

Corporate skin: Biosocial relations, tropes, and institutions in prosthetics research and development

Journal:	<i>Journal Of Material Culture</i>
Manuscript ID	MCU-17-0015.R1
Manuscript Type:	Original Article
Keywords:	Apprenticeship, Biosociality, Corporation, Organic trope, Prosthesis, R&D, skin
Abstract:	<p>Modern orthopaedic prosthetics imitate biological organs or their functions, interacting with the body of amputees, and are designed and manufactured corporately. Thus, prosthetics constitute a privileged vantage point to witness the intermingling of society and nature, how biosocial relations and institutions are understood, negotiated and constituted. We develop methodologies of apprenticeship with a worldwide corporate leader in the development and manufacture of non-invasive orthopaedics, to explore the biosocial relations, the tropes, and the institutions involved in the research and development of lower limb prosthetics. The ethnography reveals how understandings of biosocial relations are influenced by and simultaneously permeate corporate institutional practices, constituting specific organic tropes, such as the corporate skin. This trope reflects the continuous negotiation of understandings of what the skin is and what it does, of the biosocial relations associated with it, of the history of the company, its products, and how its institutional practices are being shaped by these understandings.</p>



Prototypes of breathing liner

254x190mm (72 x 72 DPI)

1
2
3
4
5
6
7
8
9 *Íslendingar í húð og hár*

10
11 *Popular Icelandic saying*

12
13 *Lit. Icelandic in skin and hair*

14
15 *Trans. Icelandic to the backbone*
16
17

18 19 20 **Introduction**

21
22 This article explores the creative dynamics through which lower-limb prosthetic
23 devices are developed at Össur, a world-leading multinational biomedical
24 corporation based in Iceland. It is the result of the collaborative analysis by the
25 authors (X and Z) of an ethnography developed by Z, employing methodologies
26 of apprenticeship at the corporation's Division of Research and Development
27 (R&D). Through the analysis of the ethnography we enquire after the biosocial
28 relations (Palsson, 2009), the tropes, and institutions that arise along the
29 corporate production of prosthetic body parts. The ethnography suggests an
30 organic trope: the corporate skin, which establishes specific relations between
31 some of the prosthesis' components produced by the corporation, the
32 understanding of the organs they emulate, and specific institutional dynamics of
33 the corporation relating to its approach to R&D. We suggest that by being
34 involved and dealing with specific biosocial relations, the employees of the
35 corporation develop explicit and tacit understandings about biosocial relations.
36 These understandings constitute tropes, cognitive devices that may permeate
37 onto the way employees relate to one another, substantiating or destabilizing
38 corporate institutions. Thereby, we explore how the processes that create and
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 modify prostheses are influenced by, and simultaneously constitute a corporate
4
5 body. In this way, we revisit how institutions are substantiated, as well as
6
7 potentialities and possibilities offered by organic tropes to understand both
8
9 specific societies and bodies.
10
11

12 Biological material is increasingly the subject of engineering, banking,
13
14 reproduction, and exchange, stretching our understanding of the body, of tools,
15
16 property, identity, agency, and knowledge, conflating rhetorical figures and
17
18 concepts. The description and broad implications of the intrusion of life itself
19
20 into economics and politics represent some of the most challenging issues on the
21
22 academic agenda at the beginning of the twenty-first century. This is highlighted
23
24 by a series of recent studies in the social sciences, humanities, and life sciences,
25
26 often associated with “biosociality” (Rabinow, 1999; Ingold and Palsson, 2013;
27
28 Lock and Nguyen, 2010) and the “culturing” of life (Landecker, 2009).
29
30
31
32

33 At the outset, Rabinow (1999) proposed biosociality to counter
34
35 sociobiological claims asserting that human behaviours had underlying
36
37 biological mechanisms shared with other organisms. Biosociality, he suggested
38
39 would focus on how human society is embedded but furthermore how it
40
41 involves, affects, and transforms biological organisms and their mechanisms.
42
43 This definition and an emphasis on the social phenomena elicited by the human
44
45 genome project led to a restricted understanding of biosociality, as a form of
46
47 (human) sociality mediated by specific biological phenomena which could be
48
49 altered in the process, but which by themselves did not need to be considered as
50
51 social. The ‘bio’ in that case simply circumscribes the realm through which
52
53 sociality is enacted (Dimond et al., 2015).
54
55
56
57
58
59
60

1
2
3 Nonetheless, deeper scrutiny into of the history of biology and the biology
4 of history reveal that this social transformation of living organisms, this culturing
5 of life is not a recent process, circumscribed to the turn of the 21st century. In the
6 nineteenth century, physiology elaborated its models of metabolism departing
7 from the technological development of combustion engines. These physiological
8 models grounded agricultural and livestock practices (Landecker, 2016), altering
9 the ways organisms related to one another and to humans (Steve et al., 2013).
10 They were also the basis for many of the developments of political economy that
11 defined ideological trends dominating the twentieth century.
12
13
14
15
16
17
18
19
20
21
22
23

24 Through this process living beings have been far from passive substrates
25 of human sociality. Landecker (2016) shows how early in the twentieth century
26 antibiotic production industrialized bacterial metabolism but also how, through
27 antimicrobial resistance, microbes challenged biological knowledge diluting the
28 assumed distinction between history and evolution. It has become increasingly
29 evident that social relations are neither limited to humans, nor simply mediated
30 and enabled by a pre-determined biological substratum. Rather living beings and
31 our relations with or through them have complex properties which may warrant
32 a strong interpretation of the adjective biosocial (Ingold and Palsson, 2013).
33 Hence, it is necessary to revise and to explore those biosocial relations (Palsson,
34 2009), and to question an understanding of institutions built upon the idea of the
35 contraposition of a human social realm defined by intentionality and a biological
36 non-human realm fixed, pre-determined, and hence paradoxically, both passive
37 and deterministic. This turn of events requires revisiting old tropes relating body
38 and society.
39
40
41
42
43
44
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60

1
2
3 Mary Douglas argues that institutions are conventions founded on analogy,
4
5 which:
6
7

8 “...grounds the institution at once in nature and in reason by
9
10 discovering that the institution’s formal structures correspond to
11
12 formal structures in non-human realms” (Douglas, 1986: 55)
13
14
15

16 Cognitive conventions justify conventions grounding their legitimacy on
17
18 an alleged fit with the nature of the universe, they also facilitate the
19
20 communication and extrapolation of conventions across multiple realms of social
21
22 interaction, reducing the cognitive load and social attrition of those participating
23
24 of the institution. However, we will argue that analogy is only one of many
25
26 different tropes, of many alternative cognitive devices, some of which do not
27
28 require us to presuppose the separation between human and non-human realms.
29
30
31

32 Tropes are rhetorical figures, ways of displacing meaning and structuring
33
34 a discourse. Tropes are ways of setting ideas in motion, ways of establishing
35
36 relations between things, thereby influencing our grip on reality. Although,
37
38 generally referring to speech, especially persuasive speech, tropes play a
39
40 fundamental role in the construction of knowledge, in the development of
41
42 technology, and therefore in the modification and constitution of some biosocial
43
44 relations. The specific tropes people use reflect the relations they perceive
45
46 amongst things in the world, but also the relations they may establish with them
47
48 (Ricoeur, 1980 [1975]). Although classifications of tropes are highly variable,
49
50 there are arguably four master tropes: *metaphor*, *metonym*, *synecdoche* and *irony*
51
52 (Burke, 1969: 503-517). *Metaphor* poses analogical relations between the
53
54 properties of unrelated things, shading alternative perspectives on each other,
55
56
57
58
59
60

1
2
3 *metonym* derives relations of contiguity or association reducing related things
4
5 with distinct properties to one another, *synecdoche* identifies holographic or
6
7 representational relations, and *irony* highlights the ulterior differences arising
8
9 from taking sameness to its final consequences. These tropes overlap to a certain
10
11 degree, a single sentence may use simultaneously two or more of these tropes or
12
13 even be interpreted as demonstrating different tropes.
14
15

16
17 At least since Plato (Shorey, 1969), through Radcliffe-Brown (1940), and
18
19 Mauss (1934), and still today in some neuroscientific discourses (Llinás, 2001)
20
21 parts of the body and tools are likened to one another, and in turn stand for the
22
23 persons employing them: the head of state, the military arms, the manual
24
25 labour... metonymically likening the bodies, technologies, and society, the organic
26
27 trope has often reduced the body and its organs to some of their potential
28
29 functions, simultaneously explaining society as a coherent and functional entity,
30
31 bound to work in a specific way for a given purpose. In so doing, the organic
32
33 trope has often essentialized and justified given hierarchies, and modes of
34
35 control over those constituting society (Scheper-Hughes and Lock, 1987; Martin,
36
37 2010; Douglas, 2002: 78).
38
39
40
41
42

43 Prosthetics is one of the fields through which the organic trope has been
44
45 questioned. The failure, loss or congenital lack of any of the body's organs can
46
47 challenge or reaffirm working understandings of the body (Sharp, 2013; Cohen,
48
49 2012). Prosthetics and transplants have a highly disruptive potential, the
50
51 capacity of altering the subsisting organism and our understanding of it, raising
52
53 in the process endless moral conundrums (Sharp, 2013). Prostheses imitate and
54
55 emphasize certain qualities, deemed fundamental, necessary or desirable, and
56
57 while aiming to re-establish a given sameness they generate the very disabilities
58
59
60

1
2
3 they set out to resolve (Jain, 1999). Thus, prosthetics question normality itself,
4
5 the grounds for differentiation, the underlying hierarchies, and the institutions
6
7 grounded on them. Prostheses have been used metonymically to illustrate our
8
9 relations with technology in general(e.g. Haraway, 1985), and synecdochally to
10
11 describe the relations of some citizens to their particular societies (e.g. Cresswell,
12
13 2009; French, 1994; Nelson, 2001; Wright, 2001).
14
15
16

17 Nonetheless, Kurzman (2001) and Sobchack (2006) note that when
18
19 treated as metaphors (or perhaps rather as metonyms) the organic and
20
21 prosthetic tropes, all too frequently simplify all the terms involved. Sobchack
22
23 criticises the tropology of the prosthetic. She argues that treating all technology
24
25 as prosthetic, is vague and reductionist in its illustration of structures, functions,
26
27 and institutional practices. Meanwhile, she argues that the usage of the
28
29 prosthetic as a trope for the role of the individual in the society often has an
30
31 objectifying tendency. It privileges essentialist understandings of the body that
32
33 fail to recognize how amputees perceive their prosthesis as something distinct
34
35 but also as something continuous, functionally belonging to the same body
36
37 (Sobchack, 2006). However, this is precisely what the synecdoche trope would
38
39 imply. Thus, although these criticisms must be taken into account they do not
40
41 represent a reason to drop the tropes altogether, but rather, a call to explore
42
43 their potential complexity more deeply. Not only as cognitive devices to illustrate
44
45 the relations people, but as means to understand how people are understanding
46
47 and acting on the world.
48
49
50
51
52
53

54 As Milosavljevic points out, through the process of rehabilitation bodies
55
56 are 'literally re-membered' (2013: 53). Rehabilitation requires amputees to
57
58 incorporate the prosthetic limb and learn to walk again, but also to re-people
59
60

1
2
3 their world, to re-construct social relations, and gain access to institutions
4
5 afforded by their limbs. We will argue that a similar re-memembering is at work
6
7 through the research and development of prosthetics. These are processes
8
9 through which novel insights, innovations and frequently intern collaborators
10
11 are incorporated into the corporation and its products. The challenges faced
12
13 through these processes evidence how much we take for granted of the workings
14
15 of those organs and how little we understand about them, revealing previously
16
17 neglected biosocial relations. Prosthetics' R&D involves the instantiation and
18
19 interaction between multiple people, from diverse backgrounds working with a
20
21 variety of tropes, specific understandings of the body in its physical but also in its
22
23 political sense. Thus we will argue that prostheses and prostheses design are
24
25 negotiated interpretations of the organs they seek to replace or enhance. We will
26
27 contend further that institutional structures and dynamics may not only
28
29 correspond but relate to the specific and complex biosocial relations instantiated
30
31 through prostheses. Furthermore, we will argue that the understandings of the
32
33 body and of technology that underly and arise through those productive
34
35 processes permeate on how members of the corporation interact with one
36
37 another, in the organization of the corporation and its architecture.
38
39
40
41
42
43
44

45 There is not a single organic trope, but rather specific tropes that arise out
46
47 of the conjunction between the dynamics of specific institutions and the biosocial
48
49 relations in which they are involved. Thus, addressing the corporate creative and
50
51 productive processes from which prostheses originate may enlighten our
52
53 understanding of the physical and social bodies.
54
55

56 Össur is a multinational corporation producing state of the art prosthetics
57
58 mainly for high-end (wealthy or well insured) amputees. The corporation is
59
60

1
2
3 widely known as the producer of the *Cheetah legs*, the elastic blades made of
4
5 carbon layered fibres, resembling the feline hind-paws, which caused uproar and
6
7 raised paradoxical questions about the ‘unfair’ advantages of a Paralympian
8
9 athletes (e.g. Oskar Pistorius) competing in able-bodied Olympics. Össur, is also
10
11 renown for producing bionic feet, knees and legs, with propriosensors, artificial
12
13 intelligence systems and actuators (Össur Corporate, 2014b)¹.
14
15

16
17 Through this text we will explore some of the issues faced by the company
18
19 as it attempts to modify the characteristics of one of its most basic but also most
20
21 important products: the *liner*, which could be described as a prosthetic callous
22
23 skin. We explore the practices and experiences involved in the process of design,
24
25 the interactions amongst biomedical engineers and designers, as well as their
26
27 interactions with amputees, technologies, and the corporation through the
28
29 collaborative analysis (by authors X and Z) of an ethnography (developed by Z),
30
31 which employed methodologies of apprenticeship through a two-month
32
33 internship with the Liner Unit of the division of R&D of Össur.
34
35
36
37

38
39 In methodologies of apprenticeship the researcher follows a training
40
41 process with a community of practice, and aims to become proficient in the
42
43 skilled practices of the research subjects (Coy, 1989; Gieser, 2008; Marchand,
44
45 2010; Simpson, 2006). These methodologies situate the researchers providing
46
47 them with a role within the community, a perspective that is true both to their
48
49 developing capacities and to the changing expectations of the group. For this
50
51 reason, they afford a particular sensibility to understanding practices and
52
53 ontologies of a community of practice. In apprenticeship methodologies the
54
55 functions of the ways of doing are experienced, situated, contextualized and
56
57 emotionally tensed with meaning.
58
59
60

1
2
3 Through the internship period researcher Z worked five days a week from
4 8:00 to 16:00, with a team of 8 researchers, and two amputee prototype testers.
5
6 He also interacted with the members of four other research teams, and with staff
7
8 from other divisions, including various interns. Field notes were recorded on the
9
10 field site and elaborated afterwards. This experience suggested insights into how
11
12 biosocial relations and hierarchies, within a biomedical corporation,
13
14 simultaneously are constituted and affect the creative processes that shape
15
16 prostheses, enskill interns, and sensitize them to the biosocial relations lived by
17
18 amputees, as well as those of their own bodies.
19
20
21
22
23

24 Through the analysis, we examine how diverse actors (researchers,
25
26 amputees, materials, technologies, prostheses, corporations *et cetera*) contribute
27
28 to the constitution of bodies: mediating, being affected, caring for,
29
30 instrumentalizing or translating one another. First, we examine the image the
31
32 corporation projects of itself to its employees, customers and investors, and
33
34 through which it perpetuates its existence. Then we examine the 'organic
35
36 growth' of its structures and developments. Finally, we explore the interactions
37
38 surrounding the creative processes of research and development in prosthetics.
39
40
41
42
43
44

45 **Corporate life: The growth of a corporate body**

46
47 Located on the industrial research parks in the eastern outskirts of Reykjavik,
48
49 the headquarters of Össur are a couple of massive buildings interconnected by a
50
51 glass-bridge. We (Authors X and Z) arrived early for a meeting with the director
52
53 of Research and Development, so we take the chance to explore the architecture.
54
55 The entrance has a somewhat hermetic look, no reception, only stairs leading up
56
57 and a display with a few artefacts: the liner, the socket and the knee-brace on one
58
59
60

1
2
3 side; the polycarbonate feet and the artificial knee on the other. We head for the
4
5 building where the meeting is actually going to take place, a huge depot with a
6
7 massive showcase window displaying a banner with the motto '*life without*
8
9 *limitations*' over a biomechanical analysis facility. People are busily designing,
10
11 coding, or writing. At the entrance there is another display showing a wide range
12
13 of ankle, knee, and hip bracing support systems. Askur,² the director of R&D,
14
15 arrives and leads us to one of the meeting rooms.
16
17
18

19
20 Askur remarks that one of the things that motivates his willingness to
21
22 take an anthropologist on board is finding out what drives his researchers, and
23
24 exploring ways to stimulate them. What inspires people to be in Össur? 'Clearly,
25
26 it is not money, they could be getting twice their salary elsewhere...' He replies to
27
28 himself, '... a part of it is the challenge, then there is the clinical side, and also the
29
30 smile on the patients' face.' His interests seem partly derived from his role as
31
32 research director. He is looking for ways to stimulate his employees. At the same
33
34 time, he is doing public relations, advertising the company and its humane, face-
35
36 to-face, approach. Then he elaborates on his general interest in the social
37
38 implications of technology.
39
40
41
42

43
44 Askur offers three possible scenarios for research. First, he mentions the
45
46 Silicone Liner Platform, the backbone of the company, constituted by a small
47
48 group of researchers. Then there is the research on neuronal interfaces. In the
49
50 middle there is another group developing research on artificial knees, but this is
51
52 much more complex research. We settle for the Silicone Liner Platform, which
53
54 after all is the basis of the company. Össur is now recognized for bionic
55
56 (mechatronic) achievements, which are echoed in the cyborgian lemma 'life
57
58
59
60

1
2
3 without limitations', however the membrane delimiting, or the interphase
4
5 differentiating, is its more fundamental trope.
6
7

8 In our naïve thoughts about lower-limb-prostheses, be they wooden or
9
10 bionic legs, the supporting structure and the artificial intelligence respectively
11
12 appear more relevant, and hardly any thought is given to the fact that the skin of
13
14 the residual limb requires protection from the sharp edges of the residual bone
15
16 or to how prostheses are attached. But in strict order of the issues prostheses
17
18 must to resolve, the functions they must perform, first stands the protection and
19
20 cushioning of the residual limb, second the attachment mechanism, third the
21
22 projected structure, fourth the articulating mechanism(s), and lastly active
23
24 control devices.
25
26
27

28 The company was built, and is still largely reliant, on the *Iceross liner* (the
29
30 Icelandic roll-on silicone socket) - an interface which fulfils the role of a callous
31
32 skin, protecting the residual limb and preserving its shape, affording suspension,
33
34 cushioning and an adhesive interface linking it to the prosthesis (Kristinsson,
35
36 1993).
37
38
39

40 The development of the Iceross liner is embedded strongly and starkly
41
42 associated with the frosty perspectives and economic politics of Cold War
43
44 Iceland. It benefitted from and articulated personal, technical, political and
45
46 cultural circumstances. Össur's liner. First, the personal motivations and
47
48 capabilities of Össur Kristinsson, an amputee himself due to a congenital
49
50 malformation, met with the background of the Cold War. The politics of the Cold
51
52 War exerted different pressures in the North Atlantic than elsewhere. The
53
54 strategic importance of Iceland in relation to the Soviet Union called for large
55
56 investments of resources from the US and Western European countries
57
58
59
60

1
2
3 promoting Icelandic Industrialization. This context fostered Kristinsson's
4
5 training as a prosthetist, his access to silicone rubber (Polydimethylsiloxane),
6
7 and financial support for his enterprises.
8
9

10 Moreover, the Circumpolar environment and Icelandic ways of dwelling
11
12 in it afford certain understandings of the skin, its workings and its importance.
13
14 As is suggested by the popular Icelandic saying in the epigraph above “ - *in skin*
15
16 *and hair*”, the skin connotes fundamental aspects of identity. Like for other
17
18 Circumpolar inhabitants (Sonne, 2007), for Icelanders fundamental identity
19
20 envelops rather than structures from within. Icelandic circumpolar dwelling
21
22 practices related to insulation from the cold (socks, caps, *et cetera*) and from the
23
24 water (oilskins) and perhaps latex condoms, which became popular after Second
25
26 World War, provided multiple tropes, a set of solutions to resolve the issues of
27
28 support and mechanic insulation.
29
30
31
32

33 In a tropical environment the tropes of the sock or the cap would not have
34
35 been available. Moreover, prototypes of the silicon liner would likely have been
36
37 quickly dismissed; as even the latest versions of the finished product are difficult
38
39 to bear.
40
41

42 It is not only the liner, other aspects of the corporation reflect Iceland, its
43
44 history and environment. As Mímir puts it on his first advice, as I (researcher Z)
45
46 am approaching his R&D team:
47
48
49

50 At heart we [Icelandic engineers and designers] are still fishermen,
51
52 we have a hands-on approach to problem solving and do not like
53
54 hierarchies, we speak our mind, and that does not mean that we are
55
56 being rude, just honest... you will know when we are being rude. So,
57
58 speak your mind. Try to be useful and get involved.
59
60

Spatial organization reflects Mímir's observation regarding hierarchies. In general terms Össur displays a highly horizontal organization, which is more in line with Nordic practice than with American, British, French or German models. The product managers, the platform leaders, the director and the VPE (Vice President Executive) share workspace side-by-side workers and interns in groups of 3 pairs of conjoined desks, which somewhat recall six oared fishing boats. The Liner group meets on a long table, on an open room next to the desks. Although such a table could lead to a cephalization of the group, the heading places normally remain chair-less. After a quick introduction, I meet the core team of eight staff members. The following day, I will meet a more extended group of fifteen staff members that includes liaisons with other divisions.

After the meeting Garðar, one of the researchers, volunteers to introduce me to Össur through a tour through the premises on our way to the canteen. Garðar's intention is to start from the beginning with an 'amputee,' so we walk at high-speed through the building looking for one.

Besides the biomechanical analysis facilities, the ground floor houses the R&D offices. I enquire about this subdivision of the research laboratories. Garðar replies that formerly all R&D if not all the company used to be located in one office. Garðar comments:

Össur started as a small business, precisely developing liners, trying to do life more comfortable for amputees. It grew organically, joining other small businesses with similar aims, similar reasons for being in business. As it grew it occupied the whole building and later this showcase building, which used to be an automobile store.

1
2
3 In this narrative, 'organic growth' is explained as the development of cooperating
4 alliances amongst peer businesses with a common goal. The result of this
5
6 developing cooperation is also, what is colloquially understood as an 'organic
7
8 growth', i.e. An euphemism for growing in a disordered and opportunistic
9
10 fashion to occupy available spaces. Later conversations, with researchers from
11
12 some the conjoined businesses revealed the aggressively predatorial aspects of
13
14 the mergers.
15
16
17
18

19 This ambiguity, slurring between cooperation and predation, is also latent
20
21 in timelines and various displays of prosthetics that portray the history of the
22
23 corporation, bearing remembrance to a museum of natural history: From the
24
25 humble beginnings of the early liner, to the shiny "symbiotic leg" through a
26
27 series of iterations, mergers, and developments. Although, the different
28
29 companies seem to stand in a relation of parity through the display, the
30
31 corporate narrative ultimately describes how the company based on a prosthetic
32
33 callous skin – a membrane mediating the interactions between the amputee and
34
35 the prostheses –swallowed companies specialized in prosthetic functions, often
36
37 more visible and deemed of higher hierarchical importance.
38
39
40
41
42

43 As the corporation developed further the architectural distribution had to
44
45 be harmonized, Garðar adds:
46
47

48 The organization into different research platforms is a recent
49
50 development. Downstairs, it aims to articulate R&D testing and the
51
52 prosthetist orthotist clinic. So that designers and engineers become
53
54 aware of the problems arising on the ground with amputees running
55
56 right through their desks. The problem of the setting is that it makes
57
58
59
60

1
2
3 testing very public, which is not always so convenient given the
4
5 traumas associated with amputation.
6
7

8
9 The arrangement has an additional result: it turns R&D into a highly visible form
10
11 of participant advertisement. It is a risky bet; users can be enticed or repelled by
12
13 the spotlight of R&D involvement. This way of conducting business attests to a
14
15 drastic difference with other biomedical engineering contexts. While engineers
16
17 developing heart prosthetics (Sharp, 2013) rarely interact directly with patients,
18
19 the development of limb prosthetics involves close contact and continuous
20
21 interactions with amputees. Through the tour, Garðar continuously tests my
22
23 reaction to the word amputee. He asks everyone aloud if they have seen an
24
25 amputee: *'have you seen an amputee, I need an amputee'*. Then he adds:
26
27
28

29
30
31 Everyone in Össur has a direct and personal relation with amputees,
32
33 many designers and engineers are amputees, or have a daughter or
34
35 a son who are an amputee. I know it sounds a bit like Disney, but it is
36
37 truth.
38
39

40
41 He is partially referring to Össur Kristinsson, Finn Gramnas, Van Phillips
42
43 and Hugh Herr, some of the *'Innovators'*, a group of foundational figures of the
44
45 company (Össur Corporate, 2014a)³ who either were amputees or closely related
46
47 to amputees, and thereby, became highly motivated researchers. Highlighting the
48
49 role of these figures the company seeks to foster its rapport between with
50
51 amputees.
52
53

54
55 The role of the amputee-engineer, becomes obscured as I talk with
56
57 Teodoro, VPE of R&D. He points out that Össur has traditionally been an
58
59 engineering company that adapted engineering solutions towards the
60

1
2
3 development of prosthetics. In his opinion, this has led towards over-engineered
4
5 prosthetics. Like the apps in mobiles and other high-tech devices, the features of
6
7 Össur prosthetics exceed usage capabilities of users while at the same time
8
9 failing to fulfil their needs. Now Össur is veering towards a greater emphasis on
10
11 the medical needs of the patient. Now, the prosthetic leg has to be considered as
12
13 a part of the patient, which has to be considered as a whole.
14
15

16
17 Össur employs a considerable number of amputees, many of them are
18
19 part of Team Össur, others, have been test subjects, and become qualified as
20
21 engineers and designers for the company. Normally, they are not considered as
22
23 patients or costumers, two categories which are applied depending on the
24
25 setting. Finally, we come across Símon, it is not evident but he is wearing an
26
27 above the knee prosthesis. Garðar comments on the paradox, they are aware of
28
29 the discrepancy between their test subjects and their expected users. The latter
30
31 are old, frequently sedentary, with tendency to overweight and low life
32
33 expectancies, while the former are young and athletic. Nonetheless, he adds, 'you
34
35 have to have some ethics and cannot go about testing stuff on an old fragile
36
37 grandma.'
38
39
40
41
42
43
44

45 **Dialogues of research and development, scavenging for ideas**

46

47
48 A few days after my induction, I am following people around, trying to
49
50 make myself useful, which as I will come to understand means developing an
51
52 independent project, addressing any of the multiple issues the team must
53
54 resolve. The task I will end up engaging on is designing a liner for the tropics, a
55
56 liner that breaths or rather that transpires, avoiding the discomforts caused by
57
58 accumulated sweat to its circumpolar predecessor under hot climates.
59
60

1
2
3 Wandering through the corporation, I find Friðrik and Líf clearing lab
4
5 storage space. Bag after bag of prototypes in which they effort and ingenuity had
6
7 been invested, but which has to be, tidied up, re-accommodated in blue boxes,
8
9 and sent to the storage room.
10
11

12 While cleaning up, they are also fishing for re-usable materials and ideas.
13
14 A couple of items draw their attention. An old lady knitted them on silicon for
15
16 Friðrik. The idea was to produce a breathing liner. Apparently, the same
17
18 airtightness, which allows the clutch lock to work, remains one of the main
19
20 problems of silicone liners. It does not allow the stump to breath, so the stump,
21
22 which bears higher blood pressure and thereby temperature, sweats creating
23
24 great discomfort. The problem is not easy to resolve. To start with, if you make
25
26 holes into the silicone it is torn apart. So, the idea was that if you knitted silicon it
27
28 would naturally have holes and breathe. However, Friðrik points out:
29
30
31

32 The problem at the design stage is that knitting is time consuming
33
34 and requires a lot of skill. However, once you have the design it is
35
36 easy to program a machine to do it, then you can play and combine
37
38 materials, the possibilities are endless.
39
40
41

42
43
44 Some days later, Friðrik welcomes me with an evil smirk, he has a project in
45
46 mind for me: developing the knitted liner. Somewhat reluctantly, I end up
47
48 accepting. Mímir cheers the news. A couple of weeks later, on a general meeting
49
50 with the R&D VPE it will become evident that resolving the airtight sweaty issues
51
52 of the *Iceross* liner is a major project of the Liner Platform. It is a project of
53
54 crucial strategic importance, given that Össur attempts to grow into the tropical
55
56 ‘Emerging markets,’ where sweatiness is a greater concern.
57
58
59
60

1
2
3 I start by thinking that the liner has some resemblance to the cod-end of a
4
5 trawling net. So, I dive into it. Such a net with fixed knots could work. However, I
6
7 am told there were two unresolved issues in previous attempts: first, how to
8
9 close the structure without using sutures at the distal end, and second that
10
11 superimposed threads result in painful pressure points. So, neither the cod-end
12
13 nor the fixed knots would be very helpful. After some thought, I consider the
14
15 potentiality of flat reed baskets like the ones used as a cushioning surface in
16
17 tropical furniture. Their hexagonal pattern would lend stable support and allow
18
19 breathing.
20
21
22
23
24

25 **Reinventing the basket**

26
27 The project of the woven liner, a solution to the sweaty issues of the airtight
28
29 circumpolar *Iceross*, was suggested to me as a laborious task. Nevertheless, its
30
31 aims coincide with my background: Coming from a tropical context, I am aware
32
33 of similar problems and of technologies which might resolve them, such as
34
35 certain basketry techniques. There are various issues to resolve, although I am
36
37 aware of the uses of basketry, I ignore the manufacturing techniques, I lack the
38
39 materials, my experience with warmer climates contravenes the original idea
40
41 and desires of my peer-mentor, and his experience with amputees indicates that
42
43 my solution will be problematic for the skin of their residual limb. The project
44
45 allows me to explore how researchers interact with materials, with other
46
47 researchers and with amputees and with their residual limbs.
48
49
50
51
52

53 Through Youtube, I get access to some videos showing how to weave on
54
55 the hexagonal pattern (Nabila, 2013)⁴. Making a flat surface out of the hexagonal
56
57 pattern is not too difficult. However, weaving a pronouncedly concave structure,
58
59
60

1
2
3 like a liner, presents more subtleties. Ultimately, these are geometrical questions
4
5 but initially my problems are derived from the properties of the elastic bands,
6
7 which unlike flat reed or bamboo are too flaccid. After devising a scaffold
8
9 method, I bang my head repeatedly trying to figure out how to make the
10
11 pronounced curvature. The solution unfolds by itself when I stop making
12
13 calculations and simply keep adding strips as if there was no issue to be resolved.
14
15 It will take me much longer to decipher what I did, and how I have done it. Still,
16
17 after understanding it, I had to rely on a sort of automatism to repeat it.
18
19

20
21
22 After celebrating this initial success, Jónas enquires about how I see
23
24 myself in relation to the company and the ways I might contribute to its aims.
25
26 Although contributing to the process of appropriation of traditional knowledge
27
28 by a multinational corporation is somewhat troubling, perhaps there is no better
29
30 acknowledgement. Moreover, personally the experience of the design process
31
32 has been very rewarding. There is a slight silence. As the conversation proceeds,
33
34 Jónas points out that:
35
36

37
38
39 Designing a product is like giving birth. It takes time. You cannot
40
41 rush the process, hiring nine mothers to deliver the baby in one
42
43 month.
44
45

46
47 Later in the afternoon, Askur who is passing by my desk comments that
48
49 the basket is starting to look like something interesting. Friðrik comments that it
50
51 looks ‘pretty’, but then he questions my choice of materials, the thickness of the
52
53 strips and the size of the holes.
54
55

56
57 The thing is that the feet have a layer of tightly packed cushioning
58
59 fat. The end of the stump lacks that layer, and there is nothing to
60

1
2
3 protect the skin from the bone, which swims loose without
4
5 attachment. The liner has to provide cushioning and maintain the
6
7 shape of the stump. On the other hand, the holes are too big so the
8
9 skin is going to be pulled through the holes producing circulation
10
11 problems and pain.
12
13
14

15 Friðrik wants me to make the strips thicker and the holes smaller. I try to explain
16
17 to him that the size of the holes is proportional to the width and thickness of the
18
19 strips. But somehow, I cannot get the message across, drawings and equations
20
21 are no use. He only wants to see prototypes. I try to explain that there should be
22
23 a minimal size of the holes, allowing the structure to breathe. He replies there are
24
25 breathing fabrics, which have microscopic pores. I believe this is the right woven
26
27 pattern. It could and should be thinner, so that the holes were smaller, but that
28
29 would also require more time spent weaving, which would slow down the
30
31 production of prototypes. So, instead I work on my materials and start enquiring
32
33 about ways of doing silicone strips.
34
35
36
37

38 Mímir indicates the easiest way to make strips would be to make a
39
40 silicone sheet of the desired thickness and cut strips of the desired length and
41
42 width. He suggests some initial dimensions, a compromise between the size of
43
44 the holes and strip thickness, and tells me to ask Sólbjörg for instructions on
45
46 working with silicone; she is the expert in that field.
47
48
49

50 At first Sólbjörg seems reluctant. She seems to evaluate whether the task
51
52 of helping me out is another load on her back or recognition of her competencies.
53
54 It is both. She helps me get sorted out with the silicone mixer, and moreover
55
56 suggests an additive, producing a silky texture and matted effect, which should
57
58 make weaving easier. The downside is that additives will increase the curing
59
60

1
2
3 time of silicone. Matted silicone will take a day to cure instead of five minutes, so
4
5 I am left on hold with my working space busy until the following day. Impatient, I
6
7 start doing some experiments sticking different kinds of textile strips at the
8
9 edges of the sheet, until I see some silicone rubber sticking out of a bin of the
10
11 laboratory.
12
13

14
15 I weave the basic pattern and test the feeling of the overlapping silicone
16
17 strips. The squared strips cut from a sheet will be problematic. The corners of the
18
19 strips are elevated at the points of overlap, constituting sharp cutting edges,
20
21 which hurt even with small pressure. I remember this is not a problem for
22
23 traditional baskets because flat reed is semi-cylindrical so that one side of the
24
25 network presents rounded contours.
26
27

28
29 I imitate the flat reed shape cutting a tube in half and using it as a mould
30
31 for my strips, the results are optimal, the point of superposition is smooth and
32
33 even cushioned but the process is cumbersome and difficult to replicate. So, I
34
35 start asking around for ways to make a rounded strip mould.
36
37

38
39 The flow of ideas while you are working with your hands is strange. The
40
41 work in progress and the materials frequently suggest many possibilities. Some
42
43 are mistakes or problems which when regarded carefully and performed
44
45 systematically could become solutions. The problem is that these ideas usually
46
47 seem to appear while you are performing another task.
48
49

50
51 Over lunch, I mention to other interns my observations from basket
52
53 making. They reply that most designers or engineers will have a similar
54
55 experience. While working with their prototypes, they learn by doing. To a
56
57 certain degree they incorporate the new stuff they are learning onto the
58
59 prototype, the crucial point however is testing. Testing a prototype means
60

1
2
3 testing an implementation of an idea. Examining whether it works as imagined. A
4
5 prototype could be tested in multiple ways, a prototype liner can be submitted to
6
7 tension, pressure or heat. A material may be examined for its texture or
8
9 appearance. The ultimate test for a prototype is to have amputees put it on and
10
11 describe their experience, in a controlled setting, but that requires approvals
12
13 from ethical committees and is expensive. Testing a prototype, they come to see
14
15 whether they are on the right track or whether they have to drop certain features
16
17 for the following prototypes or develop independent prototypes to test those
18
19 features.
20
21
22
23

24 Later, I discuss with Friðrik the progress of the basket. He points out that I
25
26 do not have to test everything in the same prototype; ‘in fact,’ he indicates, I
27
28 ‘should do various prototypes testing different hypotheses.’ (It is easier said than
29
30 done!) Thus the dialogue established with prototypes is regulated through a
31
32 hypothesis-testing approach, which restricts and focuses the inflow of responses
33
34 and issues arising in the process. We end up back in the discussion of the size of
35
36 the holes, and his preference for knitting techniques. I point out that the very
37
38 idea of a crochet knitted liner seems unbearable, the holes are too tight, no wind
39
40 can come through. He counters claiming that “the skin does not really breath.
41
42 What we have to resolve is its sweating.”
43
44
45
46
47

48 A brief review of the literature reveals that contrary to his claim the skin
49
50 is involved in respiration, it breathes (Stücker et al., 2002). Nevertheless, he is
51
52 right, the problem is sweating, transpiration, the cooling mechanism of the skin.
53
54 Then again, the issue is how to dissipate sweat or better still, how to dissipate
55
56 heat and cool the stump. So, I stick to my baskets and continue inquiring about
57
58 ways to do a mould for semi-cylindrical strips. The closest thing I find is
59
60

1
2
3 corrugated cardboard, which is too weak and I imagine that the silicone will stick
4
5 to it. Hákon suggests spraying painting in order to harden and cure it. It works! I
6
7 get a smooth and hard corrugated mould and a little later I am curing my first
8
9 batches of semi-cylindrical strips.
10
11

12 Friðrik and I converse about my advances with the basket, about some of
13
14 the experiments curing textile strips inside silicone and about my future
15
16 intentions and difficulties fixing the liner to the basket. I will get a load of
17
18 information just by having the amputees test how it feels when they wear it. 'You
19
20 do not have to test everything simultaneously, and it does not have to be
21
22 beautiful.' Indeed, after talking to him it is apparent that the real problem is how
23
24 to keep the cohesion of the basket: how to weave it and keep it tight. Sticking it to
25
26 the liner is another problem. Later, thinking how to preserve my prototypes, I
27
28 start to think that cohesion is actually also an issue with flat reed baskets. Basket
29
30 makers resolve it tying the strips with strings. Tying the strips of silicone works,
31
32 at least through a test.
33
34
35
36
37
38

39 **Walking on baskets**

40
41 Baldur, one of the amputees from Team Össur, helps me informally testing a
42
43 prototype. I hand him apprehensively a silicone basket hoping that the knots will
44
45 hold, and the basket will not fall into pieces. He holds it carefully: 'It looks like
46
47 something you want to be the first to try on, but you have to cut these so that I
48
49 can fit it on', he says pointing out to some protruding unwoven strips that I failed
50
51 to cut before (see Fig. 1). I give it a haircut so that it does not look like a jellyfish
52
53 anymore. He examines it again, and tries it on. He agrees with Friðrik, the holes
54
55 are too big. Moreover, it is oversized and short. 'You see, the sleeve should come
56
57
58
59
60

1
2
3 up to here.' He points out, indicating just below his groin. He puts his liner over it
4
5 and walks a few steps. He feels no pressure marks. Later on, I find on my desk a
6
7 cast of his stump, which should enable me to get a better fit.
8
9

10 **Figure 1 Prototypes of breathing liner**

11

12
13 Producing the long sleeve of the liner would take forever. So trying to by-
14
15 pass the problem, I am, again, finding ways to glue the basket to a liner. The
16
17 silicone glue does not hold, and in theory, silicone cannot be cured over silicone.
18
19 Indeed, it does not hold. However, it gives me another idea curing silicone to hold
20
21 a knotted strip. Surrounding the knot should be sufficient to maintain the
22
23 structure of the basket in place. The experiment works. Not only does the knot
24
25 structure hold in place, but also the silicone sticks to the thin edges of my strips
26
27 smoothing and homogenizing them further. I try on one of my baskets and it
28
29 works.
30
31
32

33
34 In the subsequent days, the task of weaving becomes easier, and I produce
35
36 a number of prototypes. Nevertheless, my cardboard strip-mould deteriorates
37
38 and I cannot find anymore cardboard. So, although better woven, my strips are
39
40 bumpy. Moreover, modelling over Baldur's cast I have been testing ways to tense
41
42 the silicone strips with weights, thereby weaving tighter.
43
44

45
46 I present Baldur with a series of prototypes. He looks at them with
47
48 interest and then tries some of them on. However, this time he is rougher. He
49
50 stretches them trying to pull them upwards. I am in anguish. 'It is too small and
51
52 the holes are too big' he says showing me his skin bumping through the holes
53
54 with a friendly annoyance, as he stretches the fabric further, straining it and his
55
56 skin, along with my nerves. Moreover, the strips are spinning around and he is
57
58 feeling pressure points. The test is a failure. The reason seems to be clear: the
59
60

1
2
3 holes are too big. However, they were bigger the first time, which poses a
4
5 dilemma. As I watch him try it on, I start thinking I could cure silicone over the
6
7 whole basket and make holes putting tiny screws on the cast.
8
9

10 The following week Baldur and Símon try the silicone covered basket
11
12 prototype on. Baldur thinks the one-millimetre holes are still too big, the holes
13
14 still pull his skin through. However, he acknowledges that the size of the holes is
15
16 easily adjustable. Taking this as a partial success, I fail to take into account that
17
18 the tension, which has allowed me to weave tighter, might be what is squeezing
19
20 Baldur's stump. Símon, on the other hand, likes it. He feels some pressure points,
21
22 at particular points, which I mark and turn out to be thicker strips and bubbles
23
24 not properly covered in silicone.
25
26
27
28

29 Early on the following week I present the collection of prototypes in a
30
31 meeting of the group. Mímir seems satisfied. He considers the project concluded,
32
33 it has produced plenty of results, which he claims will be of assistance in the
34
35 design of a breathing liner. However, after a year the issue is still waiting to be
36
37 resolved, perhaps Jónas is right you cannot hire nine mothers to deliver a baby in
38
39 one month.
40
41
42

43 Testing a prototype defines whether a development is on the right track
44
45 of or not. Test may assess diverse kinds developments under a variety of
46
47 conditions. For example, a test may assess whether a potential material has
48
49 desirable physical properties (i.e. whether it has adequate flexibility or
50
51 durability), aesthetic properties (i.e. whether which textures are more pleasant
52
53 to the tact), whether the device made of this material performs its function
54
55 adequately (e.g. it holds together), or whether it produces the desired effects in
56
57 the interaction with the body of the amputee (e.g. reduces sweatiness). The
58
59
60

ultimate test for a new product, one which cannot be characterized as an iteration of a previous product, involves amputee test subjects in blinded experiments, aimed at convincing regulatory authorities that such a biomedical development is first: not noxious to the patient, and second that it contributes to improve a condition. Following strict double blind scientific as well as ethic, protocols, such tests are extremely costly. However, if the innovation can be considered as a modification of a previously licenced technology amputee test subjects often collaborate informally providing extremelly useful subjective feedback. Subjective testing of prototypes depends on the ability of researcher and the test subject to communicate with one another: What is it that the prototype trying to achieve? How does the prototype need to be built in order to be tested? What is the experience of the amputee? And, what are its implications for future developments? Communication depends on building a relation and satisfying the expectations generated by previous prototypes tested. And part of the problem is agreeing on how to test it. My ultimate aims were to test whether the basket liner addressed the issue of transpiration and whether its structure would cause pressure points. During the first test Baldur was enthusiastic and suggested it did not cause pressure points. However, the basket was too loose which might imply that pressure points might arise when the tightness is adjusted, it was also too low. I did not realize it then but his second observation referring to the length might be the pre-condition to being able to test the liner under conditions involving transpiration. Failing to meet this requirement, for his second test and perhaps the excessive tightness of the following prototype changed his attitude. The third test was equally failed with Baldur but successful

1
2
3 with Simon, possibly revealing problems of developing the adequate size for the
4
5 prototype.
6
7
8
9

10 **Discussion**

11
12 Drawing on the history of science and presupposing a distinction between
13
14 social and biological realms, Mary Douglas, assumed that the relation between
15
16 institutional and non-human formal structures was necessarily analogical.
17
18 Analogies with nature discovered by scientists served as cognitive devices
19
20 substantiating and communicating conventions reached between humans,
21
22 thereby funding institutions. Exploring biosociality(Rabinow, 1999; Rabinow,
23
24 2009; Rabinow and Dan-Cohen, 2005; Gibbon and Novas, 2008; Ingold and
25
26 Palsson, 2013; Palsson, 2009), new materialism (Tsing, 2015; Haraway, 2016;
27
28 Haraway, 2008; Bennett, 2010) and actor network theory (Latour, 1999;
29
30 Pythinen and Tamminen, 2011; Latour, 1988), several authors have
31
32 demonstrated how human and non-human realms interact in far more nuanced
33
34 ways, which diffuse such clear distinctions. This work with lower-limb
35
36 prosthetic's R&D hinges at how human and non-human structures are tightly
37
38 interrelated in a bidirectional semantic flow, in which relations with the material
39
40 world are build up mirroring social ideas and debates, while simultaneously
41
42 understandings of the material world permeate onto how people relate to one
43
44 another. The intricacy of biosocial relations implies that other tropes besides
45
46 analogies may be more suitable to capture biosocial relations, and the
47
48 institutions they structure.
49
50
51
52
53
54
55

56
57 The internship developed for this ethnography allowed us to witness
58
59 some of the interactions between biosocial relations and institutional structures
60

1
2
3 of corporate life at Össur. The ethnography focused on R&D in the liner platform,
4
5 which was identified as the fundament of the corporation. It is likely that a focus
6
7 on the currently larger artificial knee platform, or in the cutting-edge neuronal
8
9 interphases would have rendered different perspectives. The liner platform
10
11 allows a stronger historical perspective, which suggests that the structures and
12
13 dynamics of the corporation result from its developmental history, and are is
14
15 intrinsically related with its products and the knowledges or understandings of
16
17 the body these products crystallise. The ethnography also provided a privileged
18
19 vantage point to observe the relations involved in the development of technology
20
21 that seeks to emulate biological functions, in reciprocated interaction with the
22
23 people and bodies, for which those functions are performed.
24
25
26
27

28
29 At first sight, the liner could be seen as a prosthetic accessory, a prosthetic
30
31 of the prosthetic proper. Nevertheless, providing protection, shock absorption,
32
33 structural support, and attachment to the residual limb it addresses fundamental
34
35 functions that must be resolved by every lower limb prosthetics. Consequently,
36
37 the liner became an indispensable part of lower limb prostheses in general,
38
39 highlighting some of the functions and corresponding biosocial relations
40
41 performed and enabled by the distal skin of limbs, and by membranes more
42
43 widely.
44
45
46
47

48 Like the liner to the prosthesis, the skin hardly features as an organ, and
49
50 yet it is perhaps the largest and one of the most complex, performing a vast array
51
52 of functions. From an evolutionary point of view the dermis, the skin, can be
53
54 considered as the primordial organ, which becomes differentiated in three
55
56 layers. The epidermis which corresponds to the skin, is also the one from where
57
58 the neuronal system develops, through both phylogeny and ontogeny. In a
59
60

1
2
3 similar fashion, already Freud emphasized the importance of the skin as the
4
5 locus of tact and contact in the early constitution of the self. Anzieu (2018)
6
7 further develops the argument suggesting the skin-ego as a vast metaphor or
8
9 rather as a fluctuation between a metaphor and a metonym (Anzieu, 2018: 6),
10
11 veering on synecdoche. The skin-ego envelops and contains, protects, and
12
13 exposes, defining and blurring the limits of the self and the other, while retaining
14
15 traces of these interactions in the process, reinforcing its structure in stress
16
17 areas. It is this capacity to simultaneously define and to blur difference that is
18
19 performed by the liner, and which allows the prostheses to be incorporated, to
20
21 be a continuous part of the body. In a similar fashion these characteristics make
22
23 the skin a fundamental means of social interaction, and differentiation (Jablonski,
24
25 2013; Turner, 2012). Contemporary society may further hyperbolize these
26
27 functions through representation and commodification (Borgerson and
28
29 Schroeder, 2018). However, it is in the very mechanical and aesthetic functions
30
31 where ambiguity and complexity lays, affording forms of sociality or biosociality
32
33 that may be shared by membranes in organisms by borders for societies. Some of
34
35 these biosocial relations, in particular the relation between contact and
36
37 insulation, seem to be further emphasized in the Circumpolar environments
38
39 (Sonne, 2007), where the skin seems to play an even more fundamental role
40
41 defining the properties of being.
42
43
44
45
46
47
48
49

50 The current architectural distribution of Össur's headquarters is an
51
52 actively intended design, which repurposes previously existing buildings, aiming
53
54 to optimise certain forms of interaction amongst some workers, e.g. researchers
55
56 in each of the platforms, and orthotist-prosthetists and costumer-patients. In
57
58 agreement with what Mimir identifies as an Icelandic character, the corporate
59
60

1
2
3 architecture employs various features flattening out hierarchies, and fostering
4
5 *primus inter-pares*, (first amongst equals) interactions between co-workers.
6
7

8 In contrast to the case of the R&D of heart prosthetics explored by Sharp
9
10 (2013), the R&D of Lower-limb prosthetics at Össur is highly exposed. This
11
12 difference can be partially explained because lower-limb prosthetics are
13
14 exposed, visible and palpable to patients who, to a large extent, can decide
15
16 whether and how to use them, even contravening medical advice. Consequently,
17
18 there are incentives to develop a high degree of interaction between patient-
19
20 costumers or and prosthetists-orthotists. In line with this dynamic, Össur's R&D,
21
22 in particular the liner platform, is highly exposed in its architectural position, in
23
24 corporate marketing, and in its very function, working as conjuncture for the
25
26 interaction with customers.
27
28
29

30
31 R&D is also the place that hosts guests from partner and rival companies
32
33 and apprentice interns. It is the locus of a dialogue between researchers,
34
35 patients, and artefacts-in-the-making, through which the corporation attempts to
36
37 project its niche in new directions. Ultimately, R&D is to Össur what the liner to
38
39 the prosthesis, hence we can conceive it as a corporate skin. This trope was
40
41 never made explicit by members of the corporation.
42
43
44

45 The processes of apprenticeship, allows us to perceive how R&D at Össur
46
47 works as a corporate skin, and how biosocial relations, tropes and institutions
48
49 interact in the corporation. Apprenticeship involves simultaneously a process of
50
51 enskillment and a socialization into the institutions, the structures and dynamics
52
53 that characterize this form of corporate life. Most interns in R&D, have already
54
55 undergone tertiary formal education. They are not yet practitioners, and are not
56
57 expected to learn to recreate the productive processes of the corporation. In fact,
58
59
60

1
2
3 company secrets remain guarded and out of reach for them. Rather, through peer
4
5 tutelage interns are expected to learn by doing, adapting their independent
6
7 background, and their understanding of technology, and of the body to locally
8
9 available resources and ways of thinking, towards the resolution of the crafting
10
11 issues that arise for their research team in conjunctural circumstances. They
12
13 must adapt or learn ways to negotiate their work habits, and their
14
15 understandings of the body, and of the technologies being developed with peer-
16
17 mentors, but also with the materials and artefacts available, and according to
18
19 circumstances with test subjects or patients.
20
21
22
23

24 Interns in R&D afford the corporations with means to overcome the
25
26 predispositions that established researchers have built in the course of their
27
28 negotiations with materials, prototypes, amputees and with one another. By
29
30 reinventing processes that have already been standardized, interns make evident
31
32 technical developments affording previously unavailable possibilities, thereby
33
34 allowing R&D to adapt to ever changing environments.
35
36
37

38 However, like prostheses to the body, interns and their prototypes may
39
40 also elicit corporate reactions. Polite tolerance, antagonist reactions towards
41
42 interns and the imposition of apparently menial tasks suggested have been often
43
44 described in a wide variety of contexts of apprenticeship (Coy, 1989; Lave and
45
46 Wenger, 1991). Such antagonism towards apprentices may seek to restrict
47
48 access to the trade, defending self or corporate interests, much like the reactions
49
50 of an immune system stimulated by a potentially dangerous foreign body. Such
51
52 possibility cannot be ruled out, although it is not fully warranted either. Rather it
53
54 would seem that such antagonism reflects a more fundamental dynamic of this
55
56 corporate processes, including creative developments: through which the
57
58
59
60

1
2
3 different life experiences and approaches to life become articulated in the
4
5 corporation and crystalized in its products. Although, in my case the task
6
7 imposed was indeed cumbersome, it also provided unrivalled opportunities to
8
9 interact and become acquainted with a wide variety of persons, with dissimilar
10
11 understandings of the body, with techniques, and materials, engaging in a
12
13 prototype-mediated conversation on what the callous skin is and how it could be
14
15 imitated. This conversation elucidates the political process that articulates the
16
17 different approaches to life constituting the corporation.
18
19
20

21
22 The generation of the prototype is a point where the artefact has not yet
23
24 been defined as an object. The interaction can be highly subjective, producing a
25
26 prototype is cumbersome, like a rich but somewhat frustrating dialogue in which
27
28 things do not come out as you expected them. Following a scientific approach,
29
30 researchers seek to isolate and test specific properties of the materials, artefacts,
31
32 and the residual limb, exposing different prototypes to specific conditions.
33
34 However, their labour is more closely related to that of the bricoleur described
35
36 by Lévi-Strauss, they are continuously repurposing materials and artefacts,
37
38 altering functions and consequently negotiating the tropes and conventions
39
40 associated with them. Furthermore, unlike the scientists described by Douglas,
41
42 they are not satisfied with constructing abstract theoretical models of reality
43
44 from the collection of those individual observations, instead they have to develop
45
46 artefacts that perform the functions they are trying to emulate, even when
47
48 strained under the multiple transactions to which they will be exposed in the
49
50 everyday life of the amputee. In order for the tests to be conductive, researchers
51
52 must develop rapport with amputees. They must develop communication
53
54 channels and trust. They must become familiarized with amputees, aware of the
55
56
57
58
59
60

1
2
3 biosocial relations involved, to understand their needs and requirements, and
4
5 how they experience the prototypes.
6
7
8
9

10 **Conclusions**

11
12 Prostheses like the liner attempt to replace organs belonging to organic
13
14 wholes. Thus, they constitute and embody working and social understandings of
15
16 life. As the prosthetic industry is increasingly dominated by a corporate culture,
17
18 this working understanding results from a political process articulating the
19
20 different life experiences and approaches to life that constitute a biomedical
21
22 corporation, such as Össur. In turn, corporations like Össur have been structured
23
24 and developed following processes of organic growth, which depend on their
25
26 history and on local biosocial affordances. The growth of a company is partially
27
28 explained by the articulating power of its products. That is, their capacity to
29
30 articulate different meanings and functions in specific contexts. Corporate
31
32 growth is made possible or constrained by the harmonious fitness of their
33
34 products in determinate biosocial niches.
35
36
37
38
39

40
41 Prosthetic technologies congeal the dialectic between diverse
42
43 understandings of the biology of the body (often paired with understandings of
44
45 the workings of society), practices which may or not be aligned with those
46
47 understandings, and the agencies of materials, bodies and of the corporation.
48
49 Thereby developing these products fosters specific modes of socialization.
50
51

52
53 The body, is not only as a repository of cognitive devices anchoring the
54
55 conventions that institutions are. The biological properties, the requirements
56
57 and capacities of the body, the way to understand and emulate them are the very
58
59 fields these conventions are negotiating, and by which they are structured,
60

suggesting a strong sense of biosociality, acknowledging that human sociality is embedded and affects biological relations, while simultaneously being influenced by them.

There is no single organic trope, rather there is a plethora of changing tropes, which reveal their potential complexity when we examine the actual relations between organs and tools, between bodies and environments or the co-constitutive relations between human biology, technology and communities of practice.

Notes

1. <http://www.ossur.com/corporate/products> (accessed 13/05/14)
2. All the names have been replaced by pseudonyms. Different pseudonyms are sometimes given to the same persons in different dialogues in order to avoid characterization and to maintain their anonymity.
3. <http://www.ossur.com/corporate/inventors> (accessed 13/05/14)
4. <https://www.youtube.com/watch?v=MVILvNRXxIs> (accessed 14/08/2015)

Bibliography

- Anzieu D. (2018) *The Skin-Ego: A New Translation by Naomi Segal*: Routledge.
- Bennett J. (2010) *Vibrant Matter: A Political Ecology of Things*: Durham, Duke University Press.
- Borgerson JL and Schroeder JE. (2018) Making Skin Visible: How Consumer Culture Imagery Commodifies Identity. *Body & Society* 24: 103-136.
- Burke K. (1969) *A grammar of motives*: Univ of California Press.
- Cohen E. (2012) From Phantoms to Prostheses. *Disability Studies Quarterly* 32.
- Coy MW. (1989) *Apprenticeship: From Theory to Method and Back Again*. New York: State University of New York Press.

- Cresswell T. (2009) The prosthetic citizen: New geographies of citizenship. *Political power and social theory* 20: 259-273.
- Dimond R, Bartlett A and Lewis J. (2015) What binds biosociality? The collective effervescence of the parent-led conference. *Social Science & Medicine* 126: 1-8.
- Douglas M. (1986) *How institutions think*: Syracuse University Press.
- Douglas M. (2002) *Natural symbols*, London: Routledge.
- French L. (1994) The political economy of injury and compassion: amputees on the Thai-Cambodia border. In: Csordas TJ (ed) *Embodiment and Experience: The Existential Ground of Culture and Self*. Cambridge: Cambridge University, 69-99.
- Gibbon S and Novas C. (2008) *Biosocialities, Genetics and the Social Sciences: Making Biologies and Identities*: Routledge.
- Gieser T. (2008) Embodiment, emotion and empathy: A phenomenological approach to apprenticeship learning. *Anthropological Theory* 8: 299-319.
- Haraway DJ. (1985) *A manifesto for cyborgs: Science, technology, and socialist feminism in the 1980s*: Center for Social Research and Education.
- Haraway DJ. (2008) *When Species Meet*, Minneapolis: University Of Minnesota Press.
- Haraway DJ. (2016) *Staying with the Trouble: Making Kin in the Chthulucene*: Duke University Press.
- Ingold T and Palsson G. (2013) *Biosocial Becomings: Integrating Social and Biological Anthropology*, Cambridge: Cambridge University Press.
- Jablonski NG. (2013) *Skin: A natural history*: Univ of California Press.
- Jain SS. (1999) The Prosthetic Imagination: Enabling and Disabling the Prosthesis Trope. *Science, Technology, & Human Values* 24: 31-54.
- Kristinsson Ö. (1993) The ICEROSS concept: a discussion of a philosophy. *Prosthetics and Orthotics International* 17: 49-55.
- Kurzman SL. (2001) Presence and Prosthesis: A Response to Nelson and Wright. *Cultural Anthropology* 16: 374-387.
- Landecker H. (2009) *Culturing Life: How Cells Became Technologies*, Cambridge, MA: Harvard University Press.
- Landecker H. (2016) Antibiotic Resistance and the Biology of History. *Body & Society* 22: 19-52.

- Latour B. (1988) *The Pasteurization of France followed by irreductions*, Cambridge M.A.: Harvard University Press.
- Latour B. (1999) *Pandora's Hope: Essays on the Reality of Science Studies*, Cambridge, MA: Harvard University Press.
- Lave J and Wenger E. (1991) *Situated learning: Legitimate peripheral participation*: Cambridge University Press.
- Lock M and Nguyen V-K. (2010) *An anthropology of biomedicine*. New York: John Wiley & Sons.
- Llinás R. (2001) *I of the Vortex: From Neurons to Self*, Cambridge, MA: MIT Press.
- Marchand THJ. (2010) Making knowledge: explorations of the indissoluble relation between minds, bodies, and environment. *Journal of the Royal Anthropological Institute* 16: S1-S21.
- Martin A. (2010) Microchimerism in the Mother (land): Blurring the Borders of Body and Nation. *Body & Society* 16: 23-50.
- Mauss M. (1934) *Body Techniques Sociology and Psychology: Essays*. London: Routledge & Keegan Paul (1979 Trad.), 97-123.
- Milosavljevic KL. (2013) Life and limb: prosthetic citizenship in Serbia. *Social Anthropology*. University of Edinburgh.
- Nabila A. (2013) *Exploring Craftsmanship: Bamboo Weaving*. Available at: <https://www.youtube.com/watch?v=MVILvNRXxIs>.
- Nelson DM. (2001) Stumped Identities: Body Image, Bodies Politic, and the Mujer Maya as Prosthetic. *Cultural Anthropology* 16: 314-353.
- Össur Corporate. (2014a) *Inventors*. Available at: <http://www.ossur.com/corporate/about-ossur/company-background/inventors>.
- Össur Corporate. (2014b) *Products*. Available at: <http://www.ossur.com/corporate/products>.
- Palsson G. (2009) Biosocial Relations of Production. *Comparative Studies in Society and History* 51: 288-313.
- Pythinen O and Tamminen S. (2011) We have never been only human: Foucault and Latour on the question of the anthropos. *Anthropological Theory* 11: 135-152.
- Rabinow P. (1999) From sociobiology to biosociality. *The science studies reader*: 407.

- Rabinow P. (2009) *Anthropos today: Reflections on modern equipment*: Princeton University Press.
- Rabinow P and Dan-Cohen T. (2005) *A machine to make a future: Biotech chronicles*: Princeton University Press.
- Radcliffe-Brown AR. (1940) On social structure. *The Journal of the Royal Anthropological Institute of Great Britain and Ireland* 70: 1-12.
- Ricoeur P. (1980 [1975]) *La métaphore viva*, Madrid: Ediciones Europa.
- Scheper-Hughes N and Lock MM. (1987) The Mindful Body: A Prolegomenon to Future Work in Medical Anthropology. *Medical Anthropology Quarterly* 1: 6-41.
- Sharp LA. (2013) *The Transplant Imaginary: Mechanical Hearts, Animal Parts, and Moral Thinking in Highly Experimental Science*, Berkeley, CA, USA: University of California Press.
- Shorey P. (1969) Republic. *Plato in Twelve Volumes, Vols. 5 & 6 translated by Paul Shorey*. Cambridge, MA; London: Harvard University Press; William Heinemann, Perseus Digital Library Project. Ed. Gregory R. Crane. Tufts University.
- Simpson E. (2006) Apprenticeship in Western India. *The Journal of the Royal Anthropological Institute* 12: 151.
- Sobchack V. (2006) A leg to stand on: Prosthetics, metaphor, and materiality. In: Smith M and Morra J (eds) *The prosthetic impulse: From a posthuman present to a biocultural future*. Cambridge, MA: MIT Press, 17-41.
- Sonne B. (2007) La vie est un sac rempli d'air Polysémie de Pooq et autres notions associées. *Anthropologie et Sociétés* 31: 15-36.
- Steve H, John A, Stephanie L, et al. (2013) Biosecurity and the topologies of infected life: from borderlines to borderlands. *Transactions of the Institute of British Geographers* 38: 531-543.
- Stücker M, Struk A, Altmeyer P, et al. (2002) The cutaneous uptake of atmospheric oxygen contributes significantly to the oxygen supply of human dermis and epidermis. *The Journal of Physiology* 538: 985-994.
- Tsing AL. (2015) *The mushroom at the end of the world: on the possibility of life in capitalist ruins*: Princeton University Press.
- Turner TS. (2012) The social skin. *HAU: Journal of Ethnographic Theory* 2: 486-504.
- Wright MW. (2001) Desire and the Prosthetics of Supervision: A Case of Maquiladora Flexibility. *Cultural Anthropology* 16: 354-373.