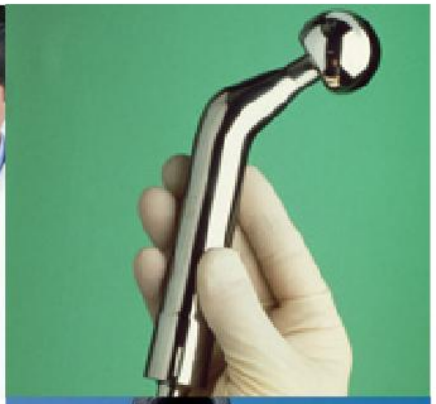
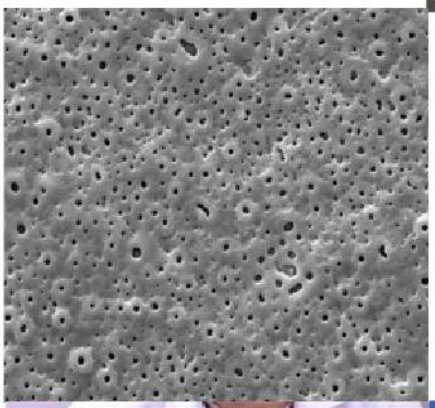



Screening Week Report

C-TEP

CERN Titanium Electropolishing

CERN, Geneve
November 12th
2009

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CERN

NTNU
School of Entreprenuership

This report is a result of the MoU between NTNU School of Entrepreneurship (NSE) and the Knowledge & Technology Transfer (KTT) department at CERN. The report is a study of the technological opportunities and commercial potential of a technology from CERN, and was created by the students of NSE during the NSE Screening Week 2009 at CERN. In addition to this report, the students held a presentation on the same topic.

The technology was presented to the students monday November 8th, with a deadline Thursday, November 12th. The presentation was held the following Friday.

Summary

Due to a longer life expectancy, and the need for a more active retirement, the number of hip implants performed worldwide each year is increasing. A hip implantation is a very costly operation, and the prosthesis itself is a valuable quality product with high margins. 800 000 hips will be replaced in 2009. The polishing industry is 10% of the total revenue, constituting a CHF 200 million industry.

The transition from steel to titanium is a dominating trend in orthopedic prosthesis as well as in spinal products, plates and bone screws. 60% of hip-prostheses implanted today are titanium. This number is increasing. Titanium is a bio-friendly material with a high strength/weight ratio, preferred by surgeons, as it does not provoke allergies.

Surface roughness and cleanliness are critical properties for a prosthesis to be placed inside a human body. A less than perfect surface may result in the body rejecting the implant, in which case the implant must be removed, resulting in great cost, pain, and even risk of death for the patient, already weak from the initial operation and subsequent problems.

Electropolishing is an advanced, highly effective method for surface treatment of metals. It provides a smooth uncontaminated surface, even for highly complex geometries, and is widely used for polishing of steel. When applied to titanium however, this method has traditionally been affiliated with a high risk of explosion, high energy consumption, need for extensive cooling, and limitations on work piece geometry due to poor conductivity.

C-TEP is a new method for electropolishing of titanium developed at CERN. With C-TEP, the risk of explosion is eliminated, and the power consumption is reduced by 90%. The C-TEP patented chemical mix has radically improved conductivity, and may be applied to both thinner and larger work pieces than existing methods. C-TEP can be performed at room temperature.

Customers for a license can be divided into two segments: Actors in the finishing industry who provide polishing services to somebody else's products, and actors who polish their own products in-house. Actors in both segments are likely to apply an aquired polishing method to a wide range of products. C-TEP is already used by Anapol, a polishing company in the UK, for polishing of titanium bone screws, and several other actors have expressed their interest and requested more information.

As a sufficient roughness can be obtained through existing polishing methods, improved operator safety and drastically reduced production cost are the dominating prerequisites for the adaptation of a new polishing method. As the product is to be implanted in a living human being, trust and credibility must be obtained when entering this market.

There are several suitable business models for this technology, ranging from licensing by the CERN KTT to the start-up of a specialized titanium polishing company. As the technology is fully developed and has been patented for some time, it is currently ready for licensing. A titanium polishing start-up will require 700 000 CHF in financing, mainly due to investment cost for facilities and equipment.

The break even point is expected to occur in year 2, and the business will be profitable after this point. There are several different funding and venturecapital organizations that can provide C-TEP with the necessary funding. These include Wellington Partners, Aescap Venture and Gilde health care.

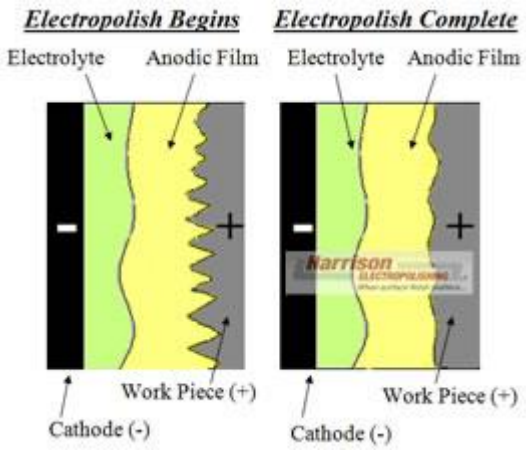
Innholdsfortegnelse

1. Product

1.1. Background

Average life expectancy is increasing due to improved life quality and medical advances. This fact is combined with a desire for a more active retirement. Strain injuries were often synonymous with a stationary and inactive life, but during the last decades, the use of artificial prostheses gives people a longer and more meaningful life. Research in Norway show that patients over 60 years enjoy an increased life expectancy (The Journal of the Norwegian Medical Association, 2002)

Titanium is the optimal material for orthopedic prostheses. The weight to strength ratio is better than the alternatives such as stainless steel and cobolt-crome, it is non-corrosive and regarded as a bio-friendly material. This means that bone can grow on titanium, and it does not provoke allergic reactions. However, the prostheses still has to be very clean for the body to accept the material and prevent infections. When producing for medical application, hygiene is of the essence, and therefore the part needs to go through extensive cleaning and buffing processes to remove excess material that might follow mechanical polishing. This problem is being solved by using chemical polishing instead of mechanical. This process doesn't introduce any alien material to the part, and results a smooth, clean surface. This surface doesn't need to be cleaned. Chemical polishing is a slow process however and is therefore not optimal for the polishing companies.



Electropolishing is a technique that was invented in 1935. This process is basically a chemical polishing process that adds electricity and uses different acids to speed up the polishing process.

1.1. Problem today

Electro polishing of titanium is unsafe, costly and difficult. It has been used broadly for stainless steels and cobolt-crome for years, but titanium electro polishing (TEP) has always been a problem. There are several different methods on the market today, but most of them produce explosive gasses and are therefore very dangerous to use. The processes that work without the explosive gasses are energy consuming and limited to small and thick parts because of power distribution on the part. This leads to increased power costs for the company. In addition to this, the processes are very temperature sensitive and needs about 5°C to work effectively because the titanium will be heated by the electricity.

1.2. CERN titanium electropolishing

CERN Titanium Electropolishing (C-TEP) is a technology that improves the composition of the chemical acid-bath which enables electro polishing of titanium. C-TEP uses 90% less power than other electropolishing processes. Because of this it can be applied to large complex structures without worrying about power distribution in the part. It is also less sensitive to temperature changes than other compositions and works effectively at temperatures up to 30ºC.

These advantages allow a wider use of this type of surface treatment for titanium. The drawback with C-TEP is the production of HF gasses. This means that the process has to be vented and the gasses extracted. The HF-gasses are already an issue today, since it is produced in the pickling process for stainless steels. The polishing companies are therefore familiar with the problem and most of them have already established sufficient methods and facilities for handling the gas.

1.3. Status

The technology is fully tested and patented and it has been applied to a wide range of structures. However, large scale production has not been carried out. Experiences with similar processes suggests that this transformation is usually easily addressed (Lenonel Ferreira, 2009). The technology is ready for sale.

C-TEP was developed for internal use at CERN. There has not been further development since the patent was issued in 2001, and the technology is not currently in use for CERN itself. It is however used on demand to make prototypes for potential customers. Current costs are associated with patent management.

There are other chemical baths which allows electro polishing of titanium, but these solutions are proprietary. This suggests that the innovation is relatively low. However, this particular acid-bath is patented and published, meaning that other companies which are searching for solutions would rather buy licenses than start an expensive R&D effort.

1.4. Scalability and dissemination

The license is easily distributed, and the ingredients and infrastructure needed are available worldwide. Once the equipment is installed, the cost of running the process is relatively low. The scalability is therefore regarded as high.

C-TEP technology benefits from economies of scale. The marginal cost after the depreciation of investments is related to the cost of acid. The process can be fully automated. TEP is applicable to larger batches than existing substitutes. A figure of the costs vs number of polished products is found in section 4.

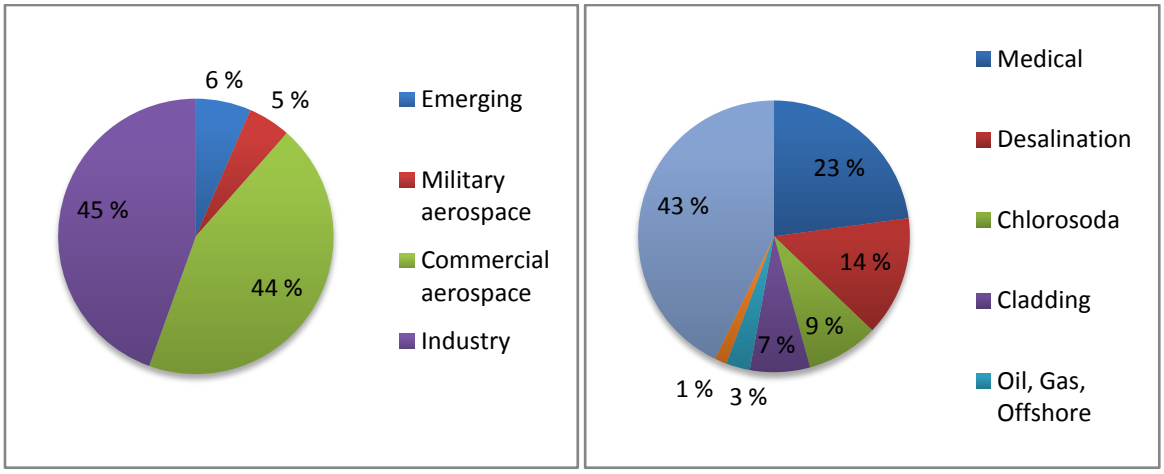
1.5. Alternative applications

There are a wide range of applications for this polishing process. Titanium is used where the strength to weight ratio is central. Applications range from airplane parts to jewelry. The applications discussed in appendix, areas of application are: medical, aerospace, watches, vacuum technology, electronics, jewelries, sporting goods, spectacles, and cutlery.

2. Market

2.1. Titanium market overview

An astonishing 95% of the titanium ore extracted is used as pigment in the form of titaniumdiokside to make the color white (Fiko Group, 2009). The overweight of the remaining five percent is destined for commercial aerospace (44 %) or industry (45%) (Dr Markus Holz, 2005). The segment called "industry" can be further divided into the elements shown in **fig under**. Noticeable is the size of the segment called "medical" which contains, but is not limited to, prostheses, bone screws, plates and surgical equipment.



The titanium surface industry is complex, due to its connections to a number of different applications. The polishing industry is one part of the surface industry. The polishing industry can be further divided into chemical-, mechanical- and electropolishing. The electropolishing of titanium has its application in the parts of titanium that is utilized in medical contexts.
Surface --> polishing --> TEP --> mainly medical appliances

2.2. Market size

The annual, global sales of hip prostheses amounts to approximately 800 000 pieces. (Bjørn Skallerud, 2009) Given a sales price for titanium prostheses at about CHF 2500 (Ortomedic, 2009) this gives a yearly revenue at CHF 2 billion. Polishing is normally responsible for 10% of the prosthesis cost, (Source:IV Mako) and this gives a yearly polishing revenue of CHF 200million. This number is further increased by other forms of prostheses like knee prostheses. These are the two types of prosthesis where titanium is most frequently used.

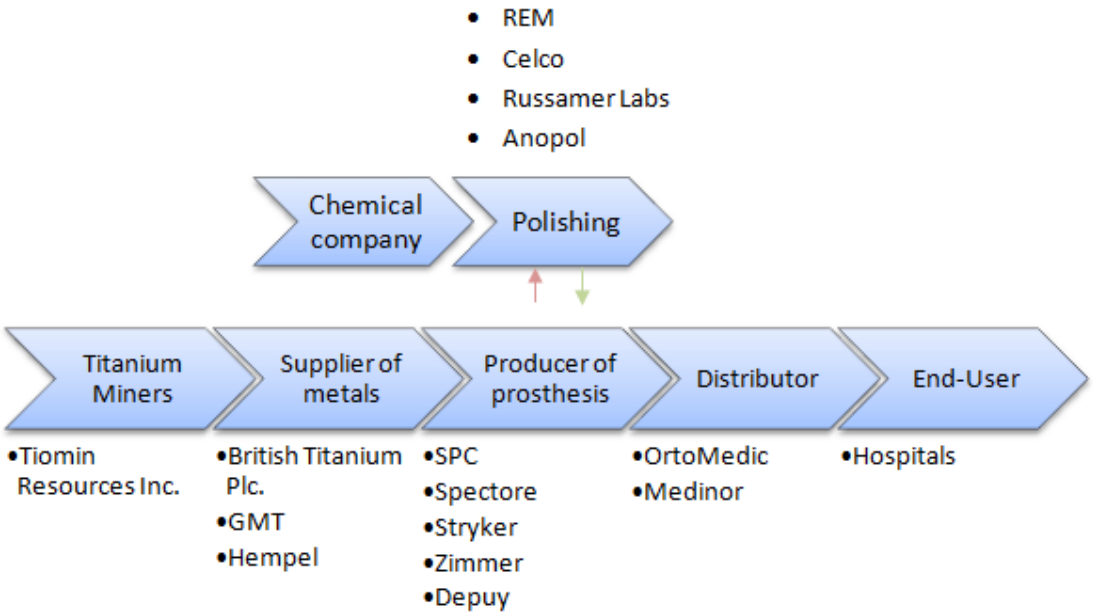
Another important market segment is bone screws, bolts and plates made of titanium. This is normally products that are covered by the same polishing companies as prosthesis. It has been difficult to find concrete numbers for these products, and this report focuses on the hip prosthesis market.

2.3. Trends

Demand for titanium as a biomaterial is constantly increasing on account of demographic factors such as longer life expectancy, and popularity of joint-damaging sports like squash. Non-cemented prostheses are becoming more preferred by surgeons and patients, and titanium is the only suitable metal for this kind of prosthesis.

2.4. Value chain

The polishing industry is complex. Some of the polishing is done inhouse by big companies, like Biotmet, while some is done externally by polishing companies, like Spectore. If the latter process is adapted, the polishing company will ship the prosthesis back to the producer before it is sold to a distributor or directly to the hospital. The polishing process will in its own turn require an input of chemicals which is delivered by chemical companies. All the different kinds of polishing needs chemicals, but for different parts of the process.



2.5. Entry barriers

There are two parts of the value chain C-TEP will have to convince. These are the end users, that is the surgeons and patients who is going to be using the product in the end. The other actor is the polishing companies who might buy licensing for the technology.
C-TEP will be directly responsible for the product and quality for the polishing. Here there are several other technologies and competitors that are established actors on the market. These will probably try to force C-TEP out of the market by attacking this technology's credibility. For the end user credibility is really important and good results over at least a ten year period is an accepted rule of thumb. (Source: Sintef, SMM) If a prosthesis company changes to C-TEP it will affect the end product, and thereby affect their credibility. This rule has proven to be more related to new producers and new products series, and it is therefore considered to be of little consequence to C-TEP.

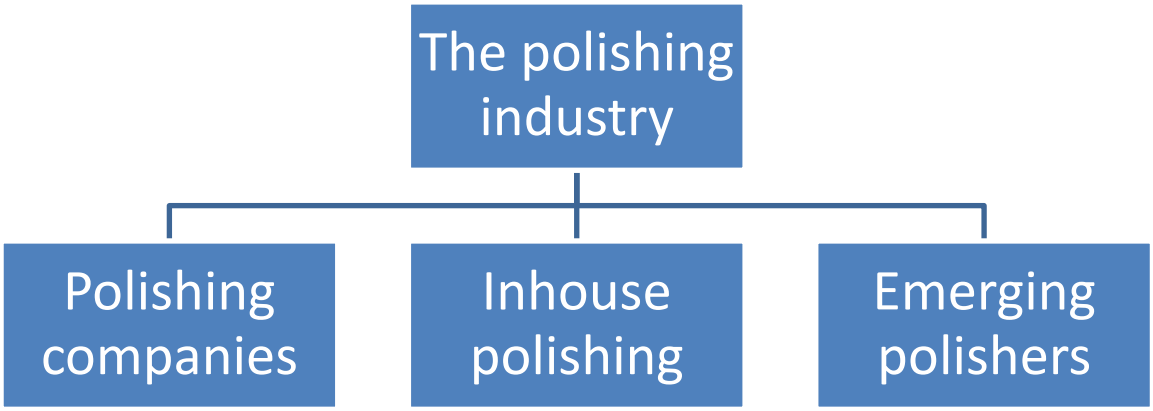
Since C-TEP only gives a marginal economic improvement for the companies that already are doing titanium electropolishing, it is important to focus on the other advantages with C-TEP such as non-explosiveness and more effective process. If the company has really big production numbers however, the economic advantage can be radical, seeing that power consumption makes up 10% of the production costs today and C-TEP reduces it by 90%.

Employee safety is important in the polishing industry. The C-TEP process produces a lot of HF-gasses which are highly toxic, and the HF-acid used is much more concentrated than the HF-acid used in pickling of stainless steel.

2.6. Customers

Customers can be divided into two segments: Actors in the finishing industry who provide polishing services to somebody else's products, and actors who polish their own products in-house. In-house polishing of titanium is performed by big producers of orthopedic prostheses. These actors also produce titanium plates, pipes and screws for skeletal repairs. Actors in both segments are, in other words, likely to apply an acquired polishing method to a wide range of products. Some may argue

that there exists a third, emerging segment. This part is filled by the companies that in some way process metal, but have stayed away from titanium electropolishing due to the former explosion risk.



- **Finishing industry**
  Examples: Anopol, Russamer, Electropolishing Systems Inc.
  - Actors who polish other metals, but wish to start polishing titanium as well
  - Actors wishing to go from mechanical to electric polishing of titanium (possibly in connection with automation of the polishing process)
  - Actors wishing to improve their existing electropolishing technique with respect to operator safety, power consumption or the possibility of polishing larger objects.
- **In-house polishing performed by large producers of titanium medical implants**
  Examples: Biomet, Depuy, Stryker Orthopeadics
  - Actors wishing to move their polishing process in-house (establishing a polishing facility for the first time).
  - Actors wishing to go from mechanical to electric polishing (possibly in connection with automation of the polishing process)
  - Actors wishing to improve their existing electropolishing technique with respect to operator safety, power consumption or the possibility of polishing larger objects.

2.7. Criteria for purchase

- Operator safety, with regard to risk of explosion and exposure to dangerous chemicals, is an absolute requirement for any polishing method.
- The technology must be proven, and the products polished by this method must be eligible for CE-approval.
- As the desired roughness is already achieved through other methods, a new method must lower production cost considerably, through reduced power consumption, reduced lead time, automation or the possibility of applying an existing technique to an increased number of objects.

2.8. Competitors / Substitutes

For the end user, that is the surgeon and patients, the prostheses are good enough today. The improvements that C-TEP provides are only affecting the polishing service provider. We have focused the market in on medical titanium equipment. There are several methods that are used to polish titanium in this segment, and all of these different technologies are potential threats for C-TEP

	Mechanical polishing	Chemical polishing	Isotropic Superfinish	Electro Polishing (other methods)	C-TEP
Average lead time for prosthesis	Medium	Poor	Medium	Good	Good
Power consumption	Unknown	None	Unknown	High. Requires cooling as well.	Low 10 V, 5-14 A/dm2
Safety and environment	Fires have occurred due to flying sparks	Dependent on the chemicals involved	Good	Risk of explosion	No explosion risk. HF-gases can be removed with standard equipment
limitations	None on size, but limitations on complexity, especially with regard to automation	Very inefficient. Limitations with regard to sharp shapes	Limitations on complex geometries. Dependent on the ability of the brush to reach every surface	Limitations on size, due to poor conductivity. The distribution of the necessary current is uneven. Not applicable on sharp edges	Not applicable on sharp edges
Control	Medium	HIgh	Medium	High	High
Surface contamination	Very contaminated. Requires extensive cleaning, and unwanted particles can still stick in pores	Good	Contamination. Requires cleaning	Good	Good

Companies that provide the titanium polishing service today are:

- Mechanical:
  - Celco Inc
  - SCP (Trondheim based company)
  - Depuy (Revenue of $300millions a year from titanium based products)
- Chemical:
  - Electropolishin Systems Inc ($2-3 million a year from medical titanium products)
- REM ISF:
  - REM surface engineering
- Electro Polishing
  - Anopol (Uses C-TEP??)
  - Able electro polishing
  - Pankl, an Austrian auto parts manufacturer has TEP solutions

2.9. Value proposition

C-TEP will achieve the same roughness as the best polishing techniques already available on the market. It will, in addition, represent a radical improvement in several important areas;

Advantages over mechanical polishing (the dominating technique)

- Drastically reduced lead time
- Improved possibilities for automation
- Leaves a non-contaminated surface
- Reduced fire risk due to sparks
- Increased roughness control

Switching benefits (from existing methods of electropolishing)

- Improved operator safety (eliminates the risk of explosion)
- Reduced power consumption by roughly 90%
- Possible to electropolish larger objects
- Drastically reduced need for cooling

3. Organization

Today, the contact person for the technology is Henning Huuse, patent portfolio manager at CERN Technology Transfer. The technological contact person for the patent is Leonel Ferreira. The organization in charge of patent management and spreading of the license is CERN Technology Transfer.

3.1. Intellectual Property Rights

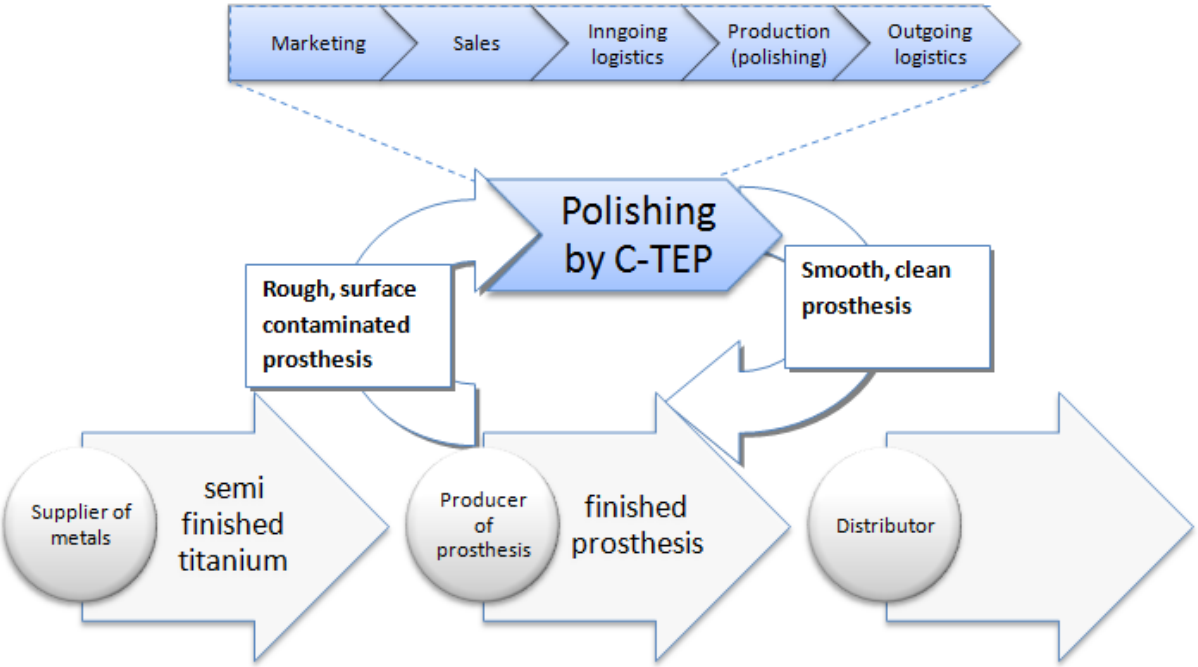
CERN titanium electro-polishing was patented in 2001 for Europe, France, Russia and USA. PCT. WO0100906. The patent is held by CERN, and includes both the chemical bath and the method for use. A trail licenses is available, but a full license agreement with a company has not been awarded. The patent is maturing, and the price is therefore decreasing. The price of a license is indicated to be 5 figured.

The patent has been dormant since it was issued in 2001. CERN does not use or need the patent in its current projects. Some member state companies has showed interest, and some prototypes has been made, but none has led to license agreements.

3.2. Business models

1. Entering the polishing business

Selling polishing services to prosthesis manufacturers involves a (exclusive) license and production equipment, sales, logistics and administration. Marketing and sales will have to be done before the



2. Selling licenses

The feasibility analysis has uncovered potential customers. CERN TT could approach these and sell licenses.

3. License agent

The sales organization works as a broker or agent which sells the license to potential customers. The sales organization would take risks, and receive commission on the license fee. This business model is not ideal from a Cern TT point of view.

4. Sales Organization

An organization with exclusive licenses for the patent which sells sub-licenses and acid-baths to potential buyers will need some logistics in shipping of the acid-bath, but production is handled by the polishing company.

3.3. NSE

The students at the Norwegian School of Entrepreneurship, NSE, have the same access to the licenses as the member state companies. However, since the technology is suited for licensing, the need for entrepreneurs is limited.

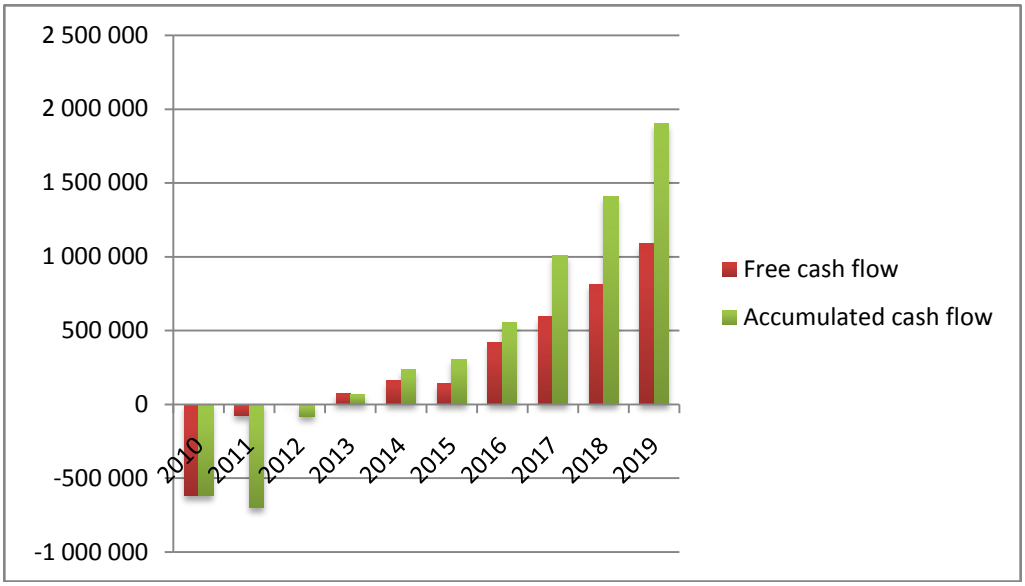
For NSE students, the only possibility for involvement is the first business model. Therefore, this possibility is further discussed and analyzed in section 4, economics.

4. Economy

In this section, the business model called entering the polishing business is assessed. The reasons for excluding the other models are that CERN have mixed experience with these, and is reluctant to adapt them, and that they are not relevant for ES students.

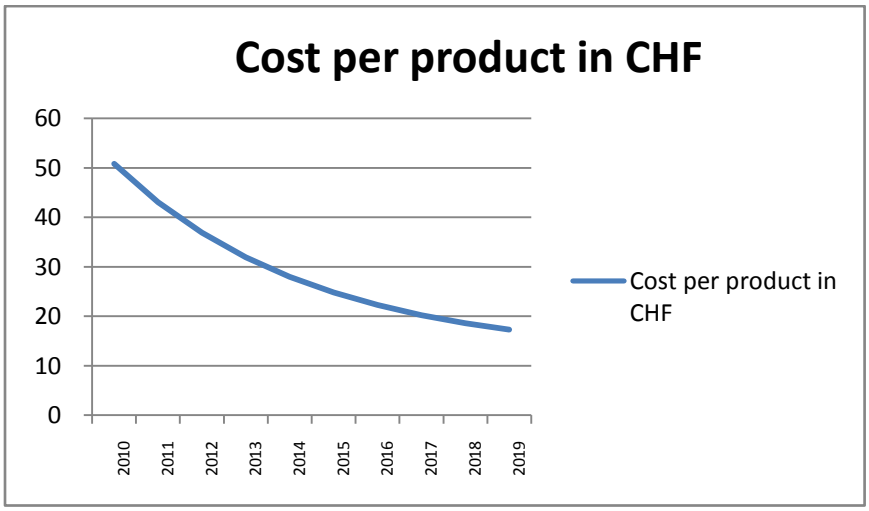
A possible outcome of this business model was simulated financially. The number of sales and sales price were estimated conservatively. The production costs are believed to be tolerably accurate.

The P&L and the cash flow statements are explained in appendix x, financial considerations.



4.1. Economic potential

The breakeven point will occur in year 2, and the business is profitable after this point. The margins in the business are high, up to 40 % when production costs are depreciated, and the cost per product is decreasing.



4.2. Product development

C-TEP is ready for use meaning that all the costs involved in development are sunk. Some costs in connection with a possible automation of the process should be calculated. However, this is not necessary before the volumes exceeds 20 000.

4.3. Commercialization

The main challenge in the commercialization phase is marketing, sales and logistics. The production volume is relatively low, and can be handled by a single production unit and one employee. According to the cash flow statement, the capital need is 700 000 CHF. This cost is mainly investments in production facilities.

4.4. Financing

If CERN KTT only is to sell licenses there will be no need for financing, but for the polishing company business model there is a need for CHF 700 000. There are several different funding and venture capital organizations that can provide C-TEP with the necessary funding. Expected ROI is 17%

- Wellington Partners is a leading Life Sciences venture capital provider, focusing on Innovative Therapeutics, Medical Technology and Innovative Diagnostics. http://www.wellington-partners.com/wp/lifesciences.html
- Aescap Venture is a venture capital company investing in private medical companies in Europe. http://www.aescap.com
- Creathor is a German funding organization. Does a lot of medical technology and biotech funding. http://www.creathor.de
- Gilde health care. It primarily invests in emerging companies working within the therapeutic, diagnostic, medical devices. http://www.gildehealthcare.nl/
- Collaboration with pilot customer - A pilot costumer could cover the capital need in return for agreements on future deliveries and/or shares in the startup. We've talked to several prosthesis companies and they can possibly be used to help with the financing for the polishing company startup.

5. Recommendations

CERN should intensify the sales today, as the lifetime and value of the license is decreasing. Multiple potential licensees were identified while working with this report.

Pros	Cons
Technology is ready for use	Complex industry
Patented at CERN	No organization or entrepreneurs currently
Emerging market	working with the technology
May be other applications with bigger	Aging technology
applications	Competing technologies and substitutes
Clear need, 2 customers identified	

For NSE, the prospects in the economic considerations are relatively lucrative, but the students have no competence or experience in performing electro polishing or starting a polish business.

Furthermore, the organization will be dependent on qualified employees and collaboration partners. This technology will be used by the industry in the future. NSE students with the necessary guts could constitute a serious player, especially with the strong CERN technology and branding as backup.

6. References

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7. Appendix

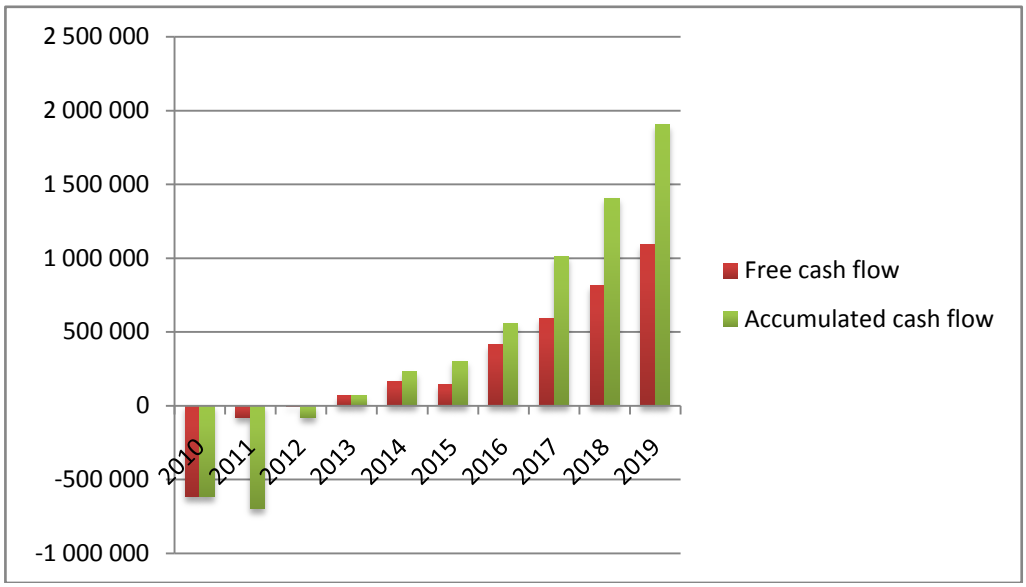
Table of Contents

P&L Statement in thousand CHF

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Number of products	2 500	3 125	3 906	4 883	6 104	7 629	9 537	11 921	14 901	18 626
Revenue										
Salesrevenue	**375**	**469**	**586**	**732**	**916**	**1 144**	**1 431**	**1 788**	**2 235**	**2 794**
Costs										
Products incl direct labour	127	135	144	156	170	189	212	241	277	321
	387	405	444	484	535	595	666	752	857	996
Administration	14	32	67	111	167	236	322	429	560	714
Total costs	**508**	**536**	**576**	**623**	**682**	**755**	**847**	**962**	**1 106**	**1 286**
Margins	-35 %	-15 %	1 %	1 %	9 %	5 %	1 %	35 %	38 %	40 %
Licenses, 25%	0	0	32	75	92	137	146	206	282	377
EBIT	-133	-69	82	75	92	37	9	7	31	111
Taxes, 17%	0	0	14	0	0	4	5	4	2	19
Annual Profit	**-133**	**-69**	**68**	**45**	**42**	**63**	**14**	**3**	**39**	**92**

Cash Flow in thousands CHF

Year	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Net Income (EBIT)	-133	-69	82	75	92	37	9	47	131	111
Depreciations (included)	0	0	0	0	0	0	0	0	0	0
Cash flow from operations	-133	-69	82	75	92	37	9	47	131	111
Change in working capital, 15 %	0	10	12	14	17	21	26	32	40	49
Cash flow from operations	**-133**	**-79**	**70**	**61**	**74**	**15**	**17**	**13**	**88**	**61**
Investments in production equipment	134				134					
Investments in other equipment	350									
Cash flow from investments	-484				-134					
FCF Free cash flow	**-617**	**-79**	**70**	**61**	**-60**	**15**	**17**	**13**	**88**	**61**
Accumulated cashflow	-617	-696	-626	-565	-625	-610	-593	-580	-492	-431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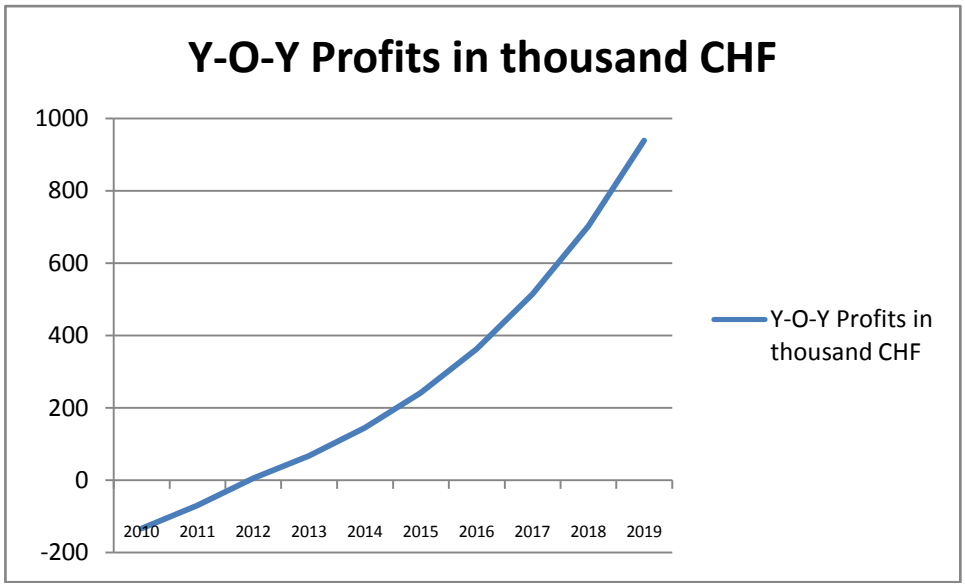
Y-O-Y Profits in thousand CHF
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Y-O-Y Profits in thousand CHF

Financial considerations

This is the explanation of the calculations which is the basis for the financials.

Costs

The setup and installation costs is the price of purchasing the parts needed to perform electro polishing. These source is Leonel Ferreira.

The acid cost are market prices from various internet sources.

The low cost for production facilites is based on the relatively small volumes and size of production equipment.

The labourcost per prothesis is set to 10 CHF. The process could be automated.

Administration costs are set to be 2/3 of total costs. Licence fee is 25 % of the margins (Henning Huuse, CERN TT, 2009), and taxes in the ZUG, switzerland is 17%.

Sales revenue

The total sales of hip implants is approximately 800 000 (Bjørn Skallerud, NTNU, 2009). The amount calculated is 2500 and 0,3 percent of the worlds potential. Sales price per product is set to 150 CHF which is significantly lower than todays offers, which is 250 CHF (Iv maco tools, 2009). Annual growth rate is set to 25%.

Cash flow analysis

Investment costs of 484 000 CHF is investmens, in both production equipment and facilites including 100 000 CHF in prepaid salaries. Depreciation is linear over 5 years. New production equipment is purchased after 5 years.

ROI calculation

All numbers in CHF

Investment year 0	700 000
Return year 10	1 900 000
Gain	1 200 000
ROI %	171,4 %
Simple Annualized ROI %	**17,1 %**

Cost breakdown

Cost assessement, in thousand CHF			Source
Equipment 2cubic metre bath			Leonel Ferreira
Chemical tub	25 000,00 CHF		
Power supply	30 000,00 CHF		
Fume Cabinet	20 000,00 CHF		
Hairwasher	25 000,00 CHF		
Misc.	25 000,00 CHF		
Total	125 000,00 CHF		
Ingredients		% per liter	Market prices
Sulfuric Acid	0,03 CHF	30 %	
Hydrofluoric Acid	1,65 CHF	12 %	
Acetic Acid	0,48 CHF	48 %	
SUM	3,05 CHF		
Recycling, 50% of cost		150 %	
Total	4,58 CHF	Per litre	
Setup Costs			
Equipment	125 000,00 CHF		
Ingredients	9 152,85 CHF		
Total	134 152,85 CHF		
Production costs per product produced			Leonel Ferreira
			One prothesis is aproximately 1 square dm
Labour	10,00 CHF		
Power	0,18 CHF		10 amps per square dm and 10 volts
Acid	1,88 CHF		20 gram titanium removed per litre acid
Total per product	12,06 CHF		
Depreciation	26 831 CHF	5	Years
Other investments (production facilities, prepaid salaries etc)			Market price
Production facilities	250 000 CHF		
Salaries	100 000 CHF		
Total	350 000 CHF		
Depreciation	70 000 CHF	5	Years

Areas of application

The feasibility study uncovered that some of the applicatoins suggested were not so interesting after all. Some of the areas of application were not analysed thouroghly due to time restraints.

Automotive industry

Titanium were used in racing and sportscars. However, regulations were changing, and the use of expensive materials are banned.

Watches

Many watches are made in titanium, but the need for electropolishing were low. The watches are sand blasted.

Jewelery

Jewelery are usually polished mechanically by hand. Due to the low volume, and low skilled workers. Some had tried electropolishing, but sand blasting was still preferred.

Piercings

Polished mechanically by hand. Low volume. Due to changing regulations, more and more piercings are made in stainless steel du to the lower costs.

Sporting goods

The polishing used is mechanical. Costs have to be low when the volumes are high.

Cutlery

Uses cheap electro polishing. Steel is the most common material

Specticals

High-end glasses are hand polished. Mechanical polishing is preferred.

Work Log

Name and number	Organization	Time	Result and notes	Contact person	Further references	Industry
cGe Aviation 2 Boul l'aéroport Bromont, QC J2L 1S9 450-534-0917 Contact : Normand Charron Normand.charron @ge.com www.geae.com	Ge Aviation	2030	Left message	Anderas		Aero space
Airbus Headquarters in Toulouse Frederic Denantes 1, Rond Point Maurice Bellonte 31707 Blagnac Cedex France Phone: +33 5 61 93 33 33 Frédéric DENANTES Technical Assistant to the Senior Vice President Research & Technology (ET) AIRBUS Phone: +33 5 62 11 86 65 Mobile: +33 6 16 39 41 29 Fax: +33 5 67 19 07 56 Mailto: frederic.denantes@airbus.com	Airbus	10.00	Engineering Department Support, Research department Switchboard. R&D department Secretary Passed me through to an engineer. Actually in Research and technology. Electro Polishing Major is the pylon . The part wich is between the engine and the wing. Massive titanium, aerodynamic is relevant Level of protection and ownership, clear information, Patents? This is impotant before ypu shar infromation. Relevant aeoredynamic parts. Frederic.denantes@airbus.com EMAIL:Andreas, Thank you for the interest in our company and products.	Andreas	mail!	Aero space

			Here are the main answers to your questions. Titanium is used mainly in Pylons, Landing gears, High load frames and Attachments. For example in the A350XWB ~14% of the airplane is titanium. Structural material properties such as elasticity, strength and density are determining in the choice of materials for structural parts, to use the right material in the right part of the airplane. Various types of engines are available on Airbus aircrafts from the major engine manufacturers. This is depending on each Airbus type and can be looked at in detail on the Airbus website. Yes you are right titanium is used in commercial jet engines, e.g. for turbine blades. This is the level of information I can provide. If you require further information, we need to get more precise information on the purpose of your request (e.g. potential technology transfer / offer, information request / survey for your thesis) to exactly define what level of protection is needed (NDA, signed agreement, …).			
Symmetry Jet Jon RObson Contact 5212 Aurelius Road, Lansing, MI 48911 USA 1 (517) 393 0233	Symmetry Jet	1600	Jon Robinson Did leave a message… Titanium? YES! We are manufacturing turbine blades.. Not using electro polishing The forge the blades, near net shape and then ship them… Producing for a customer, and then the customers do the polishing and finishing of the products.. Finishing is done by the customers He could not tell me who their customer were, Passed along to vp buisness developement, he would call me back on my norwegian cell phone.	Andreas	VP of buisness development would call me back on my norwegian cellphone...	Aero space

Doncasters Main office only administration Aerospace component department 0044 1743 454 300	Doncasters Main office only administration Aerospace component department 0044 1743 454 300	1630	Left a message at the beep,	Andreas	Alstom Sveits,	Aero space
Cirrus Aviation 201.387.6161 tel 201.387.6111 fax Email 6 McDermott Place Bergenfield, NJ 07621	Cirrus		Cirrus Aviation Sell pratt and witney turbine blades to the after market Enige overhauling and service Pratt & Whiteney Sending me some infromation of employees working with pratt and whitney	Andreas	Email contact information from pratt and whitney	Aero space
How its made 645 Rue Wellington, Montreal, QC H3C 1T2, Canada - (514) 288-3388	How its made, tv producers	1840 tirsdag	Check out the video! http://www.youtube.com/watch?v=vN3_Wkyl5PQ Series 9 - Episode 107 Jet turbine blades Ge aviation. Www.gaae.com . I will send you the direct contact information to GE! njacques@productionsmaj.com	Andreas	cGe Aviation 2 Boul l'aéroport Bromont, QC J2L 1S9 450-534-0917 Contact : Normand Charron Normand.charron @ge.com www.geae.com	Aero space
G.E Aircraft Engine Services Ltd Aircraft Services Tel: 01443 841041| Caerphilly Rd, Nantgarw, Cardiff, South Glamorgan CF15 7YJ	GE	1130	GE Aircraft engines are manufactured in the US and Canada.	Andreas		Aero space
Bernd Koegler, Pankl Racing Systems AG	Prankl	1130	We have inhouse development of the materieal.	Andreas		Auti mobile

Industriestraße West 4 8605 Kapfenberg | Austria Phone: +43(0)3862 33 999-0 Fax: +43(0)3862 33 999-181			High end and sportscars racing. How do you make them? Depends on quality For sportscars: suppliers Small quantities, grind them out of material Diffeent types and alloys. Depends on the customer Medical quality and implants, high end material. How do you polish them? Surface treatment. Residual stress Different types of coating developed ourselves. Polish is plastic process or grinding process Coating it painted on. Chemical forces - bring on an addittional material which you blast on and then grind. ECM electro polishing milling. In certain areas, depends on what you want. Use for deburring. Chemical bath for titanum, developed yourself. They are ahead, and developes their own processes! Not wery common, Besically used in steel. But they have been doing electro polishing of titanium Have you heard about this at CERN? No.. bernd.koegler@pankl.com			
Prodrive Banbury Oxfordshire OX16 3ER United Kingdom T +44 (0) 1295 273355 F +44 (0) 1295 271188	Prodrive	0930	Titanium Usage: Rules, depends on the classes in which they compete. Rules are changing towards cheaper classes meaning more fabric and standard classes. WRC does not use titanium. Not just engine parts, but where stiffness to weight ratio is essential. simple chassis parts, brackets etc. Usually titanium usage is not justified, they get satisfactory results from other alloys and aliminium. They do machining for F1 teams. The cief engineer will tell you more.	Andreas	Cheif Engineer in BMW Williams race team, Jason Hill +44 1295754187	Auto mobile
Cheif Engineer in BMW Williams race team, Jason	Prodrive	1100	Prodride produce parts for GT units, they currently use titanium for valves, before they used it for	Andreas	DelWest USA, Xceldyne	Auto mobile

Hill +44 1295754187			connection rods aswell. Today, in every motorsport regulations are prohibiting the use of titanuim for cost reasons. Even valves in titanium will be banned in the future. the Lemans prototype engine, eht LNP1 they have a more liberal use of titanium policy. Here, the connection rod are titanium. Prodrive does not produce their own parst, but use specialized manufacurers in USA and austria. The resrictions in the use of titanium started in the 90s. They want controle over the types of material used for racing in order to bring costs down. The grids in all motorsports are decreasing because of the high costs. Call our suppliers, they know more about the machining and producion of the parts		USA and europe, Pankl in Austria	
Paul Monrow, Rolls Royce London, +44 20 72229020	Paul Monroe Rollc Royce Aerospace	13.30	London Resarch department Aerospace Labarotories. Kompressors and fan blades are titanium, EMAIL:RR make many compressor blades in-house at it's plant in Hillington near Glasgow. All fan blades are made at the specialist RR facility in Barnoldswick. The only external supplier I am aware of is Doncasters Group http://www.doncasters.com. Turbine blades are made of Ni-based superalloys, Ti is used pre-combustion in the compressor where temps typically do not exceed 600C. Rolls Royce London, +44 20 72229020 Main switchboard	Andreas	Email	Auto mobile
Ben Akers Production Leader at Bernoldswick plant GE +44 1282818754	Rolls Royce	10.00 Onsdag	Rollce ROyce do polish their titanium Superpolishing, But I am afraid that is proprietary information... I work upstream from polishing and actually dont have the knowledge you are lookin for. Give me your contact infromation and I will get back to you.	Andreas		Auto mobile
Eivind Andersen, 004790030570	Founder of SPC	osda g 13:00	Value chain for prosthesis production: mining --> suppliers of material --> prosthesis producers --> distributors --> hospitals there might be several levels between mining and suppliers of materials. Some producers polish themselves, some send it to polishing and get it back before it's distributed. Titanium is molded and coated,	Joachim	For polishing costs: Kjetil Håpnes at SCP	Distri butor of prosthes es

			then it's polishd where you don't want the bone to grow. You will probably not get much from the hospitals, they don't care if th prosthesis is less expensive, they get a yearly budget anyway. The government might be interested, but for the hospitals to buy it, you need the government to regulate the law to make them. By what you have told me, licensing appears to be the best business model.			
Secretary, 0049 6172 13 9720	Creathor investment	thurs day 10.20	This sounds like something they could be interested in, but they need to discuss it further to give an absolute answer. Email specs to this adress if they are to be considered: businessplan@creathor.de	Bård		Finance
Tim Knotnerus 0031 20 570 2940	Aescap	Thurs 10.30	I sent him the specs as an email, he would get back to us during the day.. Might be interested and was going to look into it. Dear Mr. Gamnes, Thank you for providing us with a short introduction of your plans. As you may have seen on our website, we are a venture capital company focused on European medical companies. Accordingly, a polishing technology as such does not fit our investment criteria. For us it may become an interesting opportunity when the polishing technology enables the development of new and improved medical systems like implants, for which a spin out company (medical applications only)will be founded. If this will be the case, we would like to be kept in the loop on your plans. We wish you the very best with the founding and fundraising process. Kind regards, Tim Knotnerus	Bård	info@aescap.com	Finance

Christiane Løfblad, 00472333190	PinPointPiercing	13:15	Polished titanium is the material we use the most. When it comes to piercing, degree of implementation is vital. Piercing is either polished by machines or by hand, where the latter is more expensive since it's done in the US with US wages to the employees. About 80% of our sales come from titanium body piercing. A few years back, there was this weird nikkel law in europe, but it's changed now and people are starting to use more steel since it's cheaper.	Joachim	US supplier: "Industrial Stregth" Europe Supplier: "WildCat"	Jewlery
Secretary, +4401273 323758	Wildcats	13:40	We don't polish titanium ourselves, our manufacturer does it. I cannot tell you who that is, or anyone else who polishes titanium for body piercing.	Joachim		Jewlery
Undifinded woman, 0018004220220	Edward Mirell	14:50	The surface of our jewlery is porcessed by hand.	Joachim		Jewlery
Bruce Boone, 0017706456488	BooneRings	Tirsdag 16:05	We do our polishing manualy, I have two employees who put out between 10 and 20 rings a day. Others get their rings from china.	Joachim	Spectore has a large turnover of titanium.	Jewlery
Carl Fuentes, '+019544818422	Spectore	16.10	(Not in, I left a messagee)	Joachim		Jewlery
Carl Fuentes, '+019544818422	Spectore	Tuesday 15:00	Highly interested in the method, but busy, call back friday. Might be able to talk tomorrow at 0900 ET.	Joachim		Jewlery
Carl Fuentes, '+019544818422	Spectore	Wednesday 15:00	Not answering his appointment	Joachim		Jewlery
Råg Aspnes, 51522276, mob:90409160	Inventor and old titanium provider	16.30	Norway has advanced technology on some parts of the titanium process, but surface treatment is not one of them. The businesses don't realize the potential in titanium, and what you can do to improve it. He has used surface polishing on titanium some times, but this was for mechanical reasons to prevent crack growth. For ES: Had a lot of ideas, and was really interested in having them tested by us.. rag@arnes.no	Bård		Other
Fredrik Karlstad (tidl. protesemaker)	Thelma Biotel	Tirsdag 09.50	Recommends: Scandinavian Customized Prosthesis as Hornebergv. 7A	Ida		Other

			N-7038 Trondheim, Norway Telephone: +47 73401770 Telefax: +47 73963190 Email: support@scp.no			
John Swayne, 0044 1216326888	Anopol electro polishing	13.17	Does mostly stainless steel, but have equipment to do titanium as well. They bough the solution from CERN actually, so they are already a customer. Big problem with the acid: very corrosive. Attacks glass, and they had to change the glass on the company car.. needs a totally enclosed environment in order to be safe to use. Paid a lot of money to CERN to get the "receipe" and paid a lot to advertisement and commercials, but it never became a success. Very bad respons from the market. To day they make bone-screws in titanium, and also made a prototype for Bentley with their grill in titanium, but never heard anything after that, so they're still making the grill in stainless steel.. Anopol is the only UK-company that does titanium electro polishing as far as he knew..	Bård		Polishing company
Tom Hatch, 001 508 830 1717	Electropolishing Systems Inc	Tirsdag 15.05	The company is mainly in the medical applications industry, and does a lot of titanium. About 25-30% of their business revenue comes from titanium, and this is aprox $2-3million a year for them. They use chemical polishing today, but are looking for electropolishing instead to save time and money. The problem today is that the prosess is very explosive, and they haven't found a good alternative. he was very interested in everything we've got of information about the CERN tech, and wanted me to email him this. Good news, and shows that there is a need for the tech in the market today!	Bård		Polishing company
Steve, 001 877-200-5488	Celco electro polishing inc	Tirsdag 16.10	When I called, Steve was actually online looking for alternative technologies to do titanium electro polishing. He was really interested in TEP, and wanted to know more about it! The reason for going into this market was that economy was slow, and they are trying to branch out a little bit.	Bård	Russamer Labs	Polishing company

			They sell a lot of medical equipment today, but all are mechanically polished, and they are mainly made from stainless steel. BUT, there is a growing need in the marked for titanium, and also chemically or electro polished. He was very conserned about safety regarding HF acid. They use it today also, but only in about 5% consentration, and TEP will use about 10-18%. He didn't want to expose his employees to the acid to much. The mechanical polishing works today, but you extensive cleaning and buffing prosesses afterwards to ensure that the residue is gone. Quote:"I guess it's just the way we do it today." He was really keen on more information, and I will send him an email now explaining the technology and telling him to stay in touch. He talked about Russamer Labs also, I have tried to call them, but they are out of office now, and only answers to email. He said that they have a safe acid solution that doesn't use HF-acid, but wasn't sure. He thought they might use a saline(?) solution.. IMPORTANT TO CHECK THEIR TECHNOLOGY! possible competition, or they could be a big customer..			
Matthew, 001 832-467-3100	Harrison Electro Polishing	Tirsdag 16.50	They don't do titanium because there's no market need in their area. No one else does it in Houston either.	Bård	Able electro polishing, Chicago	Polishing company
Tim (?) 001 888-868-2900	Able electro polishing	Tirsdag 18.30	Titanium is just one of many alloys they polish. They have been in the polishing business for 55 yrs, and have their own methods for electro polishing. The method is proprietary information,and he refused to comment on anything. Sales numbers, and titanium market shares was also confidential, and he was getting more and more sceptical throughout the conversation. Closed up completely, and refused to talk to me at the end..	Bård		Polishing company

Gary Sroka, 001 979-277-9703	REM surface engineering	Wednesday 17.50	REM uses a vibratory finishing tecnique. This covers the part in a "soft conversion coating" first, and then uses ceramic brushes to brush away this material at the peaks. This is all done in a chemical bath, and ensures that the acid only affects the "peaks" of the surface. This method can get a roughness down to >1 micro inch. This tecnique, like TEP, only removes surfacematerial and leaves no residue on the surface. They also make micro pores on bearings etc to allow these part to "self-lubricate" Applications: Medical industry is the big one now, especially small complex shapes are big for REM. Some aerospace, but not much. I sent him and email with information, and cc'd in Henning and Ole Petter.	Bård		Polishing Company
Magnus Flett, 0044 7789 924 390	Depuy	Wednesday 20.45	Depuy uses mechanical polishing and only polishes for esthetical reasons..(!?) One implant takes under 10 minutes to polish and the cost is aprox £8. They have a yearly revenue of about $500 million, and about 60% comes from titanium (=$300million) They have an own department that monitors the market for polishing techniques, and was going to forward my email to them and ask why they don't use electro polishing today. THEY WOULD BE INTERESTED IN ANYTHING THAT CAN LOWER PRODUCTION COST! email to Magnus: mflett@its.jnj.com	Bård		Polishing Company
001 412 973 2018	Russamerlab	Tuesday and wednesday	Didn't get an answer on tuesday, sent them an email according to their answering machine. Got a reply on the first email, sent another one with questions but haven't heard back yet. Tried calling all wednesday also, but	Bård		Polishing Company

			nothing yet.. Will forward the email if i get a response from them to Henning and Ole Petter.			
Salgsansvarlig (?), 0047 67518600	Ortomedic, supplier of prosthesis in Norway	onsd ag 14.10	Titanium is mostly used in hips, but also a little bit in shoulders. In hips about 35% of the market in Norway is titanium uncemented prosthesis. Uncemented technology has had problems with the cup, the stem has been OK for some time. thats why Norway uses plastic cups and titaium stems. Uncemented gives following advantages for patiens/doctors: Shorter operation time, less bleeding, less pain. Abroad theres a more focus on uncemented titanium. The most popular stem they have is Corey, a stem thats made of titanium and has a rough, coated surface to help bonegrowth. The buying prosess is very price focused, but only the last few years. Earlier price was not important. The most important part of the buying is the reputation of the producer, must be able to show good results for the last 10 years! Don't know about official rules for prosthesis, but they have to be CE-approved. They only distribute the prosthesis, they don't do anything with them. Just ship the package through!	Bård	Magnus Flett, depuy, Leeds office	Producer of prostheses
Astrid (?), 0047 22056600	Medinor	Onsd ag 15.00	Medinor is a supplier of titanium prosthesis, but mostly coated, and some granulated. They don't supply any polished prosthesis. Uses Biotecny in France as supplier for their products. Mainly focuses on revision prosthesis, which is the reason for that they don't have polished surfaces. Small business, but happy with their products today.	Bård	Should contact Ortomedic(already did, look at line 71..)	Producer of prostheses
Knut Inge (Noe) +47 51 77 70 17	Aarbakke	Tirsd ag 09.10	Can be called back in 15 minutes. When I do the line is busy.	Ida		Producer of prostheses

Daglig leder, Telephone: +47 73401770	Scandinavian Customized Prosthesis as	10.45	Coating: Hydroxiapatitt and plastic spray. hydr. has a structure that stimulates bonegrowth, wish makes the prosthesis stick. Usually, about 2/3 of the implant is coated, while 1/3 is polished. This is done mechanically by IV Mako Verktøy. Coating an sterelizing is done in France, because nobody does it in Norway.SCP has had some colaboration with St Olavs Hospital regarding various kinds of prosthesis', but tey only offer hip implants at the moment. They supply about 150-200 hips each year.	Ida	Store aktører: depuy, zimber (?) , dryker (?), biomet.	Producer of prostheses
Biomet Norge AS Sorkedalsvn. 257 0754 Oslo Norway + 47 24 12 43 43	Snakket med Administrerende Direktør, som presenterte seg veldig fort. Navnet hans ligger ikke på nett. Praktisk.	13.00	Has little techincal knowledge, and recommends that I call Corporate in Holland, or Biomet UK, who should know a lot about manufacturing.	Ida		Producer of prostheses
Bjørn Skallerud Mobil 91897318	Head of Biomechanics Division at NTNU	10.25	This is a very well established technology. Estimates about 800 000 hip prosthesis implanted world wide each year, 5-8000 in Norway. It is the person in charge og othopedics at each hospital who decides what implants that hospital will use. knee and hip implants are the most widely used prosthesis. A Mr. Arild Aamodt at St. Olav's Hospital has written a report on the use of hip implants in Norway. St Olav's has a National Competence Centre for Orthopedic Implants. Bjørn says, that if I get hold of Mr. Aamodt I am free to refere to Bjørn.	Ida	arild aamodt på st. olavs	Producer of prostheses
Biomet Nederland B.V. Phone: + 31 78 629 29 29		13.25	I asked to be put through to someone in manufacturing, but the person I was put through to hardly spoke English. He advised me to contact customer service, because they might be able to help me. I'm not sure if he understood anything I said. + 31 78 629 29 29	Ida		Producer of prostheses
Doctor Knut Harboe 952 56 937	Aarbakke Medical/ Stavanger		Biofilm is a major problem with implants. If you get biofilm on an implant you have to take it back out. A rough surface is needed to stimulate bone growth. at the	Ida		Producer of prosthes

	University Hospital		same time an incredibly smooth surface is needed to avoid biofilm. The perfect surface must be smooth on a micro-level and rough on the macro level. Such a surface would be revolutionary! There are several available polishing methods in use, but biofilm is always a problem. In addition to titanium, 316 L steel, ortinox and other materials are used. Usually several different materials are used for different parts of the implant. The titanium part of a hip-implant costs around 5-13 000 NOK. Big manufacturers of implants are : Stryker, Smith and Nephew, Zimmer, Depuy, Biomet.			es
Elise Pegg Research Engineer Tel: +44 (0) 1793 644 111 elise.pegg@biomet.com	Biomet UK Ltd Swindon	15.00	Titanium polishing at Biomet is done manually. Elise did not see the need to improve the roughness from .02 to .01 micrometers with regards to the formation of biofilm. She did however point out a few issues with titanium polishing; Polution: In mechanical polishing alu-og diamond paste is used. This pollutes the titanium, and the workpiece must undergo extensive chemical cleaning afterwards. Biomet are thinking about automation of larger parts of their Implant production, but it is very difficult to atomate mechanical polishing of the typical implant geometries. She confirms that electro-polishing could solve these issues, and also confirms that explotion hazard was a concern with the old electro-polishing methods. Despite the possibilities for solving some of Biomets problems, she does not seem to enthusiastic about the posibility of adopting a new method. This is a "nice to have", not a "need to have" solution.	Ida		Producer of prostheses
tel: (574) 267-8143 or (800) 473-3789	DePuy Orthopaedics, Inc. Warsaw, IN (Indiana) 46582	16.29	Impossible to reach anyone. They don't have departments, or even titles it seems. No name, no phone call. Tried to reach the press and media contacts, who's names are the only ones on the website to see if they could give me a name, but they didn't answer.	Ida		Producer of prostheses
Senior Director Matt Poggie Switch table: 201 831 5000	Stryker Orthopaedics 325 Corporate Drive Mahwah, New	16.40	Yolanda at the switch table is very helpful. after a failed attempt to get me the engineering department I am put through to Senior Director Matt Poggie. It turnes out that Stryker uses titanium, but not in bearing surfaces, and they do not polish it. They use several	Ida		Producer of prostheses

	Jersey 07430 United States		other kinds of treatment, like anodizing and polishes bearing surfaces. Research and developement focuses on altering the surfaces with regard to formulation of biofilm and bone growth stimulation. He would like me to send him the patent PDF. matt.poggie@stryker.com.			
P.O. Box 708 1800 West Center Street Warsaw, IN 46581-0708 Telephone: +1-800-613-6131	Zimmer	18.45	Can not put me through to anyone unless I have a name. This is very difficult to obtain through their website.	Ida		Producer of prostheses
Elise Pegg Research Engineer Tel: +44 (0) 1793 644 111 elise.pegg@biomet.com	Biomet UK Ltd Swindon	11.03	Elise tells me by e-mail that they found the patent PDF very interesting, and that it takes 30 minutes to manually polish a prosthesis, and another 30 minutes to clean it afterwards. She has also discovered that Biomet allready use electro polishing on steel components. I send her a reply asking why they don't use it on titanium, and how much time they save when they use it on steel. She tells me that she doesn't know how much time they save on steel, but that the reason they don't use it on titanium is operator safety, meaning more than risk of explosion. She thinks the chemicals in the patent pdf look pretty "unfriendly". I have made sure to include Ole Petter Nordahl's e-mail adress in the e-mail, as a contact adress for enquiries Biomet may have regarding TiE-polishing in the future.	Ida		Producer of prostheses
Nicolai Stensby Sales representative	Biomet Norway	Wednesday 14.30	I call to ask someone to explain what product segments are relevant for titanium polishing. Nicolai says we should consentrate on Dental, Orthopedic and spinal, and possible look into O.R. supplies and maybe bracing as well. He thinks it is pretty awesome to get a call from CERN and is very happy to give me the phone number of a prosthesis engineer at Biomet in Warsaw Indiana.	Ida	Adam Finley Engineer Biomet Warzaw Indiana +1 574 371 1175	Producer of prostheses
Adam Finley Engineer +1 574 371 1175	Biomet Warzaw Indiana	Wednesday 16.00	Adam F confirms that the trend in implants is towards titanium. It is cheaper that cobalt crome, and it has a better strength/weight ratio than steel. Some people also worry about the "battery effect" corrotion when steel is in a human body over long periods of time. He says that steel is mainly used in Orthopedic Reconstructive Devices (Ca 60% titanium and	Ida	Malcolm Nailor Surface finish expert Biomet +1 574 371 1123	Producer of prostheses

			increasing) and in Spinal Products (Ca 70-80% Titanium and increasing). According to Adam, Biomet allready uses electro polishing of titanium. He gives me the name and number of their surface finish expert, who knows more aout this.			
Malcolm Nailor Surface finish expert +1 574 371 1123 malcolm.naylor@biomet.com	Biomet Warzaw Indiana	Wednesday 17.15	Molcolm Naylor is a researcher, and not involved in production unless there is a problem. He confirms that electro polishing is used, but he thinks it may not be true that they do it with titanium. He generally seems to be unsure about the production routines, and the extent to wich titanium is polished at Biomet. He would like some more information, and I send him the patent pdf, along with some quick facts and the contact info for Henning Huuse.	Ida		Producer of prostheses
Adam Finley Engineer +1 574 371 1175	Biomet Warzaw Indiana	Wednesday 20.30	Biomet performs their polishing in-house	Ida		Producer of prostheses
Kaj Vidar Sandvoll, 004745863983	IV Mako Tools	onsdag 14.00	We do molding but also some polishing of titanium. There is a 5 step process to get a smooth surface, polishing might be the last one depending of what kind of smoothnes is demanded. For the custom made prosthesis' we polish mechanicly using an operator. This cost somewhere between 1000 and 1500 NOK and takes about 2 hours. We would be very interested in reducing the cost, and especially time of the polishing, 30% of our turnover comes from titanium, 10% from prosthesis and 20% from offshore and firefighter equipment.	Joachim		Producer of prostheses
Anita Olafsen, sekretær SCP	SCP proteser	onsdag 11.40	Technical chief was not in office, and really busy. I sent her an email with the questions, and she was going to forward it to technical director and managing director.	Bård		Prosthesis producer
John Kosmatka Department of Structural Engineering, Jacobs School of Engineering University of California San Diego 9500 Gilman Drive MC0085 La	USCD	2030	Left message with contact informatino	Andreas		Scientific

Jolla CA 92093-0085 tel: (858534-1779) Email: jkosmatka@uscd.edu						
Thorild N Hernes, 0047 93028341	Sintef Helse, medical technology	onsdag 11.30	She wasn't familiar with the report, SMM no 6/2002, but would send it by email if she found it. Should talk to Arild Åmot, leader for for national center for orthopedic implants in Norway. Should also contact SCP that produces custom hip-prosthesis for St.Olavs hospital in Trondheim, Norway	Bård	Arild Åmot: 0047 73861216, SCP: 0047 73401770	Scientific
Geir Hallan, 0047 55975000	Orthopedic surgeon, and writes an article at the moment about titanium prosthesis	onsdag 13.20	When hospitals buy prosthesis it is a prosess in which several parties are involved. The surgeon gives a recommendation, the economy is important and credibility for the company is really important. They need at least10 years of proven technology to be used officially. But about 15-20% of prosthesis is up to the surgeon only to decide, and opens up for new producers and suppliers. Uses about 7000 hip-prosthesis every year in Norway, only about 20% are titanium. BUT in the rest of the world, they use more titanium than stainless steel. So Norway lags behind on that area. Suppliers of prosthesis: Orthomedic AS, biggest supplier of titanium prosthesis in Norway. Uses a depuy-product, about 6000 used since 1977. Medinor, ask for Svein Heggstad. Disadvantages with titanium: Corrodes when used with cementation of the part. So when cementing the part to the bone they need to use stainless steel. We can consider all un-cemented prosthesis to made of titanium, almost nothing else i used there. Price for a prosthesis: 10 000NOK for a cemented one including cement, and 15 000 for an uncemented part of titanium.	Bård	Paul Johan Høl, institute for surgical subjects, Post.Doc. 0047 55585443	Scientific

			They use a cup made of plastic and stem of titanium The reason for polishing the stem is to make it not grow to the bone. Bacterial growth is a factor, but not nearly as important. They want the stem to grow to the bone at the top, but not at the bottom, so they polish it to prevent it from growing. Market trend: More and more uncemented prosthesis, and thereby titanium is being used!			
Terje Hjalmar Larsen, answer on email sent earlier		16.46	Hei, har gjerne ikke så oppløftende svar til deg.. Snakket med de som har holdt på med disse stentene i mange år. Titan-coatede stenter har blitt lansert flere ganger, men aldri tatt av. De har vært coated med titan nitridoxide, men har ikke hatt bedre utkomme enn stålstentene. Stentene består av stål kobolt krom, og det er det som stort sett blir brukt i dag. Vi legger inn et par tusen slike stenter i året. Merkene er Vision og Driver. Titancoating har også vært forsøkt på hjerteklaffer, men er vel ikke det store der heller. Oppfatter at metoden din er knyttet til titan - som brukes vel mye i ledd-proteser? - så stålstenter blirt vel noe annet mhp. polering? mvh Terje	Bård		Scientific
Espen Helge Aspnes, EspenHelge.H.Aspnes@sintef.no	seniorconsultant Sintef,	15.10	Hei! Vedlegger kontaktdata til Råg Aarnes som har drevet som forhandler av titan og minnemetall i flere år. Han har muligens et nettverk som er relevant også i denne sammenheng. Han er også sekretær for Rogaland Oppfinnerforening (http://www.nof.no/rogaland/) Foruten den typen proteser som SCP representerer, brukes jo titan mye f.eks. i tannimplantater, og her har	Bård	Råg Arnes	Scientific

			det også skjedd innovasjon i Norge, se http://www.dagensmedisin.no/nyheter/2004/10/13/verdenslanserer-nytt-tannim/index.xml. Starten på dette var vel Brånemarkmetoden (se http://www.tandlplith.se/branemark.html) Brånemarkmetoden var også utgangspunkt for konsept med feste av f.eks. "eksterne" benproteser direkte i benvevet. Den første i Norge som fikk en slik protese var Rolf Nygård fra Ålesund som er ferjeskipper. (Jeg traff ham i forb. med InnoMed-prosjektet "Høydereguleringsmekanisme for benprotese" som Inventas AS (www.inventas.no) drev gjennom datterselskapet In Lieu AS. Regner med at daglig leder Einar Selvig fikk et bredt nettverk gjennom dette prosjektet.) Med vennlig hilsen Espen H. Aspnes _____ Seniorrådgiver, SINTEF Teknologi og samfunn Innovasjonsrådgiver, InnoMed (www.innomed.no) Adresse: SINTEF, Avd. Medisinsk teknologi, Olav Kyrres gt. 9, 7465 Trondheim Tlf.: 930 59 050 - Telefaks: 930 70 800 - Espen.H.Aspnes@sintef.no			
Anne Marie Fenstad, anne.marie.fenstad@helse-bergen.no	Helse Bergen		Hei, vi har sett på spørsmålene deres og svart så nøyaktig vi har kunnet om proteser brukt i Norge. Spørsmålene er tatt punktvis som dere satt de opp. Håper det er blitt forståelig. Ta gjerne kontakt igjen om dere har flere spørsmål. (Men gjerne med litt bedre tidsmargin!) Mvh Thomas Kadar, lege Anne Marie Fenstad,statistiker	Bård		Scientific

			-Antall proteser som brukes årlig? I Norge blir det utført i overkant av 6500 primæroperasjoner og ca 1000 reoperasjoner årlig. Se forøvrig vår årsrapport på nettet for mer detaljer her: http://www.haukeland.no/nrl/ -bytte grunnet bakterievekst eller andre årsaker? Dette finner dere også i årsrapporten nevnt over. Det er mange årsaker til bytte av protese som aseptisk løsning, luksasjon, allergi eller bare smerte. Den vanligste årsaken er løsning av en del eller hele protesen. -hvem bestemmer? Helseforetakene enkeltvis har anbudsrunder (muligens noen enkelt sykehus?). -Hvor mye koster en protese: Det er stor variation vanligtvis mellom 5.000-10.000. Noen er enda dyrere. -Hvor mye koster en revisjonsoperasjon? Vanlig grunnet aseptisk løsning på grunn av infeksjon. Det er veldig dyrt da det ofte gjøres i seanser og man må regne med alt personell, antibiotika etc. -Hovedårsaken til bytte: aseptisk løsning. Årsaken til aseptisk løsning kan være mange men man antar at det er kroppens reaksjon på slitasjepartikler. -Inflammasjon? Her må dere eventuelt forklare mer hva dere mener. -krav til overflaten? Det er ikke noe bestemt krav til overflaten.			

			Mye av forskningen idag går ut på å forbedre holdbarheten av proteser. Faktorer som design, overflatebehandling, material, med mere har innvirkning på holdbarheten. Enkelte design krever en ru overflate, andre er mer avhengig av en polert overflate-dette er en hel vitenskap som har blitt utforsket i 40 år og som man fortsatt ikke helt sikkert kan svare på. -hvem leverer? Proteseleverandørene, flere forskjellige.			
Rolf johansen, innkjøpssjef (55973366)	Haukeland Universitetssykehus	Tirsdag 09.30	Busy in a meeting untill 11.00	Ida		Scientific
Leif Rune Hellevik Telefon 98283895	Prosessteknologi SINTEF Materialer og kjemi	10.20	Is in France, and left his cell at home. His wife is very nice, and she thinks I should try her husbands colleague, Bjørn Skallerud	Ida		Scientific
Sentralbordet	St. Olavs Hospital +47 815 55 850	11.00	I am put through to purchasing, where some woman "has no idea", and thinks I should speak to "Bjørn".	Ida	Bjørn: St Olavs Hospital Hf Fakturamottak Fakturamottak, 6405 Molde 959 78 004	Scientific
(+ 47 73593781)	National Competence Center for Orthopedic Implants (Norway), St Olavs Hospital	11.45	Nobody is answering. There are only 2 doctors working at the Centre, and they probably don't work full time.	Ida		Scientific
Stein Atle Lie stein.lie@smis.uib.no	Haukeland Universitetssykehus Bergen	21.57 tirsdag	Stein Atle is a statistician, and not sure if he is the right man to ask, but he sent me the link to his doctorate thesis about the norwegian hip implant death-rate.	Ida		Scientific
Switch board	NTNU	Wednesday	Dr. Olav Andreas Foss is the lead orthopedist at St. Olavs and in charge of the national Competence Centre	Ida	Dr Olav Andreas Foss	Scientific

		10.00	for Orthopedic Implants. He is very difficult to get hold of, but can ometimes be reached at his St Olav office: +47 72 82 61 59, and sometimes at his Universite office at NTNU: +47 73 55 08 59. Most of the time (like right now) he is somewere in between.		(+47) 72826159/7355 0859	
Hanne Osnes Ringen, 004792060711	Kirurg, Diakonhjemmet sykehus	20:15 tirsdag	Biofilm is created on surfaces of prostheses, this is unwanted. Call me back tomorrow afternoon	Joa chim		Scie ntific
Tordis Torvik, 004790942581	UiB, iko	Onsd ag 13:30	Man får høys sansynlig økt livskvalitet av renere og glattere oralimplantasjoner, men jeg ser på det samfunnsmessige og ikke det tekniske. Men er svært interessert i å følge denne utviklingen.	Joa chim	Technical advisory to the project Mihela Cimpan, 004748022207	Scie ntific
Mihela Cimpan, 004748022207	UiB, iko, biomaterials expert	Osda g 14:45	Two things are important for implant, surface and integration. There is not much polishing of oral implants as they need to grow to the bone. The surface of oral implants is rough in order for the bone to attach itself. But I know they use titan in stents.	Joa chim	Doctor Terje Hjalmar Larsen, 004748183284	Scie ntific
Doctor Terje Hjalmar Larsen, 004748183284	UiB	Onsd ag 14:50	Here we use somewhere between 2 and 4000 stents a year. They can be upto 4 mm in diameter and 20 mm in length. Send me an e-mail and i'll answer your questions in a couple of hours.	Joa chim		Scie ntific
Karina Arnsen, fung. innkjøpsdirektør (22 11 85 03) (91 33 21 09)	Ullevål universitets sykehus	10.56	No answer	Ida		Scie ntifitc
NTNU, Centre for heat research	Olav Bolland	1415	NTNU, instituttleder på varmeteknisk Olav Bolland Titan is not used due to limitations in temperature. After combustion blades are usually complex alloys which tolerates very high temperatures. Titanium could be used in the inlet, pre-combustion compressors. No knowledge of the production methods.	And reas	Gunnar Härkegård, Svenske professor ved NTNU Alstom Sveits,	Scie ntist
Doncasters, 0044 1743 454 300	Doncasters	1045 Onsdag	You have to talk to someone at maching fab. We mostly do supperalloys etc.	And reas	Rob Williams @ machine fab	Supp lier of materials

Secretary, 001610 9681300	TiMet	18:30	Not answering, tried random extentions and got some good chats but nothing of value.	Joachim		Supplier of metal
Kjetil Mongstad, 0047 55392230	GMT titanium	Tirsdag 0913	GMT does not polish or finish titanium products themselves. They had one customer who asked for a polished surface once, and the reason he wanted it was to make an installation look nice, so it was purely visual reasons for wanting it. Should contact Strømme betex, they do more of the finishing	Bård	Strømme Betex, 56312000	Supplier of metals
Raymond Abrahamsen, 56312000	Strømme Betex	Tirsdag 0917	They don't do much of polished titanium. Raymond has worked there for ten years, and during that time, only one customer has asked for it. A polished, titanium shaft. The reason he wanted it polished was to get really low degrees of toleranse on the shaft. He couldn't remember what industry or product this was for. Should contact Bergen B&B overflatebehandling or something like that. Couldn't remember the number and wasn't completely sure about the name	Bård	Bergen B&B overflatebehandling	Supplier of metals
Quality control guy, 0044 148 979 6262	GMT UK	10.30	Didn't know anything about polishing of titanium seeing that they sold it as it was after machining.	Bård		Supplier of metals
Anselm Kuhn, 0044 1438 745115	Metal Finishing Information Services	Tirsdag 11.40	Has written an article; "The Electropolishing of Titanium and Its Alloys", but couldn't remember the specific article. I sent an email to him, and he was going to reply as soon as he could	Bård		Supplier of metals
George, 0044 118-978-0202	Hempel UK, titanium supplier	Tirsdag 11.45	They don't supply polished titanium. Never used it, don't know who does	Bård		Supplier of metals
??, 0049 208-62040	Hempel, Germany	tirsdag 11.47	Talked to someone that I couldn't catch the name of. He talked to a colleague that was the "titanium expert" there. He didn't know anything about titanium polishing, he thought they might buy it already polished before machining.. But wasn't sure..	Bård		Supplier of metals
Brian Johnson, 0033237254801	European Titanium Service	Tirsdag 17:50	We sell semi-finished titanium to end customers and intermediates, we supply the raw materials. This means	Joachim	Stryker is your best bet;	Supplier of

			row bars between 1 and 19 mm diameter. But we don't polish the titanium, that's the job of our customers. You should look into hip implants, our biggest customers there are marle and stryker in France. I know marle just spent a lot of money buying polishing equipment, so I would say stryker is your best bet. The medical industry is very technically advanced and always looking for improvements.		Mr.Colleng.	metals
Watchmaker, 004790643465	Thune	Tirsdag 0905	One advantage of titanium watches is that they doesn't provoke allergies. Titanium is stronger, has higher heat conductivity, is more resistant to scratches, it's a better material. Polished titanium has really gotten wings the last couple of years, earlier the watches were just sandblasted or brushed. Stainless steel and polished titanium doesn't differ much in price. In the more expensive segment, Ti is a bit more expensive, but not a lot. There is most definitively a market for polished titanium watches. I'm actually dissapointed there hasn't been more parts like chains and chases made out of Ti. It's easier to relate to, the part about there being less scratches is important, the customer wants their watches to look nice. Inside the watches we use syntethic rubies and steel, if titanium can lower the friction that would would be an advantage. By lowering the friction there is less wear and tear and less consumption of energy, which allows the batteries to last longer. Loss of power is the many problem o watchmakers. An other point is the influence of temperature, how does the materials expand. This influences the accuracy of the watch. Generally a kvartswatch has an error of one second a year, while mechanical watches might have an error of three seconds a day. Still, in the higher price segments, most watches are mechanical, if you go above 20 000, all watches are mechanical. The explanation is that it's fully mechanic, as one of the last gadgets of our time, is' feels better to wear.	Joachim	Swatch-group	Watches
Peter Sonje [lydskrift]	Omega	09.40	We don't have polished titanium, but I know Longines Watch has it, they even had a fire that	Joachim	Longines Watch,	Watches

			originated in sparks from Titanium polishing.		Customer Relations Manager Patric Shafer [lydskrift].	
Peter Shäfer[lydskrift], 0041329425425	Longines Watches	1100	His on vacation.	Joachim	You can call back tomorrow to talk to Anic Karnvang [lydksrift] he's in at 0900. Or you can talk to TECH.	Watches
Øvind Engen, 0041329425265	Longines Watches	1105	Polishing titanium needs to be done slowly or it can start a fire due to the high temperature and the sparks. This actually happened with our mechanical polishing at this place, but it was before my time here. We had a lot titanuim earlier, but there's no titanium in the program now. The reason? I don't know.	Joachim	Talk to product to find out whether we're going into titanium in the future. 00413294254225 Letauc Pascal [lydskrift].	Watches
Letauc Pascal [lydskrift], 00413294254225	Longines Watches	11.15	In a meeting, talks little english.	Joachim		Watches
'9101166628680/+9101166136000	Titan (largest watchmanufacturer in India)	1140	Unable to connect	Joachim		Watches
Sales, 0041326545454	Breitllinger	10.15	We don't have titanium polished watches, ours are sandblasted. Emergency is the most expensive titanium watch we have.	Joachim	Breitlinger Distrubitor in Scandinavia. 0046854490770	