Surface design methodology – the cleanability investigation

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Abstract. A conservative culture and a robust material with a genuine past is probably the best way of describing the medical healthcare environments around the country. Stainless steel has dominated for decades, and it is not only because of its technical properties. The feeling of a clean surrounding and sterile equipment are high rated within this culture, you have to trust the material and its surface. However, what will happen when stainless steel is replaced with another material, still meeting the same (or higher) technical requirements? Is it possible to challenge the steel and its robust and hygienic experience? Will the users of the equipment have fate in the new material and its surface? The purpose of this paper is to link the technical- and customer requirements of current materials to surface textures in medical environments. By focusing on parts of the theory of Kansei Engineering, improvements of products are possible. In collaboration with the topical company for this project, three new materials that fulfil the technical requirements –easy to clean and anti-bacterial came to be in focus for further investigation in regard to a new design of the steriliser for medical equipment using the Kansei based Clean ability approach CAA. Focusing on the correlation between the cleaning, the surface design parameters and the experience of the new materials/surfaces; discussions regarding the optimal material/surface design of the product and the challenging of the stainless steel are initiated. The results of this study show that materials with similar or better cleanability properties very well can exchange the traditional brushed stainless steel materials. Also, the optimal wipe material and cleaning agents system can be developed using the modified Kansei Engineering method. The continuation of this study will be to further include surface properties to influence on bacterial growth to complete the CAA.

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Keywords: Cleanability, material design, functional surfaces, Kansei Design, stainless steel.

1. INTRODUCTION

Stainless steel has dominated as a material in the medical healthcare environments for decades, and it is not only because of its technical properties. It feels secure and it mediates a sensation of a hygienic environment, (figure 1).

Figure 1: Figure illustrating the topical domain, sterilizers in a medical healthcare environment.

However, a material/surface could only be considered as a success if the person who matters understands the message (Krippendorf K, 2006) and (Wikström L, 2002). Nevertheless, the material selections are not only about ensuring the safety in a construction or optimize weight in a product for instance. Zoom into the material beyond what we can see with naked eye, and the microstructure will expose a landscape that affects us as users more than we can understand. Blood residues; and other soils need to be removable from the surface and microstructure of products in the healthcare environment, and the supplier has to be able to guarantee a surface with good cleanability. It is important for a company supplying the health care sector with products to not only impose a feeling of good cleanability, but to also take responsibility of the products actual performance and verification in terms of cleanability.

Professor Mitsou Nagamachi (Hiroshima International University) had a vision about improve products on a more detailed level than before. Hence, he developed the method Kansei Engineering (KE) in the 1970’s which has its roots from the Japanese concept of Kansei, (“intuitive mental action of the person who feels some sort of impression from an external stimulus”) (Nagamachi M and Lokman A M, 2011). According to Professor Nagamachi the Kansei concept include; "a feeling about a certain something that likely will improve one's quality of life". KE can also be defined as a customer-oriented approach to product development (Nagamachi M, 1997), (Nagamachi M, 2002), (Frisk M, and Järlskog H, 2002) and (Hedberg Ö M, 2004).

By using the framework of KE as an approach and focusing on finding correlations in between the functions; customer requirements, function requirements, design requirements and process requirements; a higher level of user quality could be obtained.

The majority of people on earth navigate through life using their impressions and feelings, and the confidence of our intuitive religion and preferences; often with a good result (Kahneman, D, 2013). The perceived quality is related to the experience of the product, and the experience is directly connected to the interaction and stimulation of the senses (Wolfe J M, et al. 2012). The costumer describes their experience of a product with describing words as; elegant, plastic or stylish and so on (Bergman M, et al. 2012). Yet, what they describe is only their feeling of a visual or haptic experience for instance, a stimuli of the senses, nothing else! By focusing on the sensation and the emotions by varying materials and surfaces textures, the perceived experience of the product will vary, and by that also the qualitative customers feeling impression (Bergman M, et al. 2012). Now, is it possible to link those parameters to the costumer's feelings and experience (and put a number onto it), but at the same time fulfil the technical requirements of the product?

The KE method modified to be adaptable to material and surface design has been used systematically to be able to develop a tailor made toolbox for designers where special tools for product surface properties optimization are introduced (see also (Bergman M, et al. 2012).

The research approach used in this project handles 6 different phases/steps, (figure 2);

1. Pilot Study – In this phase it is important to define the questions; what, who, where, how, why, and when? But also to implement a market analysis.
2. Describe the Experience – In this phase focus is lying on the description of the experience, which is possible by firstly collecting adequate describing words of the typical domain which the user express when interacting with it.
3. Define Key Product Properties – In this phase it is important to know the product and its features. It is about finding properties that affects the user, yet it is important that the properties are measurable and adjustable.
4. Connect the Experience and Product Properties – By gathering typical users into a focus group which mission is to analyse and evaluate the domain; it is possible to obtain information about the product experience. In this phase focus is lying on finding connection between the describing words (experience) and the key product properties.
5. Validity Check Point – When the correlation is established, it is important to verify potential other domains tested in the project. This is possible by measure and compares the key product properties, either the competitive domain fails the test or it will precede to the next level.
6. Synthesis and Modelling the Domain – When the experience is evaluated towards a number of different product properties and the correlation is verified, the development of a new domain is possible.

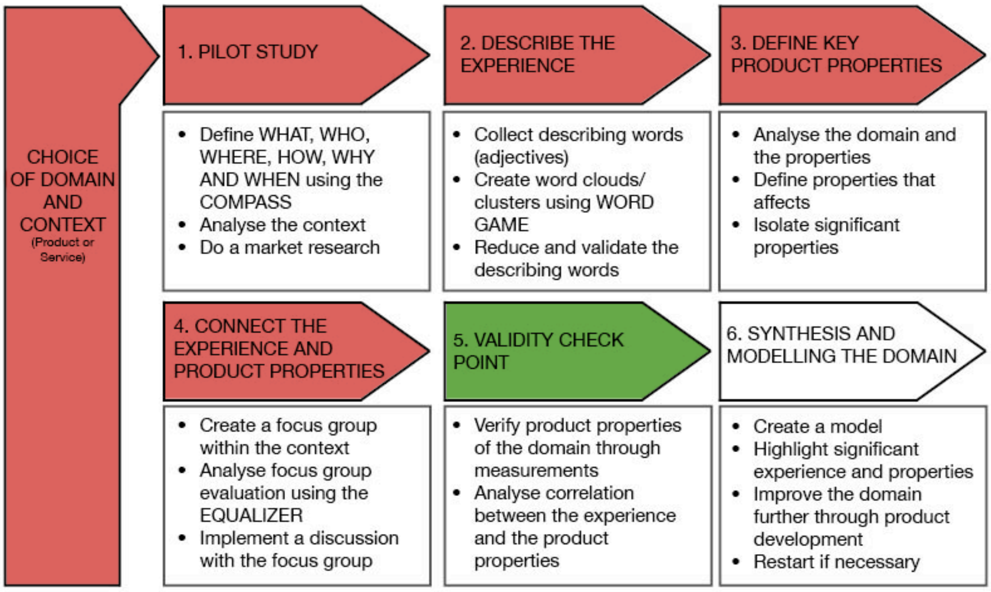


Figure 2: Illustration of the research approach. Phases 1-4 (red), is already covered in previous case studies. Phase 5 is highlighted in green and indicate the position of this case study in the overall research approach.

2. METHOD

However, the main issue in this project mainly handles the “cleanability” of materials and surfaces. Focus is lying on finding differences in three new materials for the topical company in regard to the cleanability, which in this study is implemented by a “wipe off”-test. This case study briefly handles step 5 in the research approach, the “Validity Check Point”. But focus also lying on finding correlations in-between the cleanability and the surface appearance (surface properties). This approach will be called “Clean Ability Approach” (CAA) from now on in this project. The CAA is about analysing the material and surface, which is directly linked to the product properties of the domain, EU report, (2013). Hence, the CAA could be placed in Phase 3 (if defining a material/surface) and/or 5 (if analysing a material/surface) in the research approach. However, verification of an analysed material is difficult without a reference. Hence, the topical company´s trademark surface (stainless steel with brushed texture) will be used as a reference in regard to surface parameters. The continuation of this study will be to further include surface properties to influence on bacterial growth to complete the CAA.

2.1. CAA – A “wipe off” test

The test in this case study handles different factors of importance in regard to the cleanability of the product materials and surfaces. Three different materials/surfaces were involved in the test; glass, spray painted aluminium and acrylic plastic. Three different solvents were used; 70% alcohol[5], chlorine[6] and “all-purpose cleaner”[7]. Three different materials for cleaning the surface were used;

[5] DAX, 70+ Surface disinfector – Opus Health Care AB, Malmö Sweden

[6] Refin, chlorine – Rusta AB, Upplands Väsby Sweden

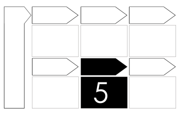
[7] All-purpose cleaner – Biltema AB, Helsingborg Sweden

microfiber fabric[8], drying paper[9] (extra good absorbency) and industry paper[10] (rough paper).

The soil that was used in the test was a blood-like chemical[11] (artificial blood), which the topical company developed and uses in their own tests. The idea of using this soil is obviously because blood in itself is difficult to remove from surfaces, fabrics and so forth.

The wiping process was made by means of a simple custom made tool that basically was a thin flexible steel arm with a clip for attachment of the wiping materials. The contact area of the wiping materials was restricted to $12cm^2$, which is about the contact area of the fingertips of one hand. The realistic wiping force was estimated using a simple wiping test and a dynamometer. The results turned out to be in between 5-15N, therefore the force in this test were fixed to 10N throughout the whole test. The amount of wiping cycles was limited to three.

3. RESULT



The result is based on a literature study, a previous case study, a cleanability-test and measurements of the company´s reference surface (stainless steel), and additional materials challenging the stainless steel in regard to the material/surface design. As mentioned earlier the result is focused on phase 5 in the research flow chart (figure 1), therefore phase 1-4 is not highlighted in the result. For a deeper understanding in the result regarding Phase 1-4 the reader is recommended to reed Surface design methodology – challenge the steel by (Bergman M, et al. 2013).

The validity check provides the opportunity of a checkpoint where selected materials are measured and evaluated, or such in this case study analysed through a special test. The material samples that advanced through the focus group in the previous case were measured using a MicroXAM phase shifting- and coherence scanning interferometry instrument[12] and analysed in Mountains Map Premium 6[13] to establish quantitative measures of the surface texture. Initial focus was concentrated on the surface texture arithmetical mean height, *Sa*, according to ISO 25178:2011. *Sa* is considered as the surface texture property closely connected in internal company standards to the legislative demands on *bacterial resistance*, and *clean ability* i.e. connecting *Sa* and CAA. In the previous study the cleanability was to be considered "OK" when the Sa value for a given surface is <0.8µm, mainly focusing on stainless steel in general, Detry, J G, et al. (2010), Hilbert, L R, et al. (2003) and EU report, (2013). NOTE: *Originally the "Ra maximum 0.8µm rule" was determined for the profile ISO 4287:1997 Ra parameter, in this study replaced by the areal defined Sa parameter according to ISO 25178-2:2012*. Detry, J G, et al. (2010) and Hilbert, L R, et al. (2003) however claims, that there is no report of a direct relationship between the Ra/(Sa)-value and the cleanability, even though the majority of investigations of cleanability focusing on this parameter. Detry, J G, et al. (2010) also says that a surface could have a Ra-value up to 3.2µm and still be acceptable as long as the cleaning fluid flow rate is "sufficient enough to remove the soils from the surface".

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[8] Turtle Microfiber Exterior – SEAB, Märsta Sweden

[9] Turtle Drying paper – SEAB, Märsta Sweden

[10] "Grov Tork" industry paper – Biltema AB, Helsingborg Sweden

[11] Getinge Soil artificial blood – Getinge AB, Getinge Sweden

[12] ADE Phase Shift MicroXAM Optical interferometric profiler characteristics [online]. http://www.tcd.ie/CMA/misc/MicroXam.pdf

[13] Digital Surf, Besançon, France, http://www.digitalsurf.fr

3.1. Developing a new quantitative method for “wipe-off” cleanability

In this study the three challenging materials where measured and analysed in terms of the CAA, and the “wipe-off”-effect. The main idea was to link the Key Product Properties with the experience of the materials and the CAA. However, the Glass, Spray painted aluminium and Acrylic plastic was measured and analysed and they all appear to pass a criteria of a Sa value of <0.4μm. The glass and the spray painted aluminium is even below <0.05μm (table 1).

Table 1: Surface Roughness; with both the 2D- and 3D parameter; of the glass, spray painted aluminum, acrylic plastic and the reference surface Stainless Steel.

ISO 25178:2011/4287:1997	Glass	Spray-Painted Aluminium	Acrylic Plastic	Stainless Steel (Reference)
Sa (3D-parameter)	0.01 μm	0.03 μm	0.39 μm	0.70 μm
Ra (2D-parameter)	0.01 μm	0.05 μm	0.33 μm	0.40 μm

To get a deeper understanding of the microstructure, and have a chance to evaluate how the microstructure correlate with the cleanability; the surfaces were compared not only with the parameters in table 1, but also visually judged and compared to the surface microstructures, (figure 2). The surface microstructure might appear very rough to the reader, although the area of the measured surfaces is 800x600 μm, and the vertical scale is magnified compared to the horizontal scales to enhance the microstructure.

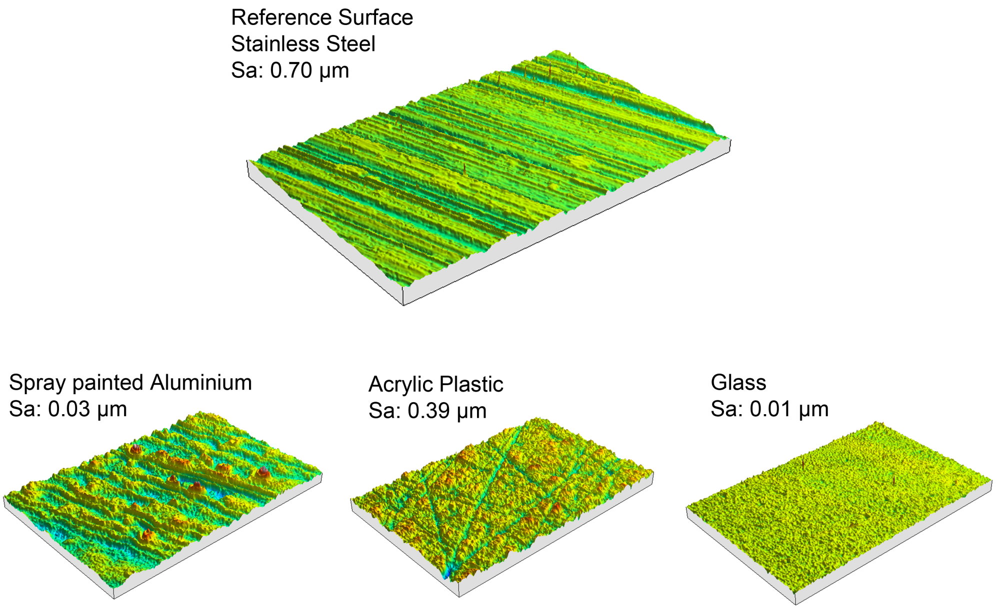

Figure 3: Illustration of the surfaces microstructure including the reference surface stainless steel.

With the three new materials and the stainless steel reference surface, the cleanability test was implemented, the “wipe-off”-test described earlier.

The main idea with the “wipe off”-test was to compare the cleanability of the surfaces, quantifying the “wipe off effect” and the adhesion of the artificial blood that were used as a soil/dirt.

Initial tests with the different chemicals and wipe of fabrics gave some unexpected outcomes though. The microfiber fabric (which is to be considered as a good one on the market), did not handle the 70% alcohol very well, it started to lose its colour onto the material/surface (in this case blue). Therefore, the microfiber fabric was excluded for the moment. It also turned out to be difficult to measure what was left on the surface after each wiping test. A photo of the surface was not enough as a result due to the fact that it became to clean to see a difference between the materials with naked eye. Hence, a new chemical were introduced in the test, Flourecinnatrium[14], which have got a fluorescent effect with UV light (black light). The Flourecinnatrium were mixed with the artificial blood, and the test could be re-established. Thanks to the mix of Flourecinnatrium in the artificial blood, after wiping the surface, the artificial blood that did not disappear were easier to see by means of UV light. However, by using UV light and focusing on the fluorescent effect the blue discoloration of the microfiber fabric would not interfere with the result of what was left from the artificial blood anymore. Hence, the microfiber fabric “was back” in to the test again.

After the initial pre-tests, 27 different tests were made in the following phase, one for each material (Glass, Spray painted aluminium and Acrylic plastic), the chemicals (70% alcohol, chlorine and “all-purpose cleaner”) and fabrics (microfiber fabric, paper with extra good absorbency and industry paper – rough paper).

The result of this test gave some answers and a few more questions. The pictures that were taken were imageprocessed to get a clearer view of the difference between the Flourecinnatrium and the surface; firstly the all pictures were inverted, secondly they were turned into black and white and thirdly the contrast was increased.

The evaluation of the cleanability were handling three different factors; “the ring” (the coagulated soil that is left after wiping the surface), “the spot” (the soil inside “the ring”) and “the leftovers” (the soil that is left after removing the fabric from the surface), see figure 4.

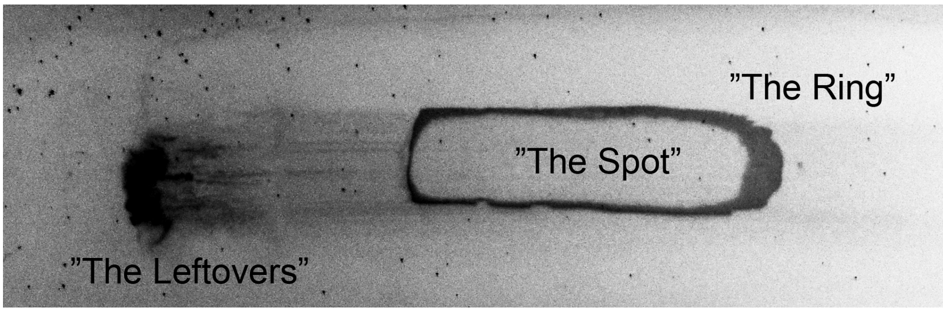

Figure 4: Picture illustrating the cleanability evaluation factors; the ring, the spot and the leftovers.

3.2. Wipe-off test results –the CAA score

The surfaces and the factors are evaluated in a scale of “1 to 10”, -the CAA score were “1” is to be considered as the worst result in the test and “10” is the best result in the test in regard to the cleanability. The score is judged by a skilled operator as the “relative absence” of fluorescent dark areas in the images. The whole test with its result is illustrated in table 2.

[14] Scharlau, Flourecin Sodium, C.I. 45350 – Fisher Scientific, Gothenburg

Table 2: Table showing the test result for the cleanability.

		"Wipe-off material"									
		Microfiber fabric, *MF*			**Drying paper** (extra good absorbency), *DP*			**Industry paper** (rough paper), *IP*			
		Solvent			*Solvent*			*Solvent*			
SURFACE	**AREA**	70% alcohol, *70%*	Chlorine, *CH*	All-Purpose Cleaner, *APC*	70% alcohol, *70%*	Chlorine, *CH*	All-Purpose Cleaner, *APC*	70% alcohol, *70%*	Chlorine, *CH*	All-Purpose Cleaner, *APC*	SUM
SPRAY PAINTED ALUMINA	The Ring	5	7	5	4	3	4	6	6	4	44
	The Spot	9	9	7	8	4	5	9	7	2	60
	The Leftovers	7	6	7	7	7	7	2	3	3	49
	SUM	**21**	**22**	**19**	**19**	**14**	**16**	**17**	**16**	**9**	**153**
GLASS	The Ring	10	10	8	4	4	2	7	6	6	57
	The Spot	9	9	8	6	5	3	9	7	8	64
	The Leftovers	6	6	7	6	6	6	1	1	1	40
	SUM	**25**	**25**	**23**	**16**	**15**	**11**	**17**	**14**	**15**	**161**
ACRYLIC PLASTIC	The Ring	3	8	5	4	2	4	3	3	2	34
	The Spot	9	8	7	8	2	7	6	7	3	57
	The Leftovers	7	8	7	4	4	4	1	1	1	37
	SUM	**19**	**24**	**19**	**16**	**8**	**15**	**10**	**11**	**6**	**128**
STAINLESS STEEL	The Ring	8	7	6	7	5	4	5	2	3	47
	The Spot	8	8	6	6	5	3	5	2	2	45
	The Leftovers	8	7	8	6	5	3	4	3	3	47
	SUM	**24**	**22**	**20**	**19**	**15**	**10**	**14**	**7**	**8**	**139**
Total of sums		**89**	**93**	**81**	**70**	**52**	**52**	**58**	**48**	**38**	
Sum of total of sums		263			174			144			

3.3. The "wipe-off" results for the four surface materials

To support the analyse of the results in table 2, radar and bar diagrams were created, as illustrated in figure 5 and 6 below, with the sum of remaining soil in focus. The "total CAA" results in fig. 5, and 7-9 exposes a number of answers; the glass together with the microfiber fabric and the 70% alcohol or the chlorine, provides the best result. The Glass is a favourable choice in terms of the cleanability, measuring the surfaces respectively area in the radar diagram (top) in figure 6. The other materials are yet not far behind. Interesting thought is the fact that acrylic plastic (which have got a lower Sa-value) in the total score became last place; even though the difference is just 8% compared stainless steel.

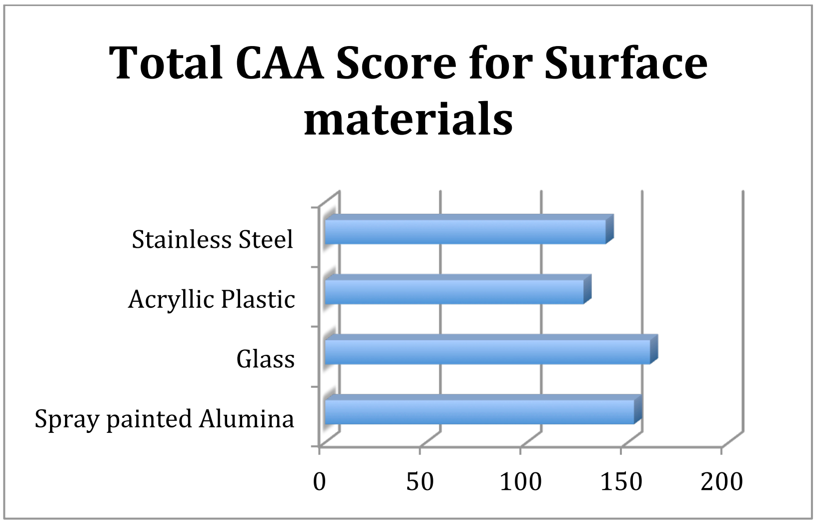

Figure 5: Figure illustrating the CAA score for the different surfaces.

The radar plot in figure 6 below adds to the results here the decreased performance for all surfaces while using the Industrial paper.

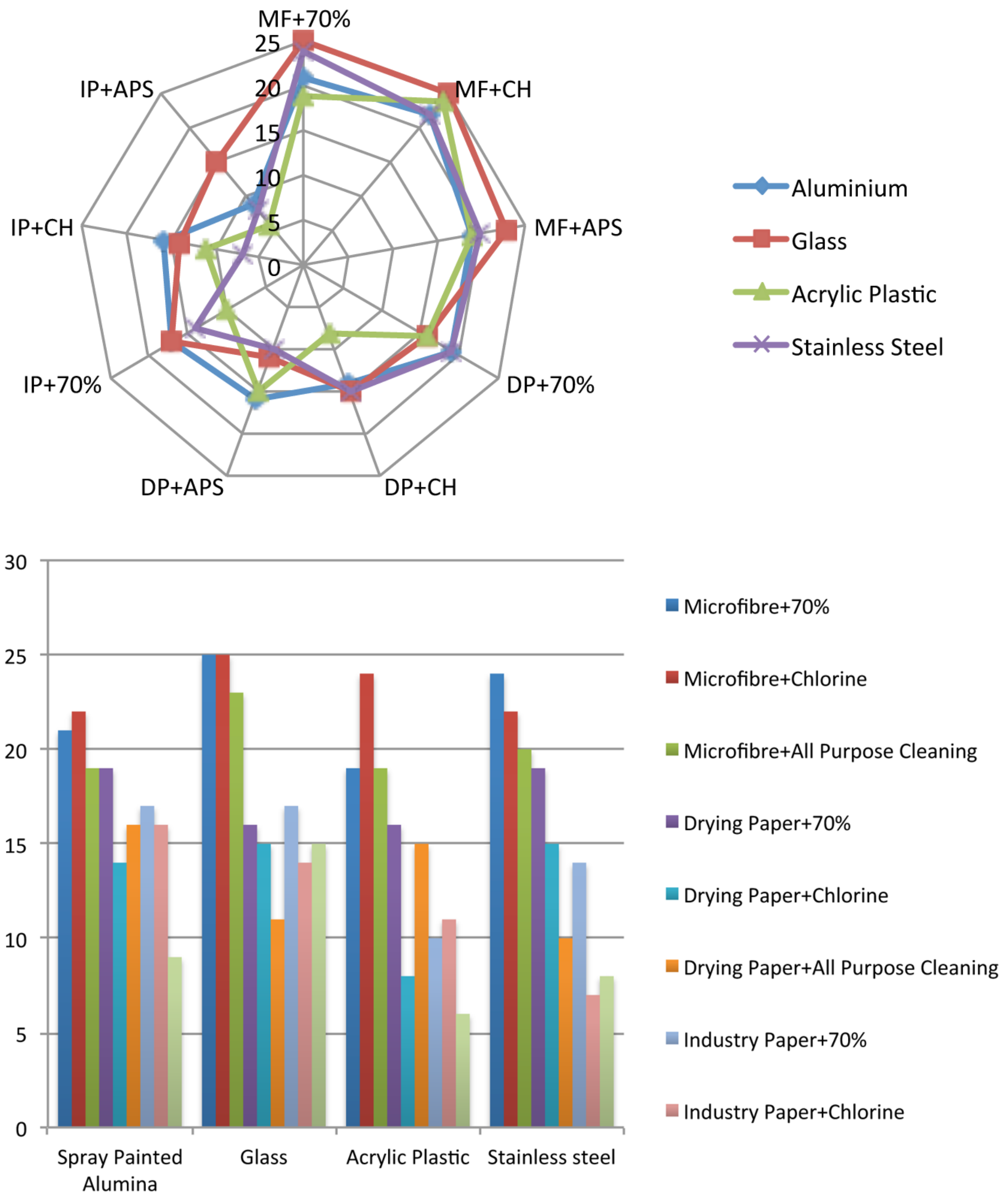

Figure 6: Figure illustrating the sum-result of the cleanability test. The bar-diagram (bottom) illustrating the "Total" score for the wipe material and cleaning agent for the spray painted aluminum, glass, acrylic plastic, and the reference, Stainless steel.

From figure 6 above, it is possible to deduct optimal combinations of wiper materials and cleaning agents for the different surface materials with regards to the total CAA score. All surface materials perform well with the microfiber wiper.

This analyse does not show the differences between the factors (the ring, the spot and the leftovers), hence new diagrams were made with major focus on the differences in between the factors and the wipe material/solvent, (figure 7-9).

3.4. The results for the three different "wipe-off" materials

It is not to surprising that the microfiber is on the first place with a 34% advantage to the next competitor, Drying paper. More surprising though is the minor different between the more expensive drying paper and the cheaper industry paper, only 17%.

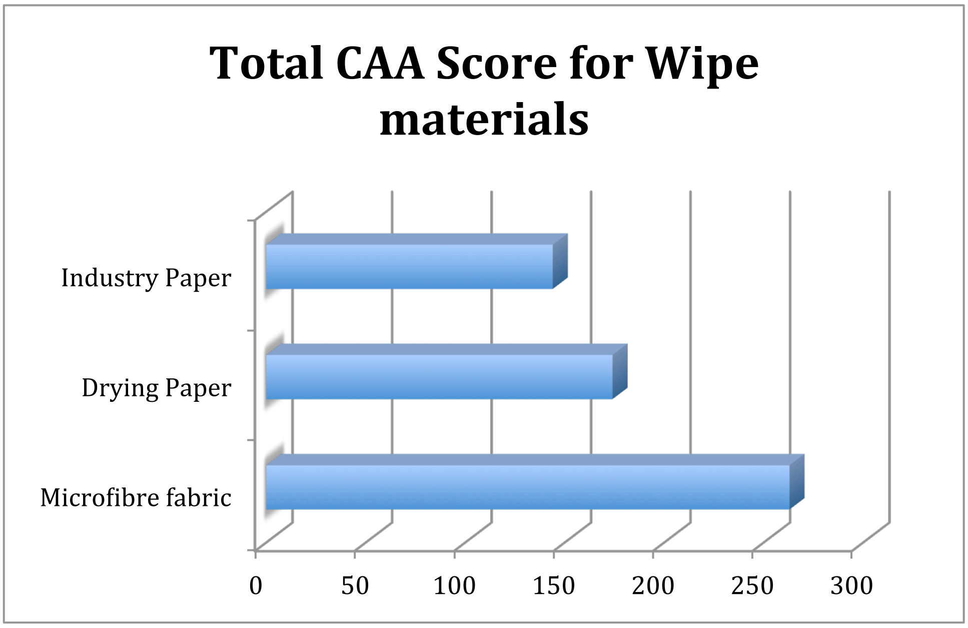

Figure 7: Illustrations of the differences in CAA score for all the three Wipe materials.

The major reason why the microfiber is 34% better score, depending on the consistently absorb-efficiency through the whole test. Yet, the test was about what is left on the surface after the test, and it is clear that the microfiber provides a better result.

3.5. The "wipe-off" results for the cleaning agents

From figure 8 below, for all the materials, the 70% alcohol display the best ability to move the soil "clean" from the surface independent of cleaning material.

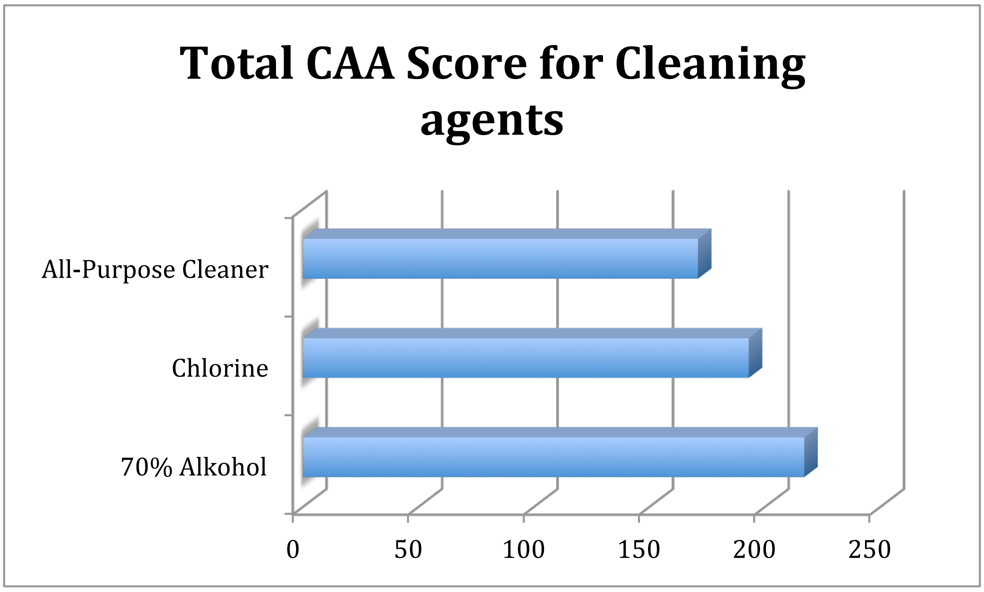

Figure 8: Illustration off the differences between the cleaning agents summed for all four surfaces respectively.

3.6. The “wipe-off” results for the combination of cleaning agents and wipe materials

From the results above, microfiber fabric wiper and the 70% alcohol or the chlorine, provides the best results. In figure 9 the total CAA score for cleaning agents and the wipe materials is illustrated.

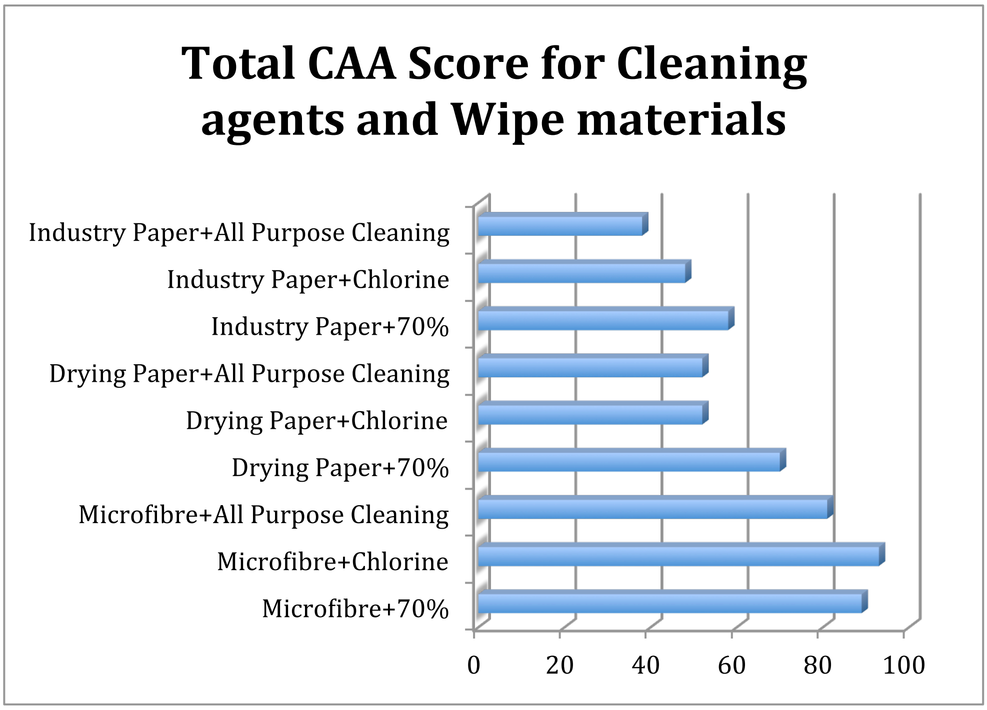

Figure 9: Graph illustrating the differences in between the combinations of cleaning agents and wipe material.

However, interesting in this diagram is the difference in between the Industry paper+70% and the Drying paper+chlorine (and APS) for instance. Even though the drying paper in general have got a better score regarding the cleanability, the Industry paper together with the 70% alcohol have got a higher score. Therefore it is important to know about the different combinations of wiping materials and cleaning agents.

3.7. The detailed “wipe-off” results for the surface materials –CAA scores for part areas

Again the microfiber is confirmed as the superior wipe material for all surfaces for all combinations of wiper material and cleaning agents for the ring- the spot- and the leftover areas. The leftover score is low for the paper material combinations for all materials, Spray painted alumina-, Glass- and Stainless steel surfaces. A big difference between Ring- and Spot scores compared to the Leftover Scores indicate either a low performing Cleaning agent (a negative difference) or a low performing wipe material with a low soil absorbance capability (a positive difference). For the Glass surfaces its clear from Fig. 10 (top right) below that the Industry paper can’t absorb the dissolved soil while the Drying paper in combination with all cleaning agents have a problem to both dissolve and to absorb dissolved soil.

By not focusing on one of the materials, but only the factors of artificial blood, shows consistently that the ring was the most difficult factor to remove. This is obviously caused of the coagulation process of the artificial blood; it coagulates faster at the edges. However, the Spot on the other hand was consistently the easiest factor to remove due to the opposite; it coagulates slower and therefore the adhesion is lower to the material. Now, how about what is left when deviate from the surface with the wiping material? Well, the leftovers expose how good or bad the wiping materials actually absorb the artificial blood. This is primary varying in between the wiping materials and the different surfaces/materials, as mentioned above. The Industry paper for example, might appear to be effective wiping the spot although it is basically just pushing the soil in the front of the paper and leaving a sizable leftover. Although the Microfiber fabric wiper, consistently absorbs the artificial blood better and leaving less soil on the surface. The differences of the factors and the four surfaces are illustrated in figure 10.

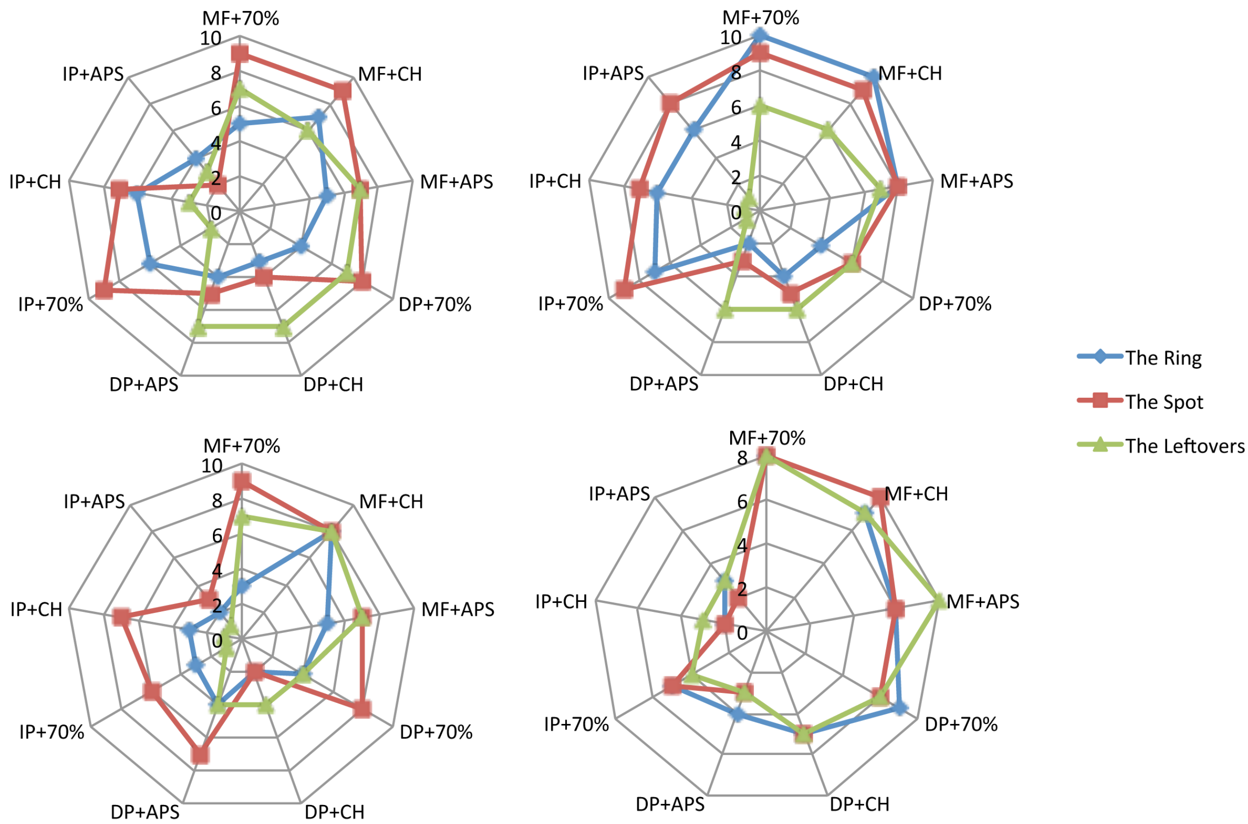

Figure 10: Radar diagrams illustrating the differences in between the factors and the wipe material/solvent of the Spray painted aluminium (top left), Glass (top right), Acrylic plastic (bottom left), and the reference, Stainless steel (bottom right).

The reference material Stainless steel react partly different from the Glass; all combinations of wiper material Industry paper and cleaning agents show both a low dissolving capacity for Ring- and Spot areas as well as a low capacity to absorb the dissolved soil. Combinations of Cleaning agents and the Drying paper are here performing better than the Industry paper but the Microfiber outperform both the paper variants.

4. DISCUSSION

Now, the experience of a visionary product is difficult to concretize, and even more difficult to put a number on to it. Nevertheless, by converting the experience to describing words such as adjectives, it is easier to understand and analyse the outcome of the emotions. Bergman M, et al. (2013)

The main issue in this case study was to find an approach and to evaluate the cleanability, but also finding correlations in between the cleanability, different materials and the emotions (experience) of the domain. Now, we know that the Glass, Spray painted aluminium and Acrylic plastic, in an earlier case study, passed through the focus group discussions about an visionary product and that these materials fulfil the visionary experience of a; *robust, resistant, clean, warm, sleek* and *elegant* product, Bergman M, et al. (2013). However, did they stand up for their good reputation even through this case study?

As shown in the table and figures there were some differences in between the surfaces total score but also between the factors, wipe off materials and solvents. A figure assembled of seven different photos is illustrated below to get an even better picture of how these surfaces could looked like after cleaning, (figure 11).

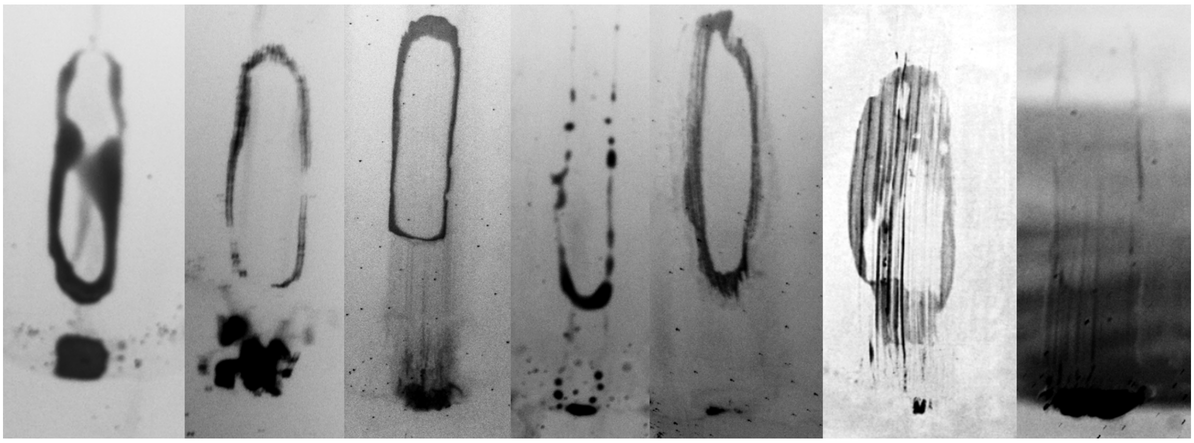

Figure 11: Figure illustrating a selection of seven different results from the wipe off test were the factors; the ring, the spot and the leftovers, have got a variance.

Now, the result of the wipe off test reveals three important things; the choice of wipe material is significant and so is the solvent. Nevertheless, the choice of material is fundamental; in this case study the Microfiber fabric together with the 70% alcohol or the Chlorine on the Glass gave the best result. Yet, the surfaces (all four of them) are good enough in terms of the cleanability in regard to the measurements.

4.1. The design of the microstructure

We can confirm that all of the four materials tested, passed the technical requirement of open contact surfaces, Sa <0.8μm, even though the surface roughness specification using Ra could be challenged separately. Focusing on the three challenging materials (Spray painted Aluminium, Glass and Acrylic plastic) they all are between 2-70 times smoother in terms of the roughness Sa-value. It appears to be correlation between the Sa-value and a cleaner surface (the cleaner surface the lower Sa-value). However, there are more parameters in the ISO 25178:2011 and 4287:1997 that could have an impact on the cleanability. What we do know is that the topical company wants a parameter to specify their own surfaces and to be able to guarantee their polishing process in regard of the surface roughness. From that point of view the Sa-value is clearly a good initial choice of design parameter since the long industrial experience in using the closely related Ra-value for specification and the current common use of Ra when specifying surface topography in publications on cleanability and bacteria growth.

4.2. The total CAA score results

The total CAA score results exposes that the Glass together with the Microfiber fabric wiper and the 70% alcohol or the Chlorine, provides the best result. This result offers the companies a possibility to create their own surface cleaning and maintenance procedures guaranteeing “cleanest surfaces”.

4.3. The factors – the ring, the spot and the leftovers

The factors affecting the cleanability of the surfaces became an interesting parameter. Soil that are removed quickly (before it is coagulated) is obviously easier to remove, although a spot of coagulated blood residues with variance in thickness for instance could appear the same way as in this case study. It is significant; and it is important to choose a wipe material and a solvent that not only dissolves the soil, but also absorbs it effectively.

4.4. The conceptualization of emotion/experience

So how does the result from the wipe off test correlate with the design of a future product? First of all the material selection has to be proper; form follow function. Using the three “Stainless steel challenging materials” with their proven cleanability properties, one concept design of a future sterilizer challenging the current design (figure 12, left) is illustrated in figure 12 to the right. Here the Glass with its cleanability performance are covering the major area of the domain where the human operators normally interact with the product and create needs of cleaning. The transparent Glass is also providing the opportunity of adding a graphical pattern using a background foil without losing the desired cleanability function materialized by the Glass surface. The semi elastic Acrylic plastic is shock- and scratch resistant; and therefore placed directly under the Glass (grey part in fig. 12 right) where the loading trolley encounters each loading cycle. The lower part (dark blue in fig. 12 right) is covered with cost effective Spray painted aluminium –all surfaces with verified cleanability performance compared to the traditional Stainless steel.

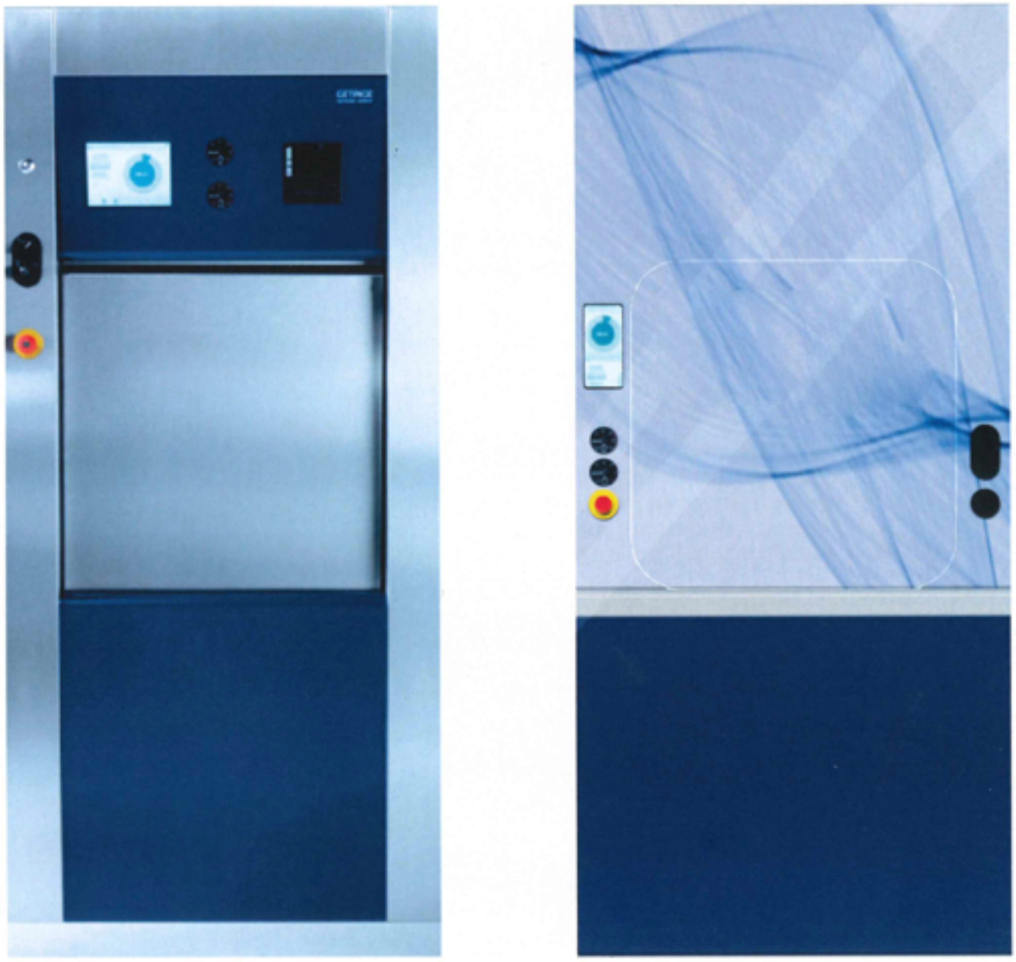

Figure 12: Figure showing the existing domain (left), and a visionary product (right).

The overall experience of healthcare environments could be improved if suppliers understand benefits and capitalize on advanced material and surface selection, not only from an economic viewpoint, but also from a functional and user perspective. If the topical company want a higher level of visual and haptic stimuli of their products the material and surface design is fundamental. The Spray painted aluminium, the Glass and the Acrylic plastic does not only provide a clean surface after maintenance, but also convey a *robust, resistant, clean, warm, sleek* and *elegant* feeling.

4.5. Additional implementations

We know that the design of the microstructure matters regarding the cleanability, and that the Sa-value is the only reference to the roughness in regard of a surface specification for the company so far. Yet, there are parameters that might interfere with the cleanability if focusing on the bacterial growth and the adhesion as well rather than the wipe off effect only. Dürr, H (2007) claims that the contact angle between the soil and the surface matters as well, which could differ depending on the soil, but also the surface roughness. For a deeper understanding on the contact angle and the effects of it, the reader is endorsed to read Woodward R P, (1999).

5. CONCLUSIONS

- For the challenging of traditional Stainless steel materials; Glass, Spray painted alumina and Acrylic plastic all are compete able alternatives with superior or similar cleanability properties.
- For the wiping materials; the Microfiber have got the best properties in terms of getting the cleanest surface.
- For the cleaning agents; the 70% alcohol or the chlorine have got the best properties in terms of getting the cleanest surface
- For the emotion and the experience; stainless steel should and could be challenged using the here introduced Clean ability approach to be able to change, and improve, the user experience of products in healthcare environments.

ACKNOWLEDGEMENT

The functional surface research group at Halmstad University would like to express a special acknowledge to Getinge Infection Control AB Sweden for the financial support, but also for the special interest in this project.

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BIOGRAPHY

Martin Bergman was born 1985 in the middle of Sweden close to the lake "Vänern", which by the way is the 3rd biggest lake in Europe. He has a background as a technician/engineer in the plastic industry and has a design engineer bachelor. His 2-year master thesis is within industrial design, and was about functional surfaces for the typical sauna environment. Today he is currently a PhD. student in Mechanical Engineering/Industrial Design at the Department of Business and Engineering at Halmstad University (Högskolan i Halmstad) and also Industrial Design Education Manager at Halmstad University. Martin has been into several projects within material design, starting 2010 by traveling to Kansas (US) for a life there doing research at Kansas University in collaboration with architectural company, A Zahner Company. Since that moment, material and surface design has been in focus.

Bengt-Göran Rosén, BG, was born 1962 in Halmstad on the Swedish west-coast. He is currently professor in Mechanical Engineering at the Department of Business and Engineering at Halmstad University (Högskolan i Halmstad) and heads one of the main research areas – Mechanical Engineering and Industrial Design. He has been appointed visiting professor at Lund University in the south of Sweden, at ENISE Ecolé Nationale d'Ingénieurs de Saint-Etienne in France and is currently visiting professor at Chalmers University of Technology in Functional Surfaces and BISTU, Beijing Information Science & Technology University. 2010-2012 BG was the Chairman of the national Swedish Production Academy and is currently vice president for the same organisation. BG is active in international- and national standardisation work within the ISO TC 213, Dimensional and geometrical product specifications and verification, as Swedish expert in the field of surface structure- and previously co-ordinate measuring machine metrology. BG has been working since 1988 with the different Volvo companies and lately also Scania on manufacturing, characterisation and function on drive train components from engines to cam-shafts and gears. BG also have an interest in surfaces for prosthesis applications like dental implants and hip-joints and has lately worked intensively with industrial designers to promote surfaces as a strategic tool for the successful innovative companies.

Lars Eriksson was born 1964 in the Swedish capital city, Stockholm. He has been working as an Industrial designer since 1994 when he was graduated in Umeå with a Master of Fine Art at the

School of Design in Umeå at Umea University. Lars has been working 11 years as Industrial Designer with over 30 industrial clients, in total included research and educational company collaboration over 100 clients. Today he is a professor in industrial design and occupied with education and research with a focus on Industrial design in general and surface properties in specific. For the last five years Lars has been involved in design research with a special focus on surface properties with a functional approach. Lars is at present time co supervisor for 4 PhD students, 3 in surface properties with Licentiate degrees of Engineering and 1 in the properties of lighting and design.