimming, running, climbing. All purpose built to optimise the users ability to complete the task at hand.

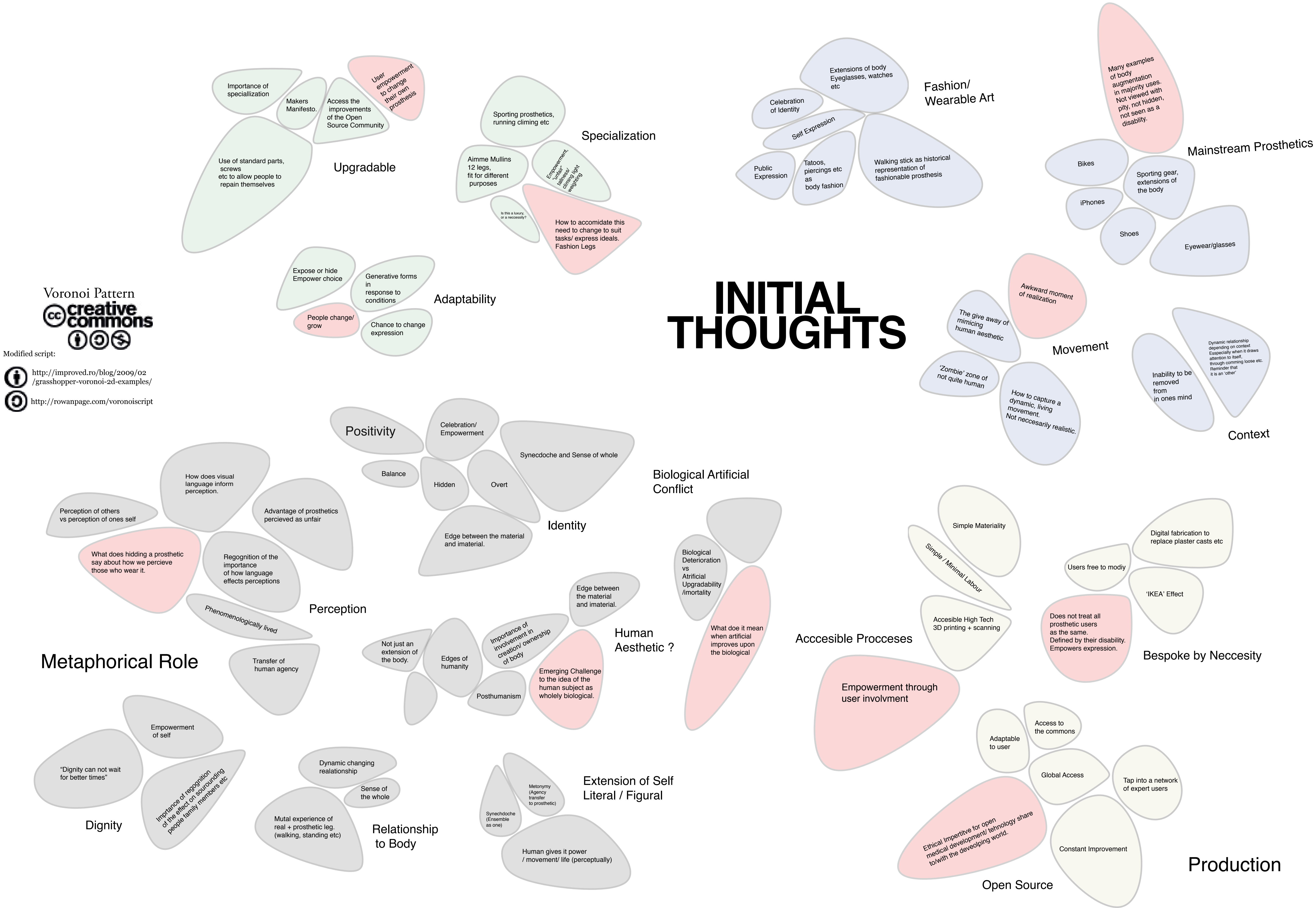
OPEN SOURCE DESIGN

How can the design exist in an open model. Ready to be upgrades, manipulated and improved. Beyond the designers control.

> **“Open design is part of a growing possibilitarian movement. Rooted in information and communication technology. It gives us all the instruments to become the one man factory, the world player operating from a small back room**
>
> Marleen Stikker, Waag Society



INITIAL THOUGHTS



INTERESTING CONTRADIC-TIONS

Vs.

Elegance (Simplicity)	Necessary Complexity of Inclusion
Medical Model	Social Model
Realism	Functionalism
Users	Patients
Biology	Engineering
Frivolous Fashion	Serious Engineering
Body Issues	Object Issues
Disability	Ability
Design	Hidden
Personal Experience	Others Experience
Craft	Mass Production
Confidence	Hidden
'The' Prosthetic (Object)	'My' Prosthetic (Relationship)
Tact	Embrace
Material	Metaphorical
Literal	Figurative
Alive (Perception)	Object (Reality)
Metonymy	Synecdoche
Perception of self	Perception of 'others'

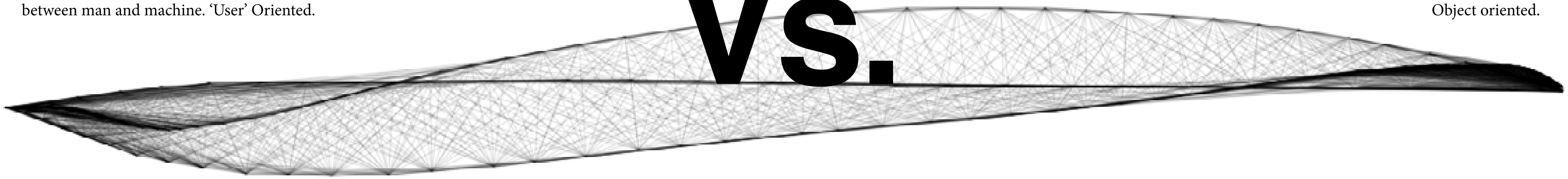
METAPHORICAL ROLE

Phenomenologically interesting object. Intersection between man and machine. 'User' Oriented.

Vs.

FUNCTIONAL ROLE

The functional imperative. Engineered performance. Object oriented.



PROCESS FLOWCHART
SEMESTER ONE

Objectives

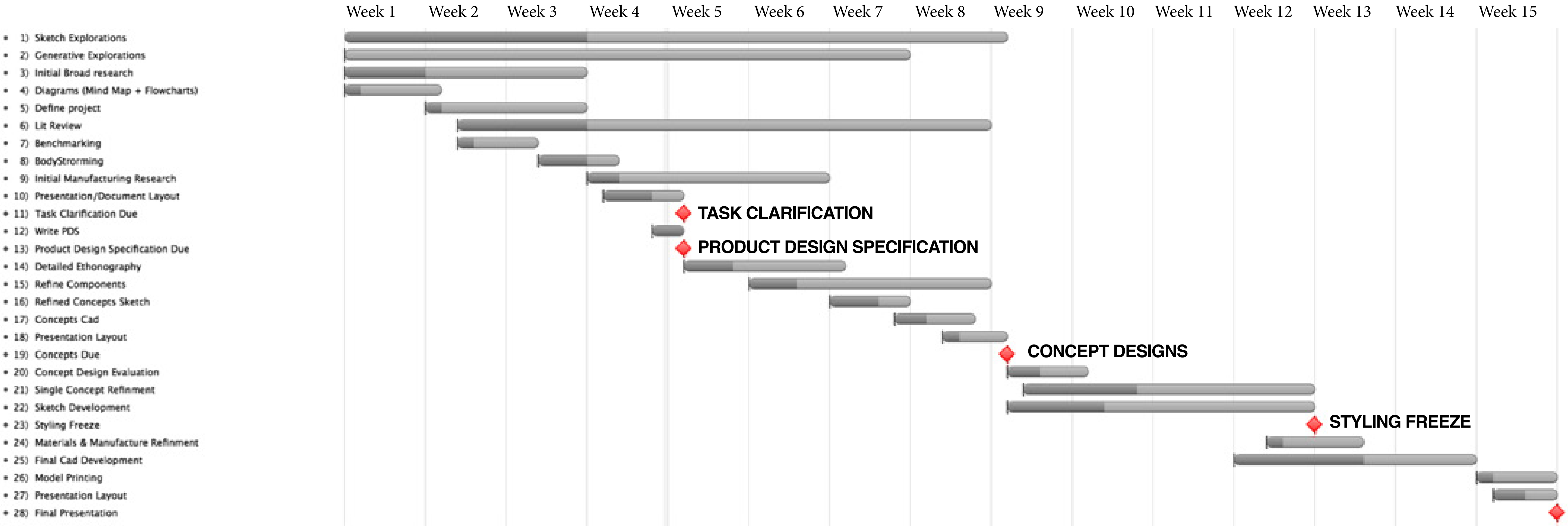
- Explore and understand the current offerings in prosthesis
- Understand peoples relationships to their own and others prosthesis
- Explore generative design, and the users role within this
- Explore digital fabrication technologies and open source methodologies
- Challenge the medical and discretion based aesthetic of prosthesis design
- Produce a proof of concept model

Methodology

Analyse the major high end, high tech prosthesis Analyse the major prosthesis available in the developing world Explore the means by which both sets are constructed Analyse the way they serve their users, both functionally and in the relationship they create. Identify opportunities to improve the process of construction, and knowledge share between Developing world and developed world.	Perception, Web, and Sunrise to Sunset Diagrams Journal Articles, Construction Instructions for current open sourced prosthesis. Construction Standards Ethnographic Research, Interviews with users, Talks given by prosthesis users. User complaints Research into modern production methodologies, Journal Articles, Maker Movement, Explorations into using and analysing emerging open source technologies.
Conduct detailed ethnographic research	Contact centres for prosthetic research in Melbourne. Arrange interviews if possible with prosthesis users in addition to those who make, fit and design the prosthesis. Prepare 'sensitizing packs' to continue the research into the home. If possible.
Understand the physiology and functional requirements of a leg	Anthropometric research. Cloud scanning of physical legs. Sketching, Movement Observation.
Explore digital design techniques	Building experimental parametric 3d generative models in Grasshopper, Maya, Processing Exploring sketching scripts for concept generation. Using and contributing back to the commons. Blogging results. Research into growth and methods to inform generations. of form.
Explore digital fabrication technologies	Explore 3D scanning as an alternative to casting methods. Use a Makerbot 3d printer to explore and understand 3D printed forms. Journal research and forum research into emerging design methodologies.
Produce 3 viable design concept directions	Identify the key components of the prosthesis. Identify if any of these will be off the shelf modular components, Investigate how they can be fabricated and designed digitally. Sketching Cad development of surface patterning and form explorations Explore different fabrication and usage scenarios.
Refine single direction	Define the components used and finalize packaging. Define how components will be produced. Design the surfaces of the model. Define the parameters for editing. Define the type of generations that will be explored to complete the final model.
Proof of concept model	3d printed components. Using makerbot. At 1/2 scale or bigger. Approximation of generations, and illustration of parametric nature.

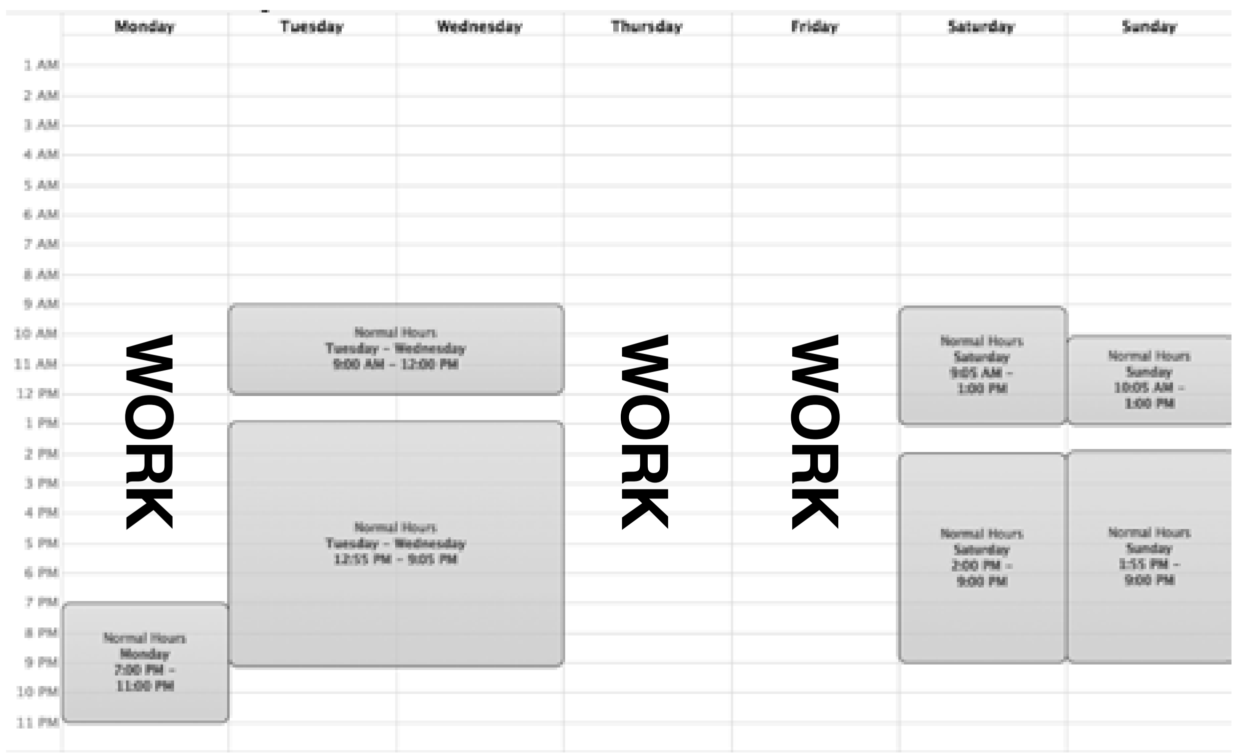
PROJECT MANAGEMENT

Major deadlines and tasks to complete this first phase of the project. Up to proof of concept soft model.



Dark shaded areas represent the amount of days work to complete each task. Light shaded areas represent the length of time available to complete the task within.

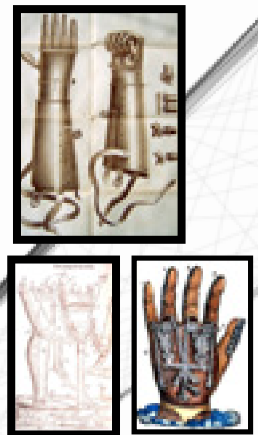
Maximum amount of time per week/ pockets of time that can be realistically dedicated to the completion of the thesis.



SUNRISE TO SUNSET

Tracking major milestones in prosthesis development.

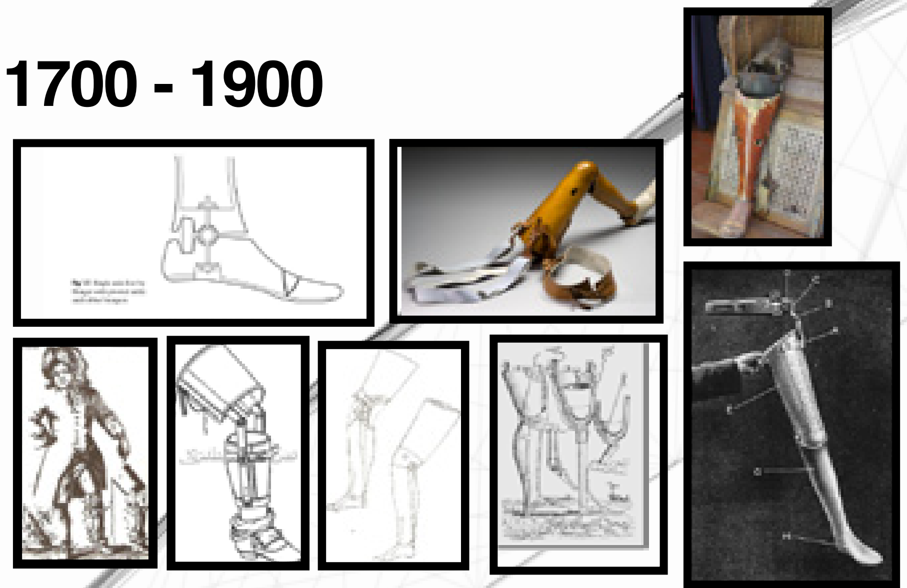
ANCIENT



RENAISSANCE (15th Century)

Interesting materiality (soft leathers, golds, bronze) and sculptural forms, complex clockwork gear mechanisms.

1700 - 1900



POST WWII

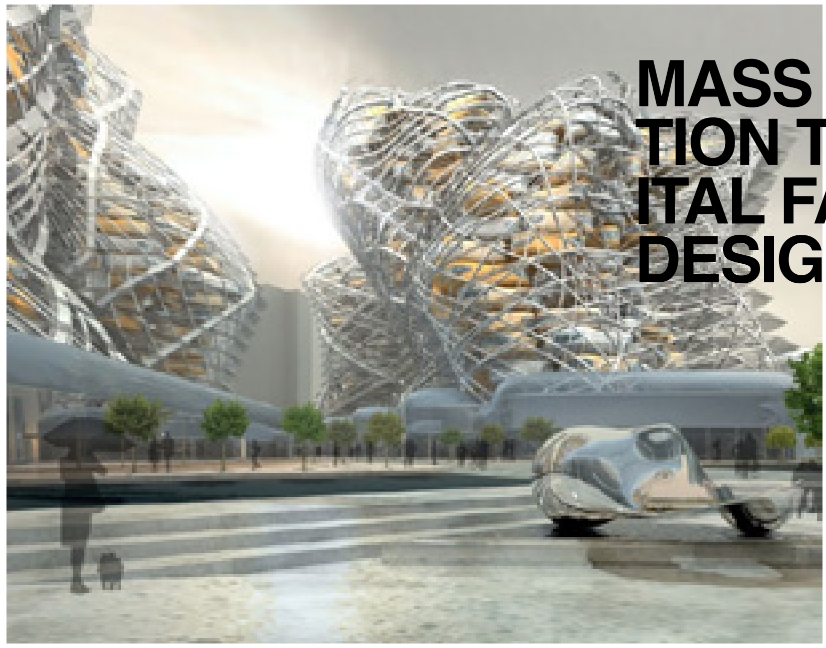
A large leap forward in development following the war. Prosthesis at this point are very similar to the average non computer controlled prosthesis of today.

CURRENT (DEVELOPED)

Another wave of innovation. High end and light weight composite materials are introduced, along with computer controls and miniaturized electronic systems.

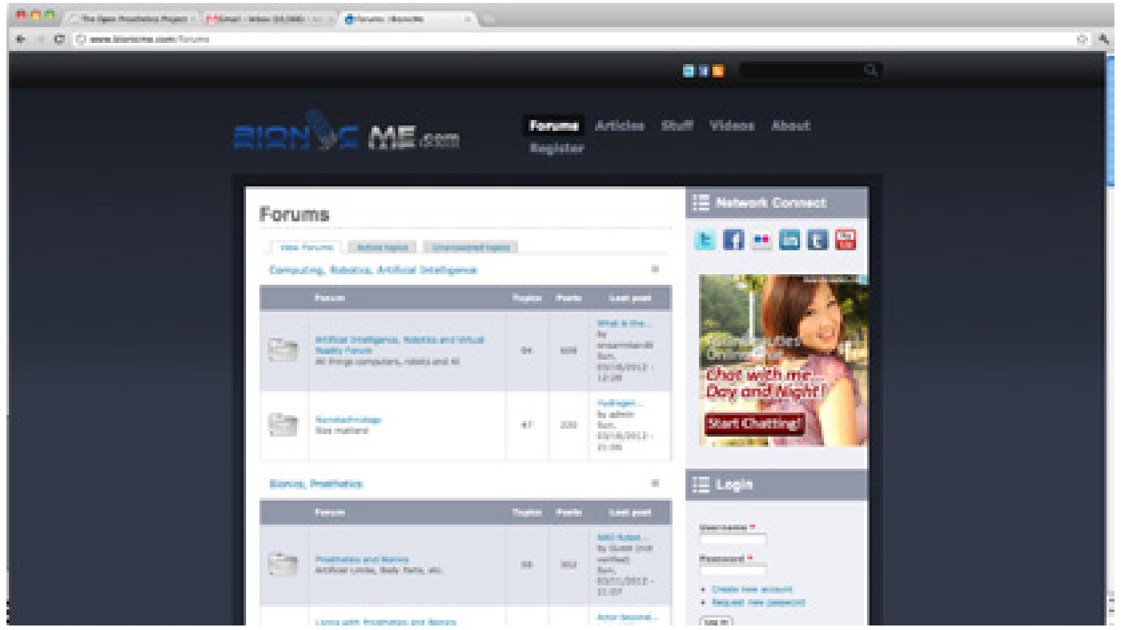
CURRENT (DEVELOPING)

Wide variety of interesting solutions of varying quality. Leading devices like the Jaidpur leg employ many of the same manufacturing methods of high end (non computer controlled) prosthesis, yet simplified and using more accessible materials.



MASS CUSTOMIZATION THROUGH DIGITAL FABRICATION & DESIGN

ONLINE FORUMS



INTEREST IN EQUITABLE PROSTHESIS

HIGHLY COMPLEX ELECTRONIC SYSTEMS

TRENDS

Some emergent trends within prosthetic development over the last 5 -10 years.

A growing trend toward personalization and expression in prosthetics. This can be seen in Otto Block offering hydrographic printing on their sockets (and the growing popularity of this among users). And also in the custom designed fairings of Bespoke Innovations. With custom materials, forms and surfaces.

This could perhaps be seen as a subset of a growing trend in design towards complexity, user empowerment and service design.

As the trend in mass produced items moves towards a very mass produced aesthetic (Apple etc) more aesthetic contrast is appearing in bespoke goods. A rebirth of the arts and crafts movement.

Leading people to have a balanced of very quite mass produced items, and very expressive individual items. Prosthesis are the definition of individual items.

Architecture and housing is the key area we are starting to see the emergence of digital technologies allowing powerfully complex expression.

PERSONALIZATION

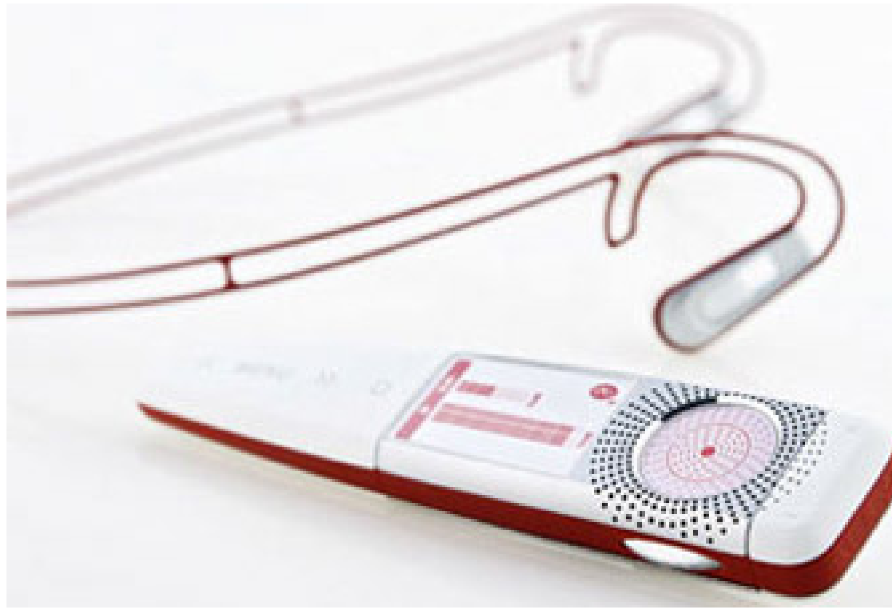
DESIGN PRECEDENT

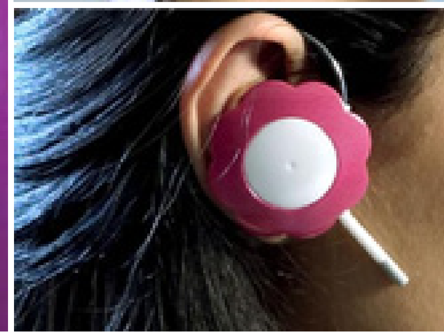
A collaboration between the Royal National Institute for Deaf People, the Victoria and Albert Museum and many leading design studios asks the question; "Could hearing aids become as fashionable and desirable as glasses?"

The diversity of responses, and the variety of issues they respond to, provides an interesting starting point to explore the intersection of art, design, and disability. And to understand the powerful role design can play in assistive technology.

The first interesting areas arise out of these products; The first being a rejection of the pursuit of tact and hidden disability by all the designers. The second, that the miniaturization of hearing aids in pursuit of this hidden aesthetic impacts their function. All of these devices pursue a size more appropriate for including adequate technology, while also expressing the fact the user is wearing an assistive device. And the final area of pursuit is into how the assistance provided by hearing aids could be celebrated beyond mere replication of human hearing. The goldfish allows recording and playback of sound, the 'corono' by tangerine allows the user to define a field of hearing blocking out conversations in the distance or in the foreground.

Visual form is also important in communicating the function of these devices. Ross Lovegrove's 'the beauty of inner space' attempts to communicate difference between being open to communication vs the closed to communication traditional headphones would, while also exploring the importance of materiality.





HEARWEAR

RNID, V&A Museum, Various Design Studios

TABLETALK

IDEO, HearWear Project, RNID

DESIGN PRECEDENT

TableTalk by IDEO challenges the role of assistive technology as only for repairing disability. Through this it makes reference to disability as a spectrum and as defined by the environment it occurs in, something that impacts us all, and something we can all learn from. It addresses the stigma associated with assistive technology through normalizing it.

By adapting the technology of induction loops, broadcasts of sounds in close proximity (ie a movie) specifically for hearing aids, to a product. The table talk allows a group of friends to hear each other while talking in a loud environment such as a bar. Further exploration into how disability aids can be used in a wider context would not only spur interesting and novel developments that will assist us all, it will also highlight the notion of a spectrum of ability we all live on, the ways environment impacts on these disabilities and help prevent a stigmatizing of disability as an ‘other’.

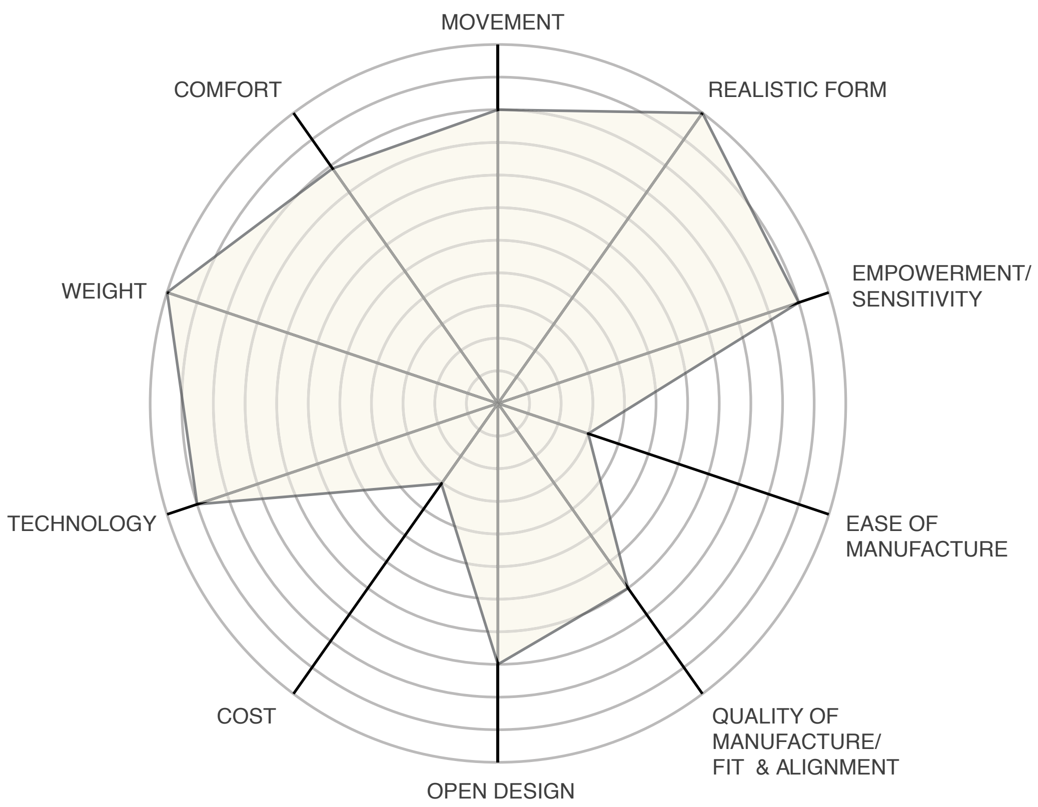
DESIGN PRECEDENTS
STATE OF THE ART

TECHNOLOGY BENCHMARK
C-LEG

ACCESSIBILITY BENCHMARK
JAIDPUR FOOT

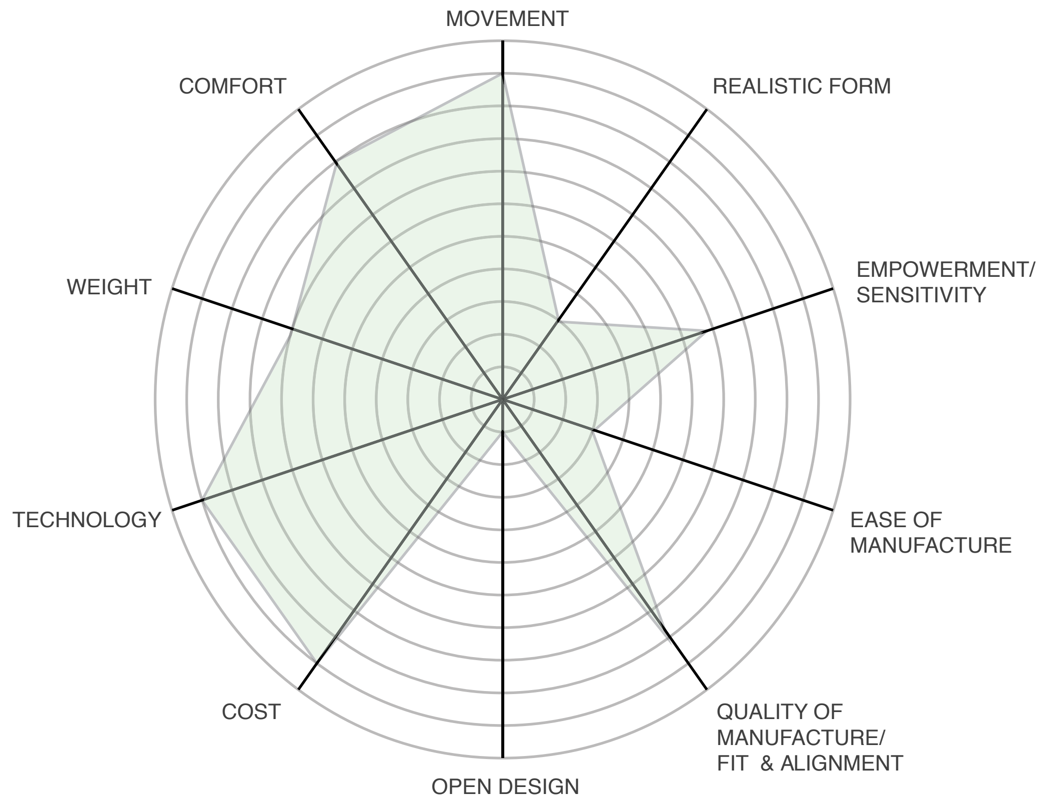
AESTHETIC BENCHMARK
BESPOKE INNOVATIONS

THE HUMAN LEG



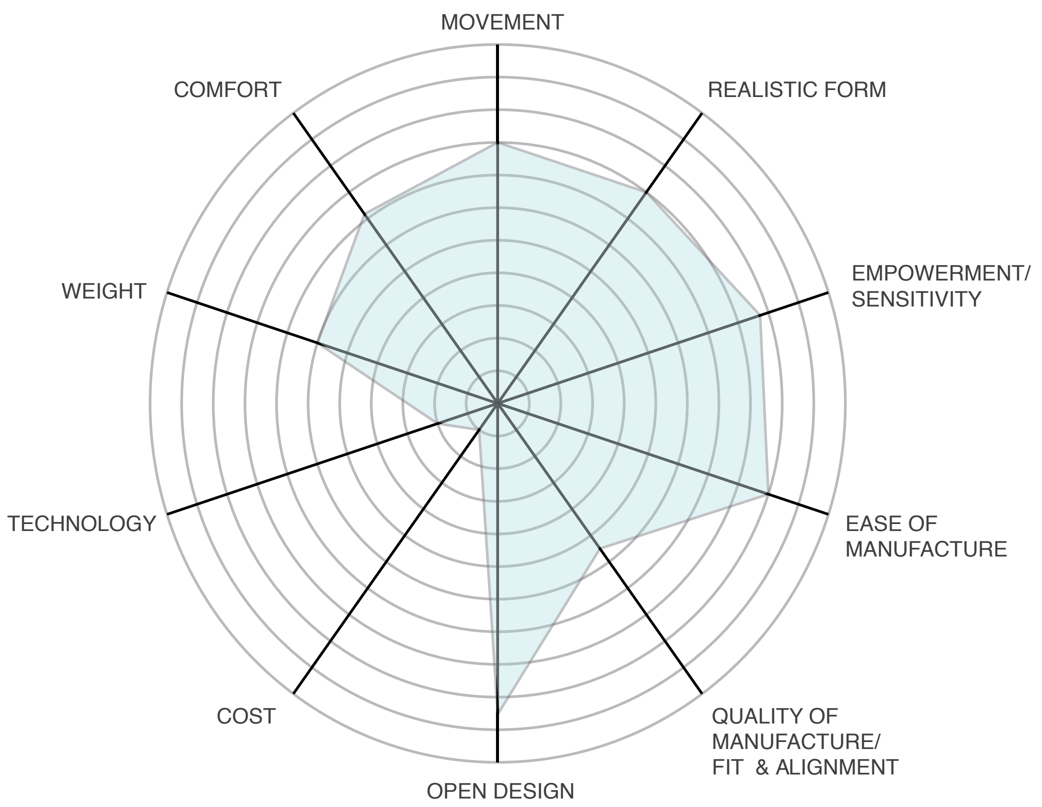
Realistic Form:	The benchmark of realistic form, texture, tactility & complexity.
Movement:	Realistic complex movement, High rate of energy return, susceptible to damage that is extremely difficult to repair.
Empowerment/ Sensitivity:	Captures the nuances of individuality, allows for some self expression (tattoos etc). Yet is difficult to alter and adapt this aesthetic.
Weight:	Heavy, but offset by high energy return.
Ease of Manufacture:	Long complex process, high error rates, extremely difficult to repair.
Quality of Manufacture:	High error rates, difficult to repair (although with some excellent self healing functions) Wears dramatically with time.
Comfort:	Very comfortable. Although repair difficulties result in long term comfort issues for many users.
Technology:	Highly complex system of parts, no electronics or micro processors, but complex calculation and responses.
Cost:	Low initial cost. Yet of extremely high value to users. High cost of repairs.
Open Design:	Unpatented, yet many design details unknown. Not reproducible outside its system of use (yet)

THE C-LEG



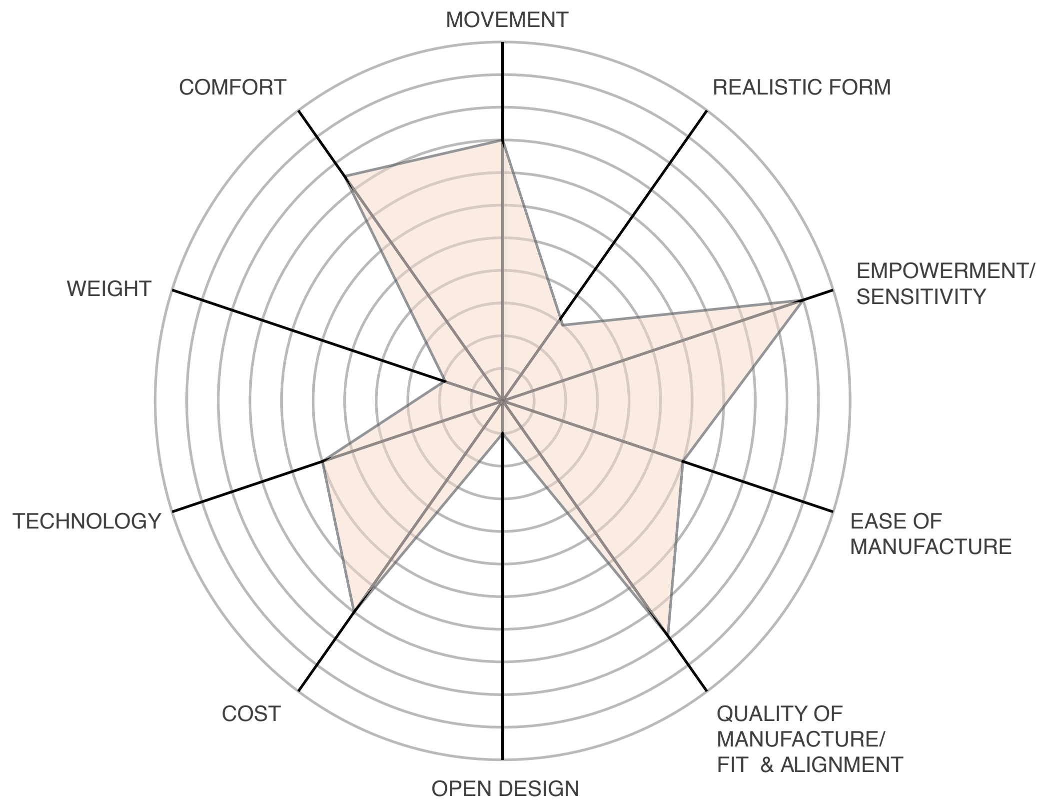
Realistic Form:	Engineered form. Although generic foam covers with silicon skin coatings on them are available.
Movement:	Realistic complex movement, Motors, sensors and microprocessors to create realistic motion.
Empowerment/ Sensitivity:	Generic engineered aesthetic. Allows realistic movement, freeing the user to accomplish more tasks. Not sensitive to individuality.
Weight:	Medium weight, but offset by high energy return.
Ease of Manufacture:	Complex. Many expensive highly miniaturized complex electrical components.
Quality of Manufacture:	High.
Comfort:	Very comfortable. Due to energy return and complex natural movement. No tactile sensitivity.
Technology:	Highly tech prosthesis. The benchmark for technological systems. US Army provides these prosthesis to injured soldiers.
Cost:	Extremely high. $30 000 to $40 000
Open Design:	Patented closed design.

THE JAIDPUR FOOT



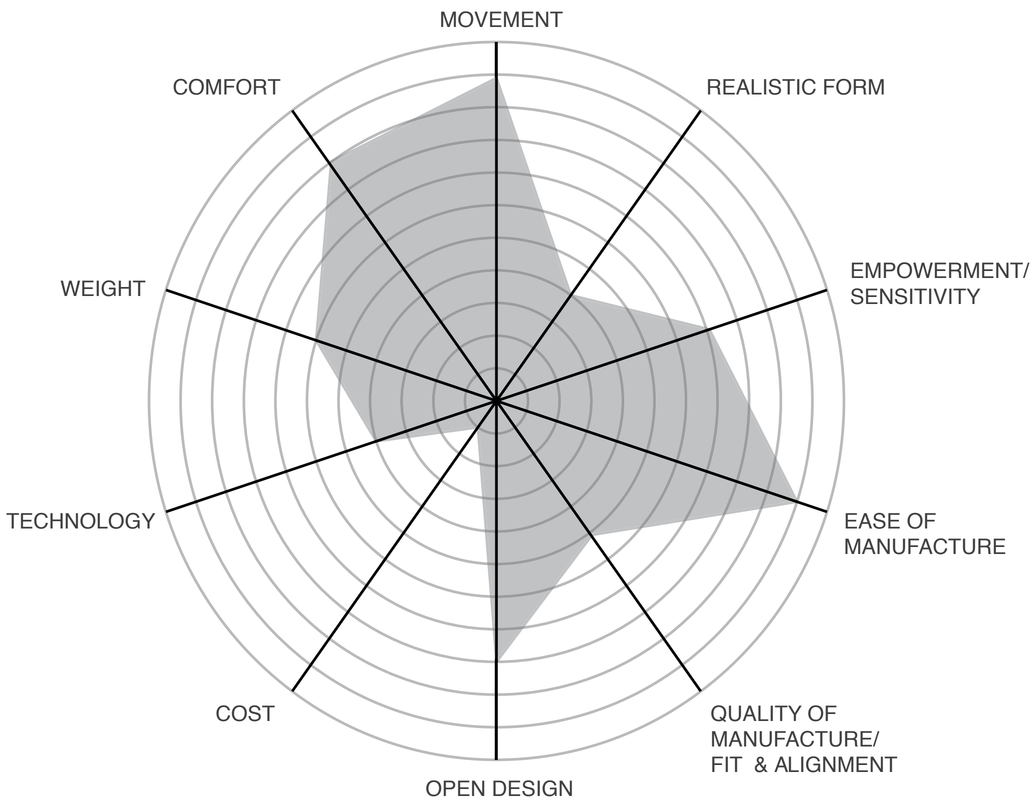
Realistic Form:	Somewhat simple shape, plasticy material, 'skin' coloured.
Movement:	High flexibility of the foot allows for a wide range of movement. And for comfortable walking on uneven ground.
Empowerment/ Sensitivity:	Designed for the specific needs of barefoot walking. Culturally sensitive to context.
Weight:	Average prosthesis weight, yet minimal energy return. Can still be warn for reasonable periods of time.
Ease of Manufacture:	Created for local artisans manufacture with training. 3-4hrs to make each one.
Quality of Manufacture:	Highly variable due to artisan construction, high levels of training needed. Large problems with poor hand made tolerances allow resulting in fit and alignment issues.
Comfort:	Allows for walking comfortably over rough terrain, squatting, sitting. Fit and alignment issues can cause discomfort for users.
Technology:	Low tech, low cost approach.
Cost:	$35 Materials, $100 - $200 Labour
Open Design:	Unpatented. Originally built using modifications to the open source SACH foot.

THE CHEETAH



Realistic Form:	The benchmark of unrealistic form. Reflect their purpose. Direct the conversation into the interesting area of body augmentation & performance.
Movement:	High energy return. Natural movement at speed, yet extremely hard to move at slow speeds, or when still.
Empowerment/ Sensitivity:	Purpose built aesthetic. Celebrates the task. Overt expression.
Weight:	512g (18.1oz)
Ease of Manufacture:	Complex, multiple steps and high end machinery needed.
Quality of Manufacture:	Custom fit & precision construction using robotic arms & milled moulds.
Comfort:	Reaction dampening effect minimises energy use and increases comfort. Not comfortable for low speed use.
Technology:	High technology materials, construction and design. No electronics or complex motors.
Cost:	$18, 000 Each
Open Design:	Proprietary Technology.

MOBILITY for EACH ONE

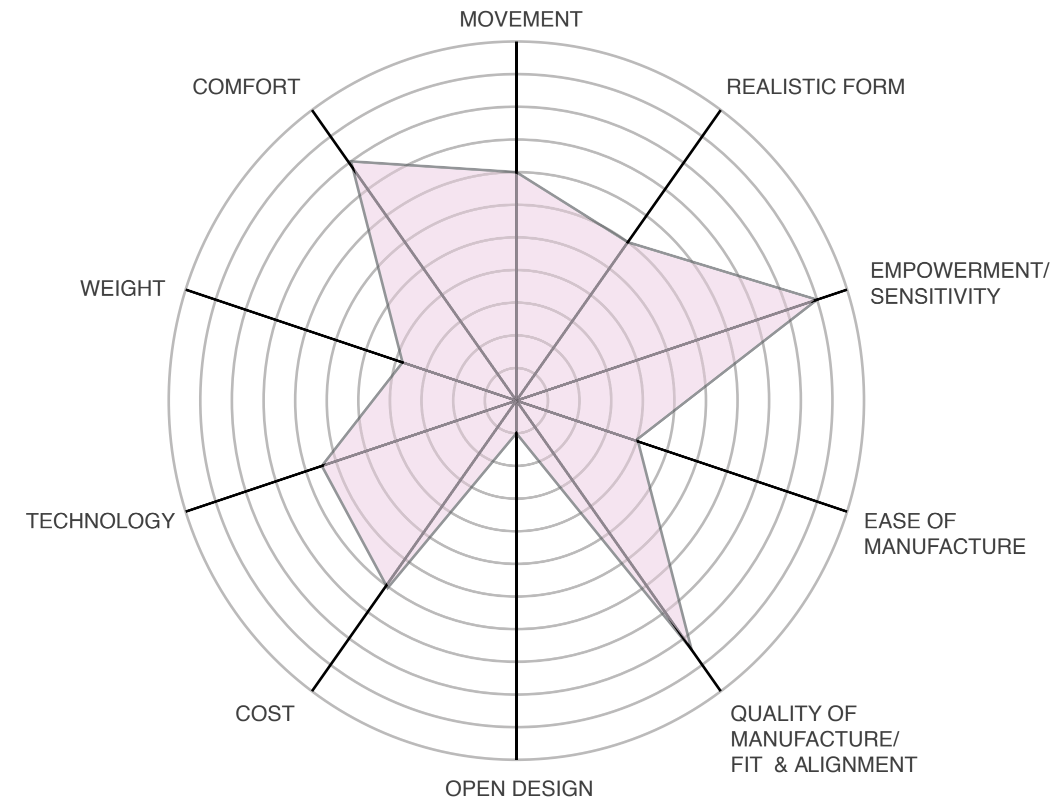


Realistic Form:	Interesting high tech performance aesthetic. Simple fairing for more realistic form.
Movement:	Energy return prosthesis - Spring heel, flexible.
Empowerment/ Sensitivity:	Reduces stress on the user, longer usage periods. High tech look, perhaps not as sensitive to local needs as the jaidpur leg.
Weight:	Low. .
Ease of Manufacture:	Locally made, Low part count. Low variation in materials.
Quality of Manufacture:	May suffer from similar tolerance and alignment issues as the jaidpur leg. Due to hand worked construction.
Comfort:	Light weight and energy return contribute to comfort and long periods of wear.
Technology:	No electronics but high tech materials and energy return.
Cost:	$8 (Concept) Imagine a similar, if not more expensive labour cost than the jaidpur also. $100 - $200
Open Design:	? (Concept)

CONCEPT DESIGN with working prototype

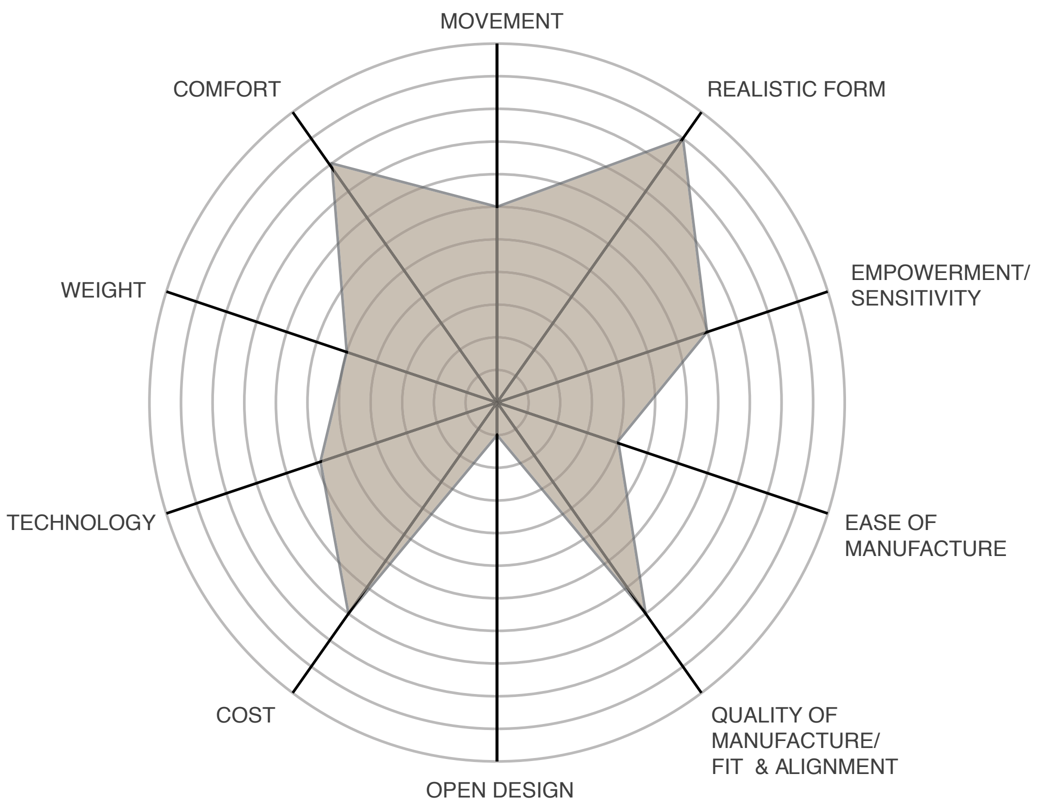
FAIRINGS
visual coverings for prosthesis

BESPOKE INNOVATIONS



Realistic Form:	Built to match 3D scan of matching leg. Non realistic materials/ textures.
Movement:	Coverings work around existing prosthesis. Allow a range of movement.
Empowerment/ Sensitivity:	Purpose built aesthetic. Overt expression. Engages users in the creation of their own prosthetic.
Weight:	Material dependent. Light weight.
Ease of Manufacture:	Complex, each fairing is created and modelled as a one off by a designer.
Quality of Manufacture:	3D printed. High tolerances.
Comfort:	Adds tactility. Variety of materials. Feeling of form.
Technology:	Fairings are 3d printed and laser cut. #D scanning. Yet no electronic technology in the coverings.
Cost:	$4 000 to $6 000 Each
Open Design:	Proprietary Technology.

SUPER SKIN



Realistic Form:	Highly realistic in terms of form and finish. Hair follicles can be added, skin like tactility.
Movement:	Static. ie if calf muscle flexed for aesthetic goals, it remains always flexed.
Empowerment/ Sensitivity:	Promotes the idea of tact. Yet also gives users the choice of an highly realistic prosthetic.
Weight:	Low. But still an additional weight to the prosthesis.
Ease of Manufacture:	Made by hand, formed by the prosthetist by hand out of foam, before covered with the silicon spray.
Quality of Manufacture:	Good quality workmanship. Creator dependent to some extent.
Comfort:	Form of a natural leg. Good tactility.
Technology:	Simple but to a high degree. No additional electronics etc.
Cost:	$2000+
Open Design:	Proprietary

FAIRINGS visual coverings for prosthesis

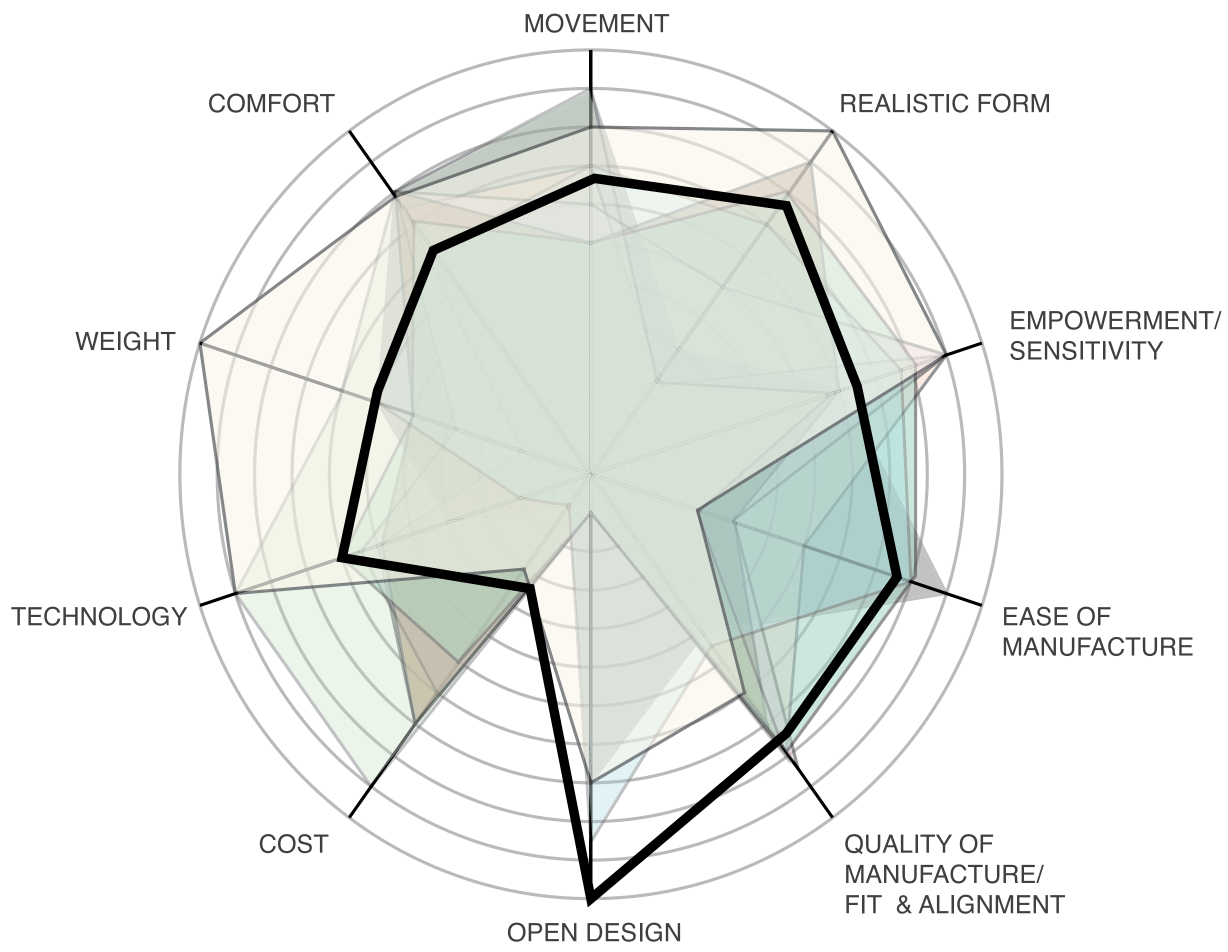
SUMMARY

The designers goal is to achieve something similar to the jaidpur leg. Through this comparison exercise it is been found that the Jaidpur leg offers a great goal in terms of achieving a low and accessible cost point and executing a leg that delivers high functionality at that price point. In terms of movement, function, and functional sensitivity.

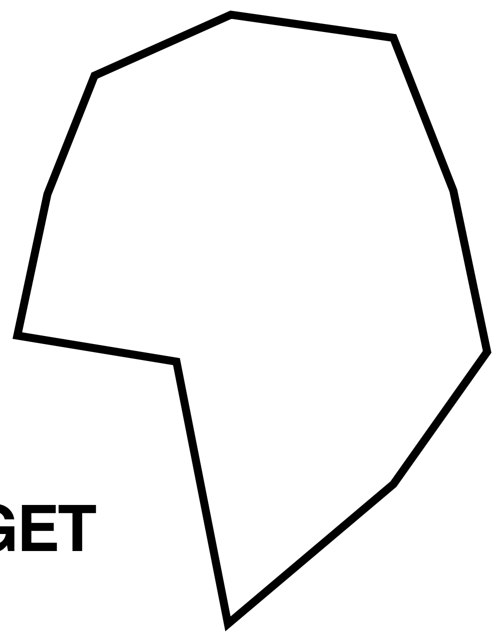
The open design model that Jaidpur is a part of is something the designer wishes to continue to explore an expand upon. And investigate how radical departures from the traditional process can be integrated with the typical developed world process. Similar to how the designers of the Jaidpur leg took the SACH foot and radically changed how it functioned. While mimicking traditional process' in a low cost way to form the body of the leg. In doing this the designer hopes to address some of the alignment and tolerance issues through engaging new digital fabrication tools. And expanding the open collaboration into a transparent, and digital one that the users themselves can engage with. One informed by, and that can inform, the high end prosthetic market.

I also wish to extend the excellent functional sensitivity of the Jaidpur leg into an aesthetic sensitivity that empowers users in the creation of individual forms. And harness this open user generated process to enable the users to tailer the prosthesis to their own needs globally, in a way no one designer could ever hope to understand. Especially one privileged, white westerner with both legs in tact.

The Jaidpur legs powerful accommodation of the barefoot culture of India is surely just one example of how locally driven development can spur meaningful innovation. Providing the tools for this to occur, and illustrating, not dictating, a solution is what the designer hopes to achieve with this project.

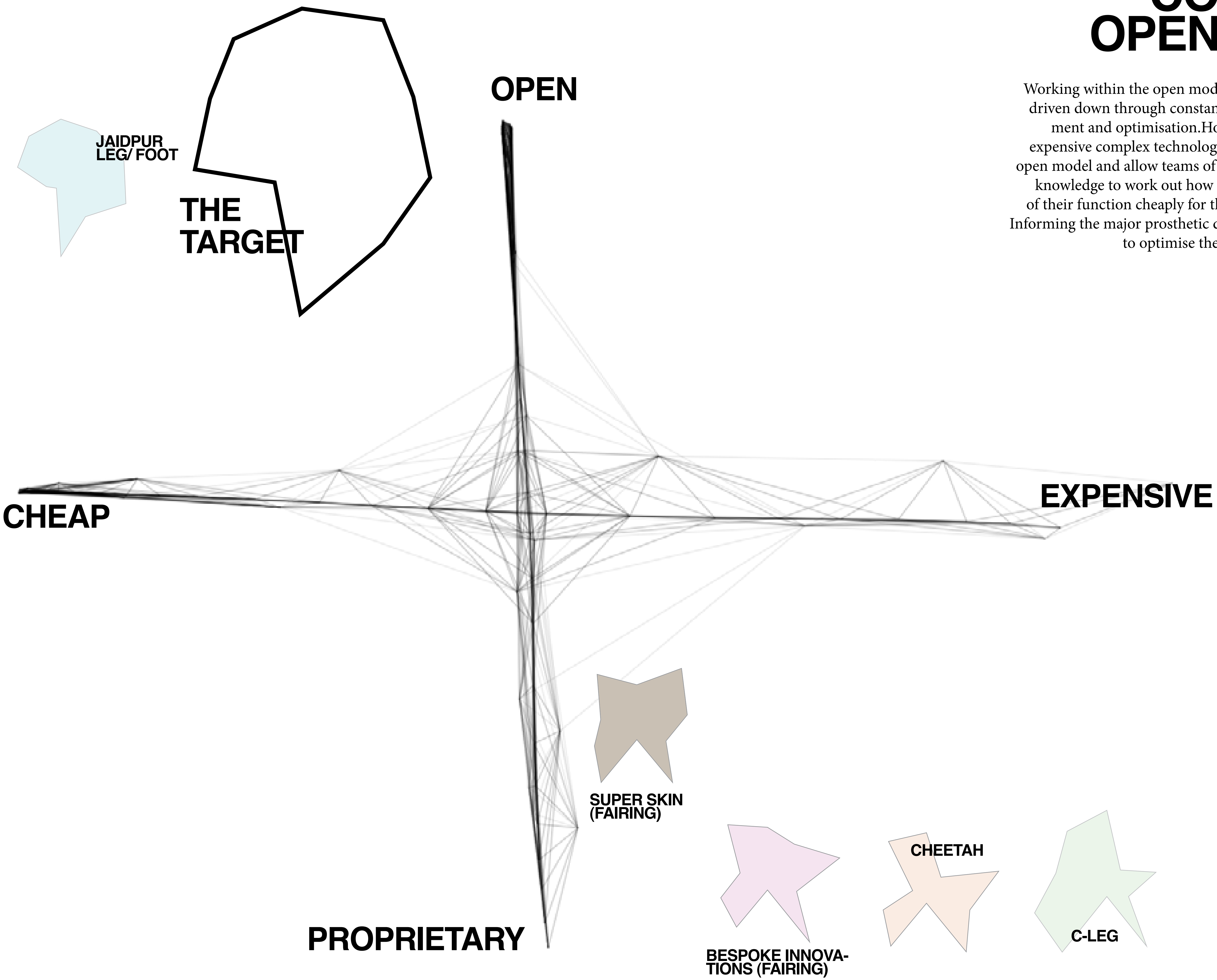


THE TARGET



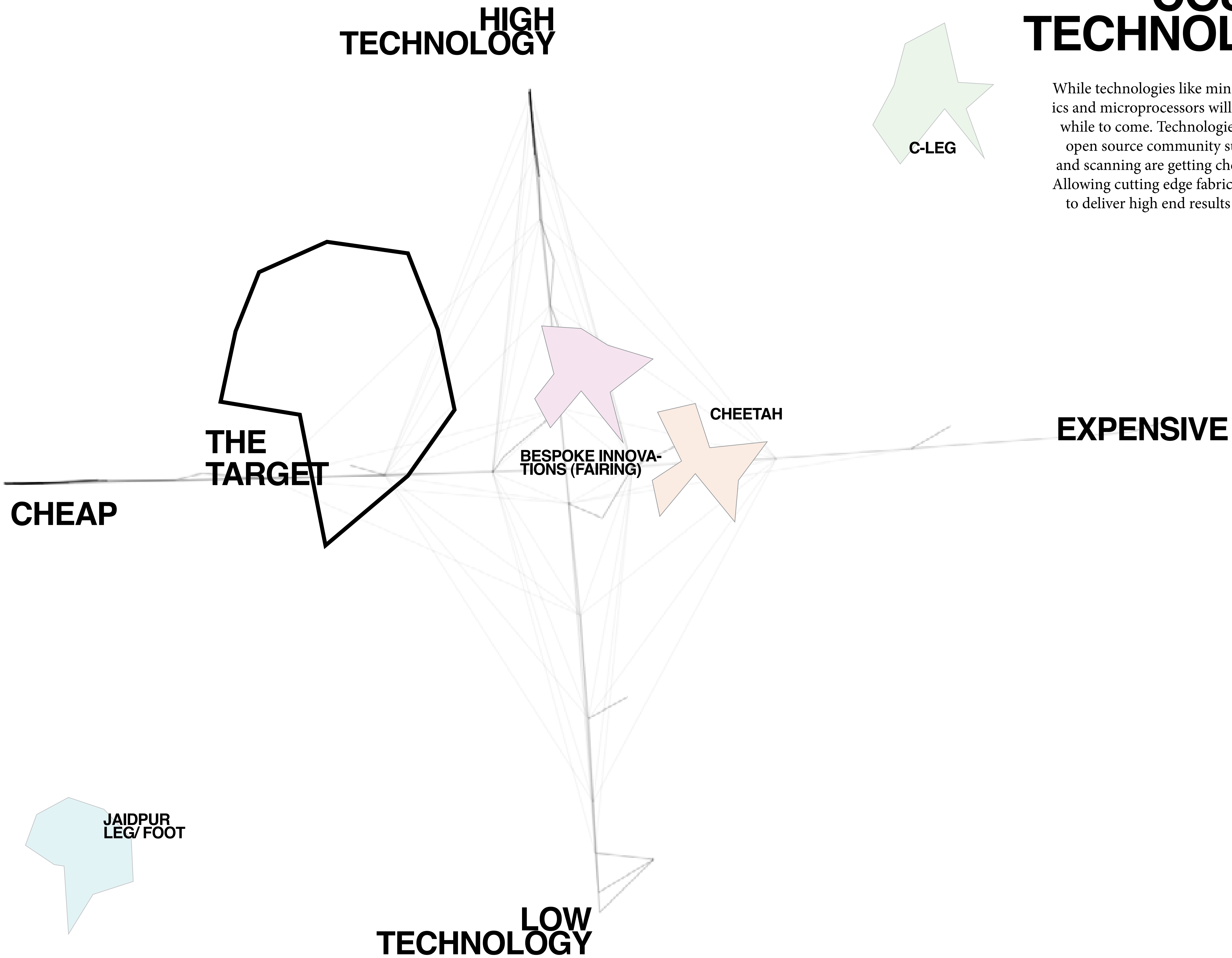
COST Vs OPENNESS

Working within the open model costs can easily be driven down through constant iteration, improvement and optimisation.Hopefully in the future expensive complex technologies with embrace the open model and allow teams of designers to use this knowledge to work out how to replicate elements of their function cheaply for the developing world. Informing the major prosthetic developers with ways to optimise their own technologies.



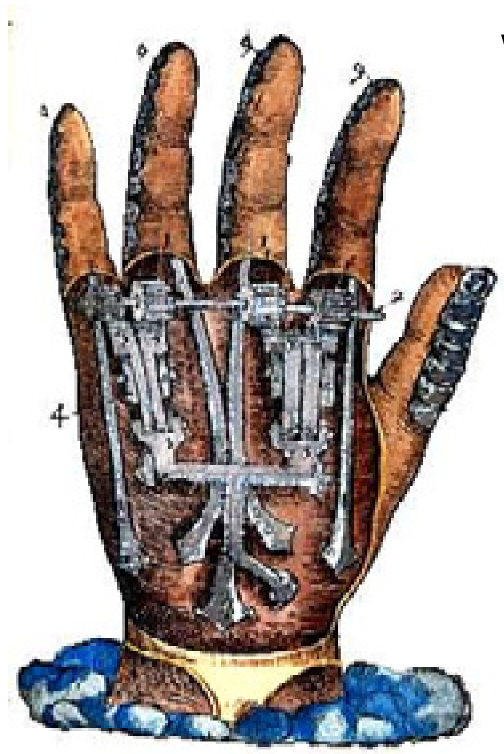
COST Vs TECHNOLOGY

While technologies like miniaturized electronics and microprocessors will be expensive for a while to come. Technologies embraced by the open source community such as 3D printing and scanning are getting cheaper and cheaper. Allowing cutting edge fabrication technologies to deliver high end results for very low costs.



DESIGN OPPORTUNITIES

URGRADABIL-ITY/



TACTILITY/ WHIMSY

Bring back some of the tactility and whimsy of renaissance era prosthesis. Play with the interface between soft and hard, supportive and tactile that exists in biological form.

SOCKET

Investigate how 3D scanning and printing can reduce the large amount of highly trained labour needed to produce the socket. And also to address fit and alignment issues that result in the vast majority of pain from wearing a prosthesis.

Also investigate materials such as silicon that could be used within this new process to produce more comfortable results.

MAIN FORM

Creation of elements by 3d printing allows for form to match individuals biology. But also provides a canvas for individual expression. Opportunity to change decorative forms to suit different purposes.

ANKLE MOVEMENT

Realistic movement, with energy return. Ways to simplify technologies from high end prosthesis that can be replicated with digital fabrication.

FOOT

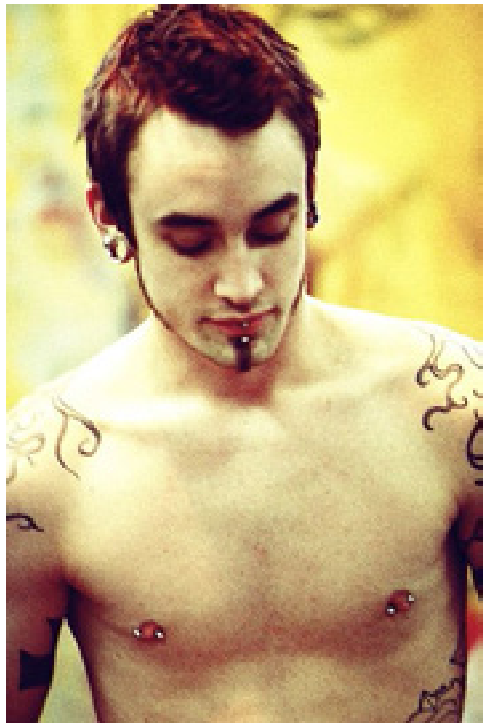
Opportunity to alter with modularity. Different foot attachments for different needs, such as wearing of high heels, sports, different tasks.

VISUAL CULTURES
body augmentation

A strong culture of body augmentation for decoration exists. This has particular significance to many cultures, and many subcultures use various methods of body augmentation to various degrees.

Highly individual, highly personal, sense of belonging to cultures/subcultures. Ever evolving.

Body decoration in the form of tattoos in particular is becoming more and more common.



VISUAL CULTURES
art & disability

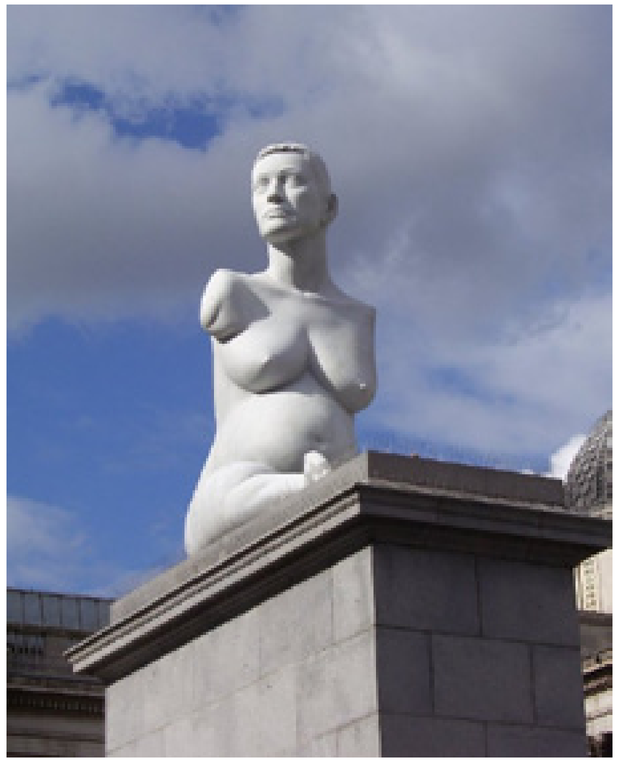
Most art relating to disability and amputation explores the relationship of others to those with amputation. And in the prosses intends to confront them with the reality of the amputation. Not try to hide it away. Often in straight, frank terms. And by doing so normalizing and making visable this part of life.

Considering 1 in 200-300 people in the deveolped world have a limb amputation. It is not something that is esspecially visable within society. And is thus something that is still taboo. Hidden behind tactful forms.

Amputees and their experiences are as varried and different as wider society. But these pieces, and the wider trend towards prosthesis personalization, show that their is at least a group that ateempting to visually own their amputation. And incorporate the reality of it into their interactions with society at large.

“AMPUTEES OFTEN SUFFER LOSS OF SELF IMAGE. I WANTED TO TRANSMUTE WHAT MIGHT BE CONSIDERED A DISFIGUREMENT INTO SOMETHING MARVELLOUS AND EXOTIC.. THAT WOULD NO LONGER CAUSE SHAME... (BUT WOULD) BE AN OBJECT OF HEALTHY CURIOSITY.

PROVOCATION ACCEPTANCE&



VISUAL CULTURES
machine beauty

In rejecting a mimicary of human form and intending to celbrate the reality of the machine form it is important to realize the design must still have a beauty and sensuality associated with the human body.

An embrace of machine form is not a move to an engineered aesthetic. Is not a rejection of beauty, sensuality and tactility.

Like fashion items, the prosthesis must be as beautiful as the person wearing it.

There are many examples of the intersection of beauty , sensuality and performance.

HIGH PERFORMANCE SENSUALITY

“ **EXPLOIT TECHNOLOGY THAT IS ATTACHED TO MY BODY IN A WAY THAT IS POSITIVE.** Hugh Herr

“ **IN SOME WAYS THE ARTIFICIAL PART OF MY BODY IS IMMORTAL.** Hugh Herr

“ **DESIRE TO BE FEMININE... NOT TO BE LIMITED IN ANY CAPACITY.** Aimee Mullins

“ **WHAT OTHER PEOPLE PERCEIVE OF AS MY DISABILITY.**

Aimee Mullins

“ **BUT AIMEE, THAT’S UNFAIR.**

Aimee Mullins’ friend in response to her increasing her height to 6’1” for a party.

“ **BUT THAT’S UNFAIR.**

To Herr in reaction to his specialized climbing prosthesis.

AIMEE MULLINS HUGH HERR&

What has struck me most while listening to these celebrity amputees speak. Is the moments they discuss when their condition enables them to transcend the abilities of those around them. And how they have both been able to harness the power of their ‘disability’ to change the conversation from one of pity, to one of, “that’s unfair.”

Is human ability to be taken as the only valid end goal of assistive technology? Is it ‘unfair’ for people to exploit their situation to obtain super human abilities in one area.

How can people be empowered by the abilities afforded to them by assistive technology. Not just mimicry of what was there before, what is there in ‘able bodied’ people, but by the chance to do something difference. How can this be reflected through the design of the product also, not just its functional abilities.

FURTHER ETHNOGRAPHY

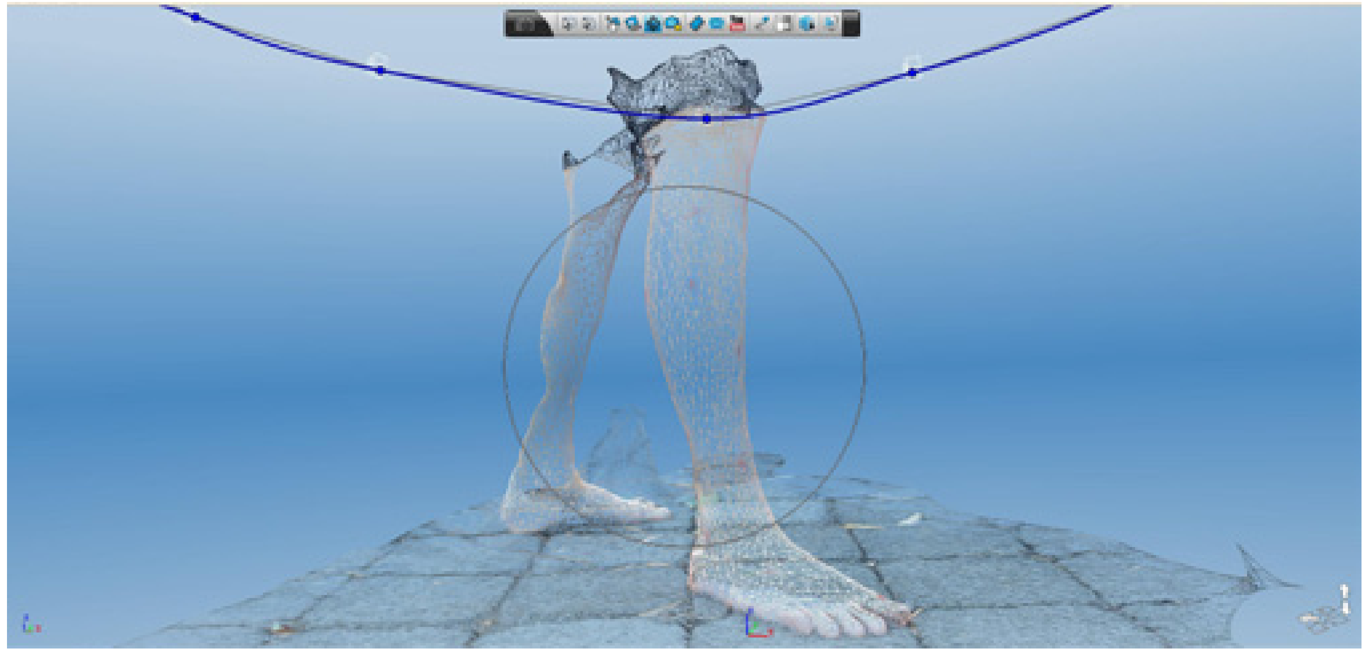
People with limb amputationss are as varied as any wide cross section of the community. It is difficult to characterise them into one group under their shared imparement.

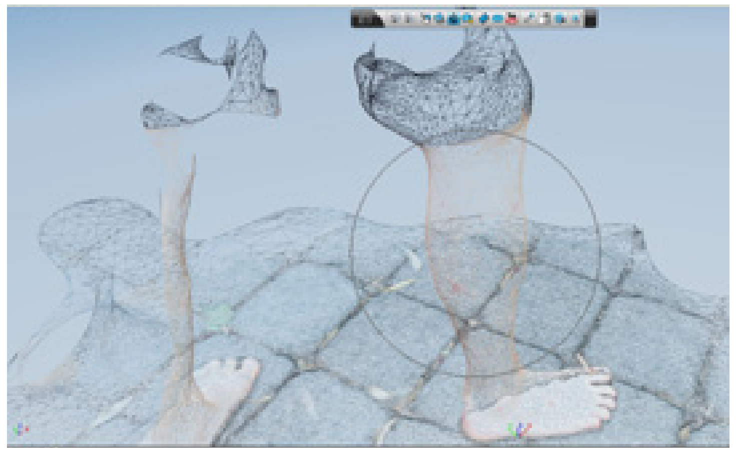
Having said that the designer is currently in consultation with the Nation Center for Prosthesis & Orthotic development at Labtrobe university. Hopefully though this a more detailed ethnographic study can be undertaken with a small group of users. Design variations explored with different users. And a single user selected to deveolp the final proof of concept model in conjunction with.

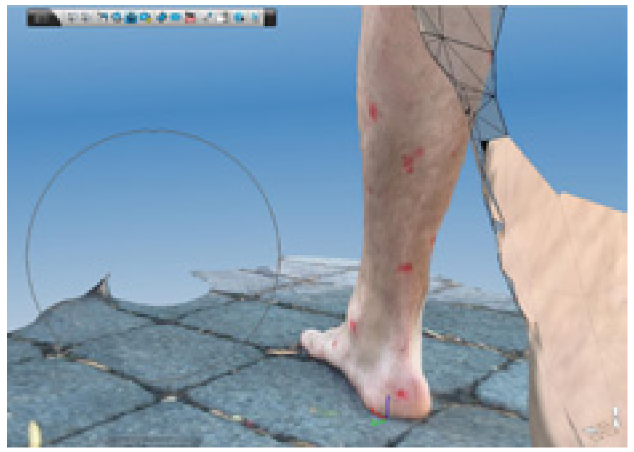
BODYSTORMING 3D SCANNING

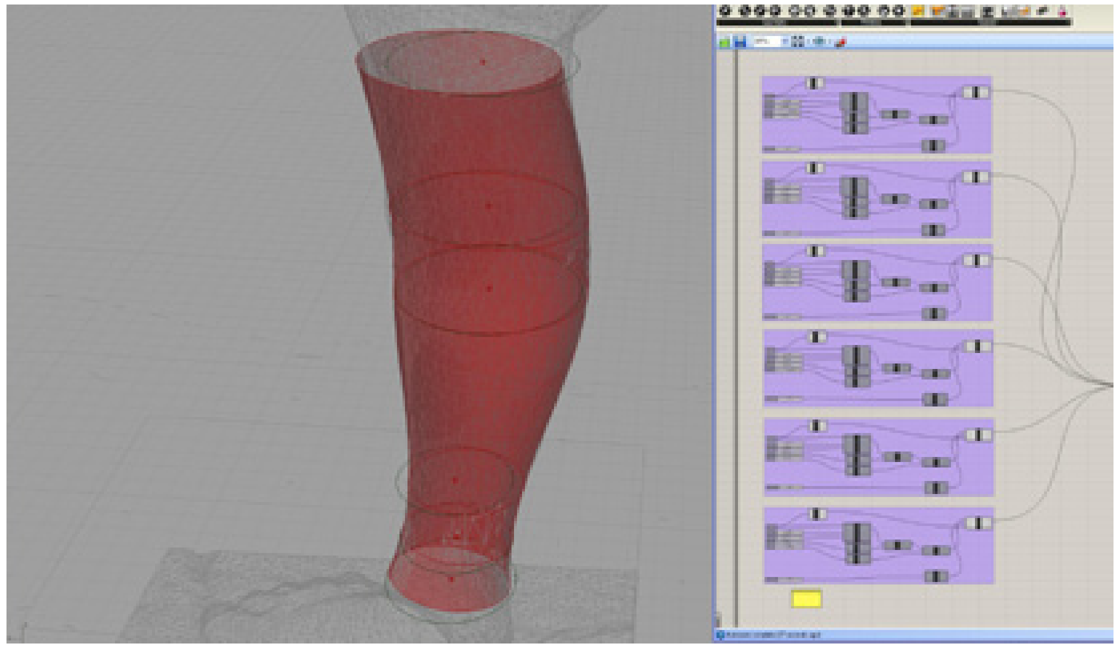
Experiments in capturing the nuances of form and dimensions of the human leg through image based 3D scanning in Autodesk 123D Catch. Experimentation found the resolution of the scan was improved by adding location dots to the leg. And my opptomising the photos taken to 20- 30 in two passes.

MESH SCAN
ROWAN PAGE
17th MARCH 2012





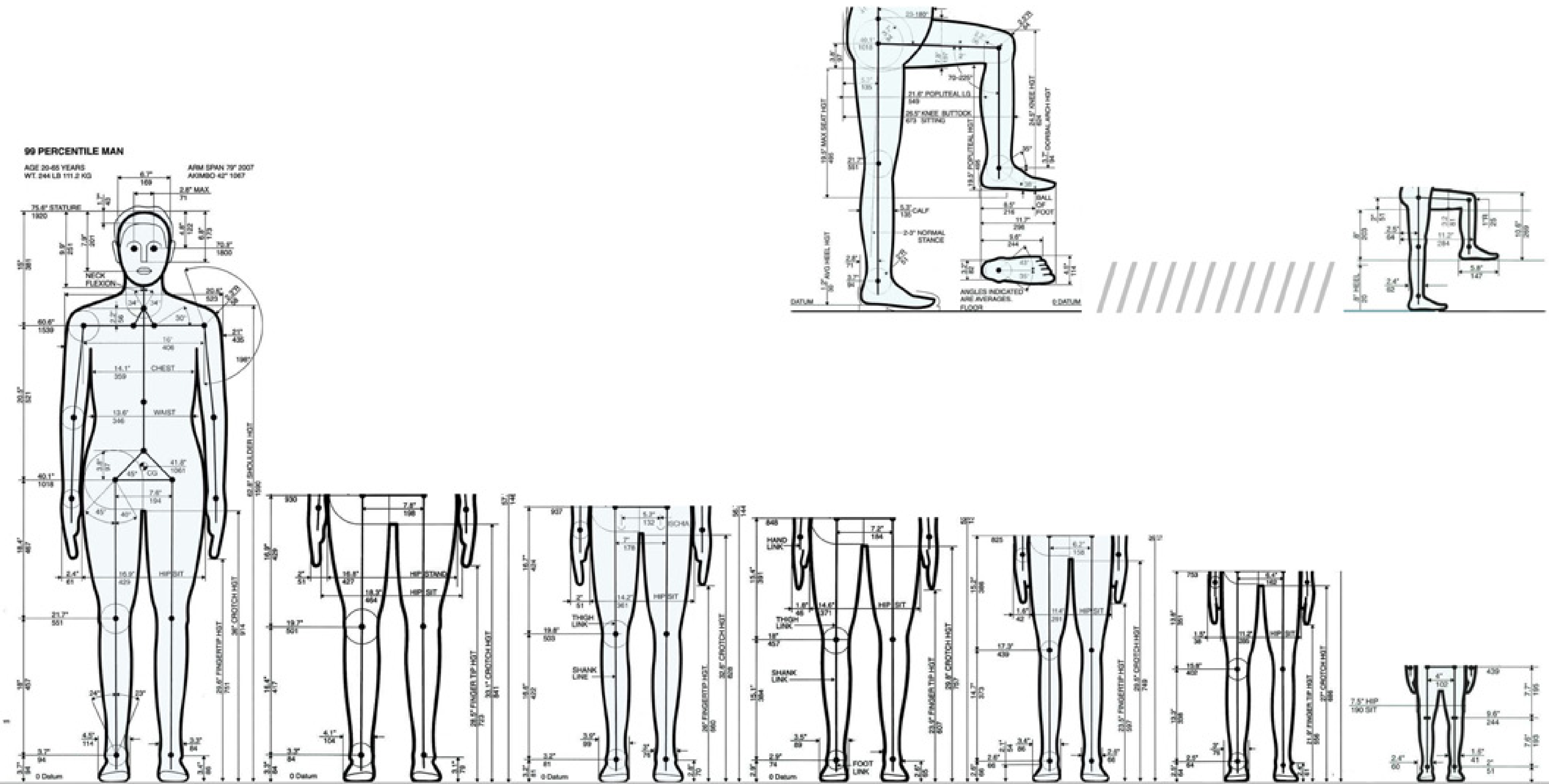




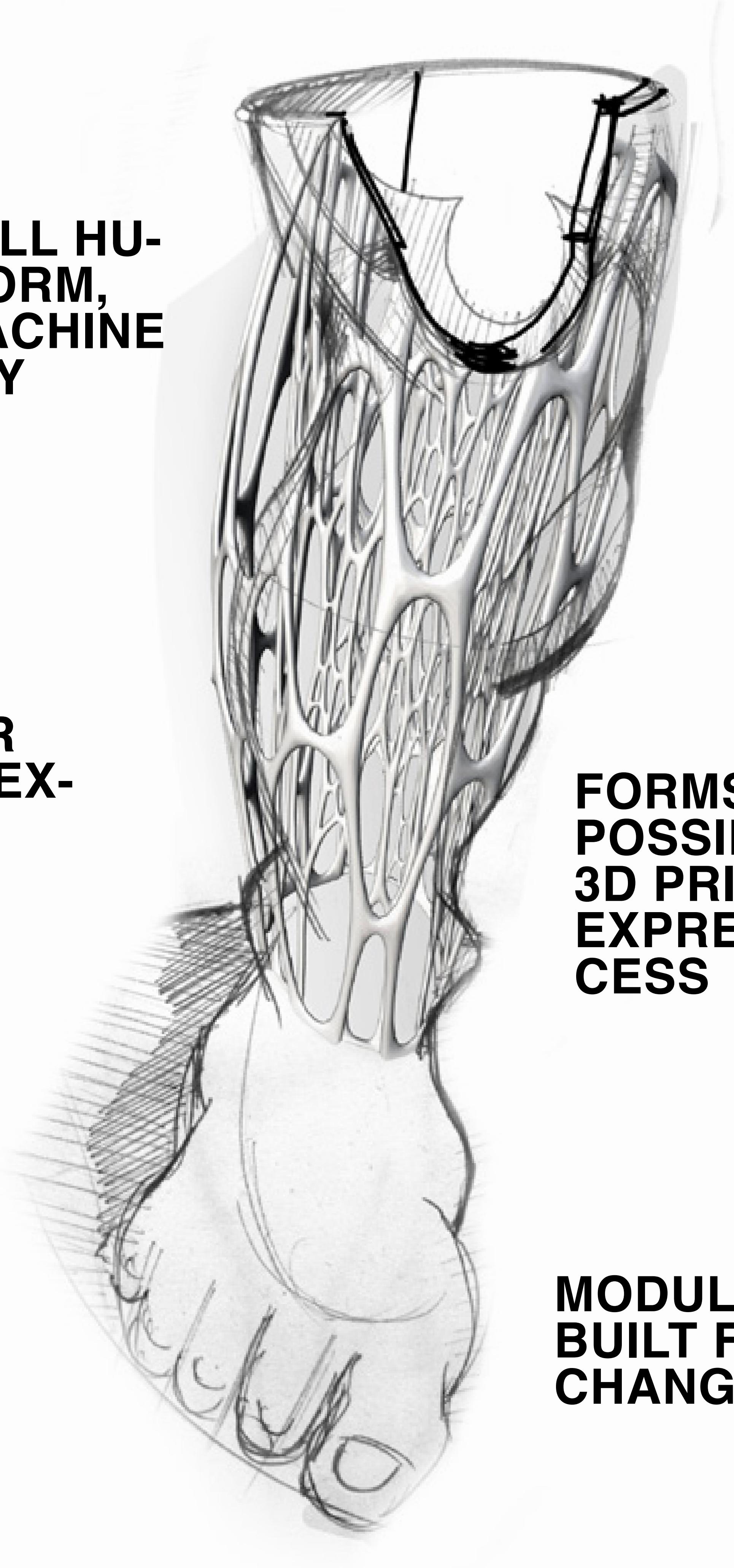
Parametric model of main leg section in Rhino/ Grasshopper. Adheres to the Mesh with six defined control points. Proof of concept for this workflow from the scan.

BODYSTORMING -ANTHROPOMETRIC

Measure of Man & Woman. An attempt to understand the huge range of difference in the sizing of human legs. And thus the sizes that my design will need to accommodate.



DESIGN DIREC-
TIONS



TACTILITY, PLAY BETWEEN HARD & SOFT MATERIALS

OVERALL HU-MAN FORM, YET MACHINE BEAUTY

FORMS THAT EXPRESS THE COMBINATION OF TECHNOL-OGY& BIOLOGY

CANVAS FOR INDIVIDUAL EX-PRESSION

FORMS ONLY POSSIBLE WITH 3D PRINTING, EXPRESS PRO-CESS

MOVEMENT & DYNAMIC FORMS

MODULAR & BUILT FOR CHANGE

“WHAT MADE HIM STAND TALL WAS NOT THE LEGS, BUT THE DIGNITY. Alberto Cairo, Afganistan orthopedic Rehabilitation.

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