1. INTRODUCTION [1, 2, 3]

In recent years, a great deal of effort has been made on durability and poor maintainability of upholstery leather. The main purpose of finishing is to increase the durability and beauty of leather. The compatibility and nature of the leather product, materials, tannage, colouring, fat liquoring to name a few, play an important role in the character of the leather and its properties. These include wear resistance, chemical resistance, and of course soiling resistance. Since the introduction of water- based finishes for upholstery leather, moving away from traditional organic solvent-based products for environmental reasons and the increase in the level of pale coloured finished leather due to fashion, a noticeable increase in consumer complaints has been recorded regarding soiling. The problem manifests itself in lighter coloured leathers, although it is considered that most leathers with this type of surface finish behave in a similar way, darker colours simply mask the problem.

Furniture upholstery in leather accounts for around 20 % (£240 million) of the UK upholstery market. Therefore a reduction of consumer complaints will improve the image of the leather industry, also a reduction of returns, will lead to reduced operating costs for the leather sector. This explains why leather companies are making great efforts to solve the soiling issues. Obviously, in order to avoid it, it's necessary to understand its effect, behaviour and mechanism.

To understand soiling it is necessary to consider some factors, which may affect it.

- Soil release defined as a removal of soiling by cleaning, should be more widely considered. Also removal of soiling by dry spot removal and other techniques such as suction, beating of carpets and every conceivable method of soiling removal.
- Soil release (removal) is dependent on composition.
- Not only the soiling should be removed from the material to be cleaned, it must be prevented from redesposition.
- Soiling does depend on the method of soiling, and soil release depends on the method of cleaning and the method of assessment.
- Studies about removing soiling determined casein and fluorochemicals gave significant improvement against the tendency to soil, but fluorochemicals shows a further improvement over the casein in the removal of soil by a simple sponge cleaning.
- Cleaning is generally associated with washing, except for the more delicate fibres where dry cleaning is more appropriate, not because it is more efficient, but because in solvent cleaning there is less risk of shrinkage and distortion.
- Soil prevention is better than the cure.

Considering that leather are manufactured in the most different types of leather which have been treated with a great variety of tanning agents, dyes, fat liquoring or finishing agents, the cleaning of leather is much more difficult and labour-intensive than cleaning of textiles. In addition, there are many different types of possible soiling such as staining by different items of daily use like coffee, wine, and specially biro ink, stains caused by raindrops, discoloration, perspiration marks or change of handle can be also recorded. An example of cleaning procedure for garments, which can be recommended to the consumers, is shown below:

Sorting: For leather garments is essentially an individual treatment. The leather is sorted according to suede and nubuk leathers, finished and unfinished grain leathers and leather/textile combinations. The nature of soiling also has to be taken into consideration.

Pre-treatments: Sections of garments, which are heavily soiled, should be pre-cleaned by hand, if necessary by adding cleaning intensifiers (special surfactants) if the stain is water-soluble.

Washing: Wet cleaning is only possible if leather material is labelled as washable. This is not the case with most leather garments. If possible, garments are washed in washing machines with a maximum water temperature of 35 °C and the use of detergents or neutral soaps. Drying should be very gentle recording is necessary to soften the fibres. Shrinking or considerable changes of shape may be caused.

Dry Cleaning: This method is the most frequently employed. The most detergents used are perchloroethylene and fluorocarbon. The ratio of liquor (material to be cleaned to solvent) should be at least 1:20 to avoid maltreatment of the material and scuff marks. The time of application should not exceed 30 minutes to protect the leather material. In most cases 10-15 minutes are sufficient.

Drying: Drying of the cleaned leather garments should be as gentle as possible, if possible on hangers or wire netting frames. There is a risk of shrinkage and deformation during drying.

Moreover, cleaning technologies have been made a big effort in order to increase cleaners efficient in the last few years. All leather article of everyday use require permanent care. In most cases, this comprises only superficial treatments, which should be chosen individually for each type of leather. The method of care depends of the finish and surface condition of the leather in question. Some examples of leather care products that can be available are shown below:

Polishes, Sprays and liquids: On grain leather these products have the function to cleaning the surface of the leather, imparting gloss and providing a protective film against water, dust, dirt, etc. These products are divided into:
Oil products: Pure oils, waxes, paraffins, etc. These products are suitable for shoes care but there is a risk of staining on leathers, which are porous. Film-forming substance must not be used for suede and nubuk leathers.
Emulsions: There are water-in-oil, similar application as a pure oil without a risk of increase staining, and oil-in-water.
Aqueous product: These products are free of organic solvent. They are used to treat leather garments, upholstery leathers and also fine leather articles.

Mild Detergents: In dissolved form these can be used for clean superficial dirt from finished leathers by rubbing lightly. The surfactants contained in these detergents help to dissolve the dirt.

Neutral Soap: Non-alkaline soap solutions. Made from palm oil or olive oil. Used for suede leather with a light fat liquoring effect.

Leather oils, leather greases: These consist of mixtures of neutral fats, synthetic fats or oils, mineral oils and waxes. Their purpose is to preserve pliability, mostly of vegetable tanned leathers.

Water-repellent agents: Many water-repellent substances are used by aerosol application to achieve a thin protective barrier.

Even though information about cleaning and maintainability is available as mentioned above, consumer complaints are still recorded. Due to improper use of cleaning materials and the availability of products that are not suitable for purpose.

2.OBJECTIVES

The main objective of the project is to investigate the effects of cleaning products on upholstery leather finishes. Focusing on products applicable to upholstery leather cleaning, non-typical leather cleaners (and possible contaminants) or ink removers, in order to find out their behaviour, understanding how they work and if they are suitable for their purpose. Moreover an initial investigation about mechanism of soiling is proposed, in order, in the future, to avoid the soiling or develop an anti-soiling system making an improvement on the durability and maintainability in the leather types and producing an increase of the leather quality.

2.OBJECTIUS

El principal objectiu d'aquest projecte es la investigació dels efectes de productes de neteja en la tapisseria de cuir, profunditzant en els productes aplicables per la seva neteja tal com; netejadors per tapisseria de cuir, no específics per cuir (i altres) i finalment, netejadors per taques de bolígrafs. El propòsit és esbrinar el seu comportament ,entendre com funcionen y si realment són adequats per al seu ús. A més a més, es va portar a terme una investigació inicial sobre el mecanisme d'embrutiment de la pell, per tal de, en un futur, evitar possibles taques ó desenvolupar un sistema que eviti ó com a mínim disminueixi l'embrutiment, produint una major durabilitat i mantenibilitat en els diferents tipus de pell i produir un augment de la qualitat del cuir.

3.METHODOLOGY [4]

Methodology is divided into four parts. First one is explaining upholstery leather cleaners that are available for leather industry. Upholstery leather is a high technology product which qualities specification will depend on its destination as a furniture or automotive leather. Generally these properties are colour fastness to rubbing, flex resistance, tearing strength, for name a few. Also depending on the quantity of pigment used in finish process, upholstery leather can be divided into;

- **Aniline**, which consists just in a extremely thin film allowing to observe all the natural looking of the leather, even hair porous of the skin.
- **Semi-aniline**, which are leather with several irregularities and they suffered a mild addition of pigment.
- **Pigmented**, which are leather with higher irregularities on the finish and they suffered a strong addition of pigment, giving a glossy surface and rubbing and water resistance. With pigmented finishing is not able to observe even hair porous on the surface.

In order to assess the leather cleaner results it was used 2 pigmented upholstery leathers, beige and black colours, from the same finish process, for regarding their behaviour in light and dark leather. Therefore they were used as standard upholstery leather, which would be comparing with sample leathers at physical testing after cleaner application.

Second part is about Non-Typical leather cleaners and possible contaminants. Studies about unconventional products that can be used for clean leather up were made. Also possible contaminants can affect somehow upholstery leather. Physical testing and optical microscope observations were carried out in this direction.

Third part consists in a deep work about ink soiling. Studies were carried out focusing in a visual and chemical effects produced by ink soil, using optical microscope, electro microscope and attenuated total reflectance (Infrared spectrophotometer) respectively.

Finally last part is an initial test about mechanism of soiling that can be produced on the leather surface. Investigations were developed focusing in some leather properties such as surface tension and surface charge.

3.1 Upholstery Leather Cleaners

The aim of this stage was to carry out physical testing; either upholstery leather samples or standard upholstery leather controls, used as a reference, before and after leather cleaners were applied. In order to understand if any change in the physical properties of the leather was developed. Also to assess how the leather samples can be affected. Information on their efficacy and fitness for purpose will be gained. Physical testing was carried out as below:

Test	Standard Method
Flex Resistance	EN 13512: 2001
Rub Fastness	BS EN ISO 11640/ ISO 11641: 1998
Water Spotting	SLF 420: 1996 (IULTCS)
Maintainability	BLC/IKEA method (AB RCR96-7-013)
Softness	IUP 36: 1998 (IULTCS)
Gloss	No standard method
Handle	No standard method
Coated Fabrics	BS 3424: Part 11: 1982

These standard methods were used to examine 18 leather cleaners/aftercare kits using 17 upholstery leathers, which are divided in different leather types.

- 7 Pigmented Automotive Leathers
- 7 Pigmented Domestic Leathers
- 2 Semi-Aniline Domestic Leathers
- 1 Aniline Domestic Leather

According with testing protocol; prEN 13336 and prEN 13336-2 for each leather types, was carried out the following specifications:

LEATHER TYPE	SPECIFICATION
Automotive Upholstery	**Flex:** 100.000 cycles **Rub Fastness:** 1000 cycles Dry. Min grade 4 500 cycles Wet. Min grade 4 100 cycles Pers. Min grade 4 **Water Spotting** **Maintainability** **Aesthetics**
Domestic Pigmented Upholstery	**Flex:** 50.000 cycles **Rub Fastness:** 500 cycles Dry. Min grade 5 250 cycles Wet. Min grade 4 80 cycles Pers. Min grade 4 **Water Spotting** **Maintainability** **Aesthetics**
Domestic Semi-Aniline Upholstery	**Flex:** 50.000 cycles **Rub Fastness:** 500 cycles Dry. Min grade 4 80 cycles Wet. Min grade 3/4 50 cycles Pers. Min grade 3/4 **Water Spotting** **Maintainability** **Aesthetics**
Domestic Aniline Upholstery	**Flex:** 50.000 cycles **Rub Fastness:** 50 cycles Dry. Min grade 3 20 cycles Wet. Min grade 3 20 cycles Pers. Min grade 3 **Water Spotting** **Maintainability** **Aesthetics**

3.2 Non-Typical Leather Cleaners (and possible contaminants)

Physical testing was carried out to examine some typical household cleaners and possible contaminants on beige standard pigmented upholstery leather. These products may be used to clean leather and may contaminate; it is important to know if any effect on the leather was developed; and also a comparison with leather cleaners could be made.

These standard methods were developed for a physical testing as following:

Test	Standard Method
Flex Resistance	EN 13512: 2001
Rub Fastness	BS EN ISO 11640/ISO 11641: 1998
Softness	IUP 36: 1998 (IULTCS)
Gloss	No standard method

The products examined were:

- Washing up liquid
- Furniture polish
- Stain removing sprays
- Hair gel
- Hair spray
- General upholstery cleaners
- Leather dressing

According with testing protocol; prEN 13336-2 for each leather types, was carried out the following specifications:

LEATHER TYPE	SPECIFICATION
Domestic Pigmented Upholstery	**Flex:** 50.000 cycles **Rub Fastness:** 500 cycles Dry. Min grade 5 250 cycles Wet. Min grade 4 **Aesthetics**

3.3 Ink Soiling [5]

Ink soiling studies were carried out as part of research program "Leather Finishing Soiling". This program explained first of all leather cleaners couldn't remove coloured stains unless fast treatment after soiling occurs and in some cases, such as semi-aniline leathers, cannot be removed even if cleaned immediately. Ink penetration investigations were carried out.

The main conclusions from this investigation were:

- Ink can penetrate deep into the topcoats in short periods of time under mild conditions.
- Once penetrated it become very difficult to remove without finish removal.
- Humidity has the greatest effect on penetration. Temperature and pressure play only a minor part.
- Inks penetrated a distance of around 20 times the average thickness of a topcoat within 24 hours at 20°C and 65 % r.h.
- Acrylic polymer appears to have better resistance to ink penetration than polyurethane.

The investigation of ink soiling was continued, focusing on ink remover products.

3.3.1 Test ink penetration over time

Studies were carried out to investigate the mechanism of ink removal with different ink types and at different method of application. Ink types were applied onto light and dark standard upholstery leather and 8 types of ink removers were used to clean the leather surface after some time. A first understanding about how they can performance was taken. No specific method was developed.

3.3.2 Surface examination by optical microscope [6]

Using microscopes in the leather industry has been for many years an important tool, especially for quality control. The optical microscope uses visible light passing through a lens or lenses to create a magnified image. The simplest form of using light passing through a lens to obtain a magnified image is the magnifying glass. In the laboratory, the most common form of light microscope is the compound microscope. Light is passed through the sample (usually from underneath using a light source in the microscope base plate) and passes through 2 lenses in the microscope, the objective and ocular. The real image is formed at the objective lens whilst the image viewed by the microscopist, is seem through the ocular lens (the eyepiece). This results in the image viewed being magnified twice, once at each lens. Using objective and ocular lenses of differing magnifications and by altering the working distance the sample is viewed from can considerably alter the magnification the specimen is examined at.

The wavelength of visible light and the ability of the human eye limit the magnification obtained by light microscopes. The normal human eye has the ability to resolve two point's 0.1mm apart at its nearest distance of distinct vision. This means that any sample magnified must have a minimum resolvable distance of 0.1mm to allow the human eye to distinguish it.

A schematic of an optical microscope is shown as below:

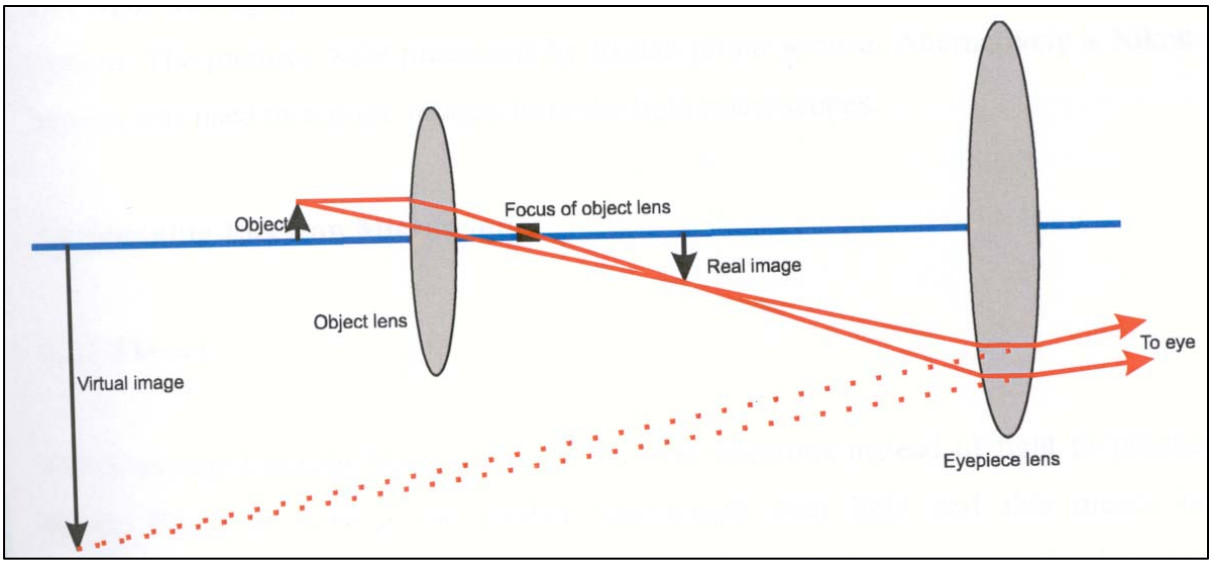


Figure 1: Schematic of an optical microscope.

Two convex lenses can form a microscope. The objective lens is positioned close to the object to be viewed. It forms an upside-down and magnified image called a real image because the light rays actually pass through the place where the image lies. The ocular lens, or eyepiece lens, acts as a magnifying glass for this real image. The ocular lens makes the light rays spread more, so that they appear to come from a large inverted image beyond the objectives lens. Because light rays do not actually pass through this location, the image is called a virtual image.

The magnification of the sample when viewed under the light microscope has to be calculated using a standard. This can be roughly calculated using the quoted magnifications of the lenses, but for accurate magnifications, a graticule or stage micrometer must be used.

In this case, Optical microscope was used to obtain images of the surface, either for non-typical leather cleaners (and possible contaminants) or ink soiling after ink remover application. This provides visual information about the effect of these products.

3.3.3 Surface examination by Scanning Electron Microscope (SEM) [6]

Scanning Electron Microscope (SEM) is a important tool for leather analysis due its advantages such as non-destructive technique, use the electrons instead of light for obtain an image and higher magnifications can be achieved on SEM than the optical microscope. An electron beam is produced from a tungsten filament which functions as the cathode located at the top of the column. A voltage is applied causing it to heat up. The anode, which is positive with respect the filament, forms attractive forces for electrons. This cause electrons to accelerate towards the anode through the column, reducing the bean diameter by the condenser lens (approximately from 50μm to around 5nm), and focused as a very fine point on the surface of the specimen by the objective lens. Underneath this lens is a set of apertures, which define the angle of the final bean. The size of the aperture in conjunction with the working distance controls the depth of focus of the probe beam. The scanning system, which consists of sets of beam deflection coils that move the beam across the specimen. The coils are controlled by an oscillator, which provides different frequencies to the coils, controlling movement of the beam both across and down the sample. As the name suggests the scanning electron microscope obtains an image by scanning the surface of the specimen with an electron beam.

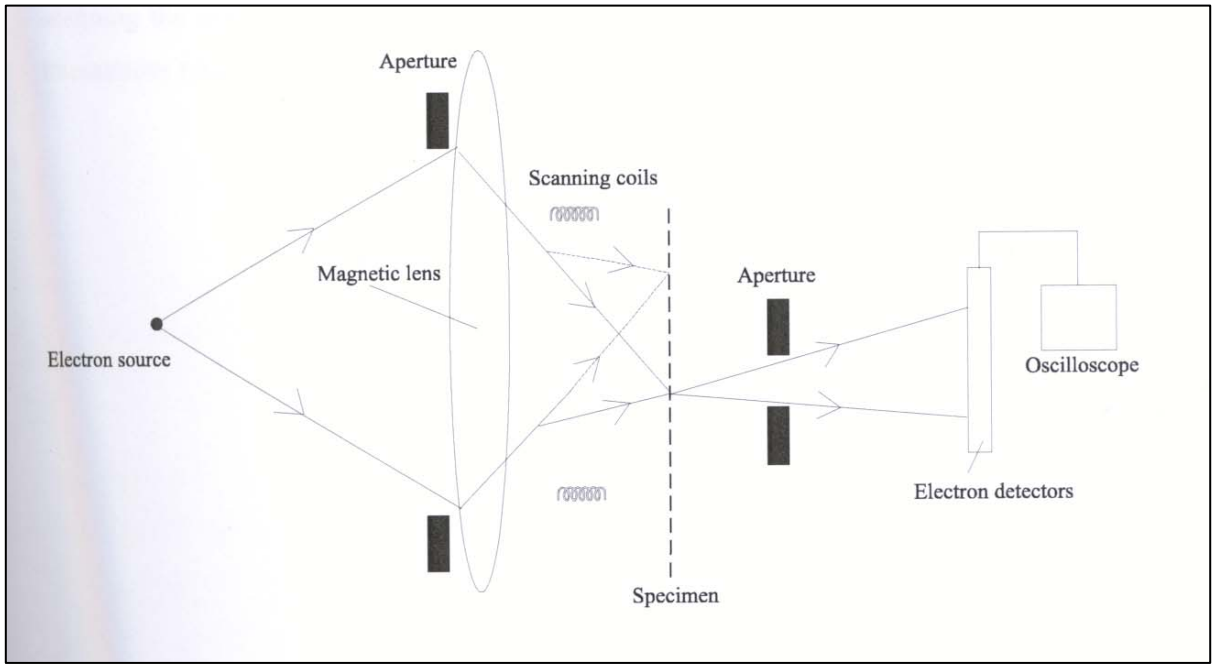


Figure 2: Schematic of the mechanism of scanning electron microscope.

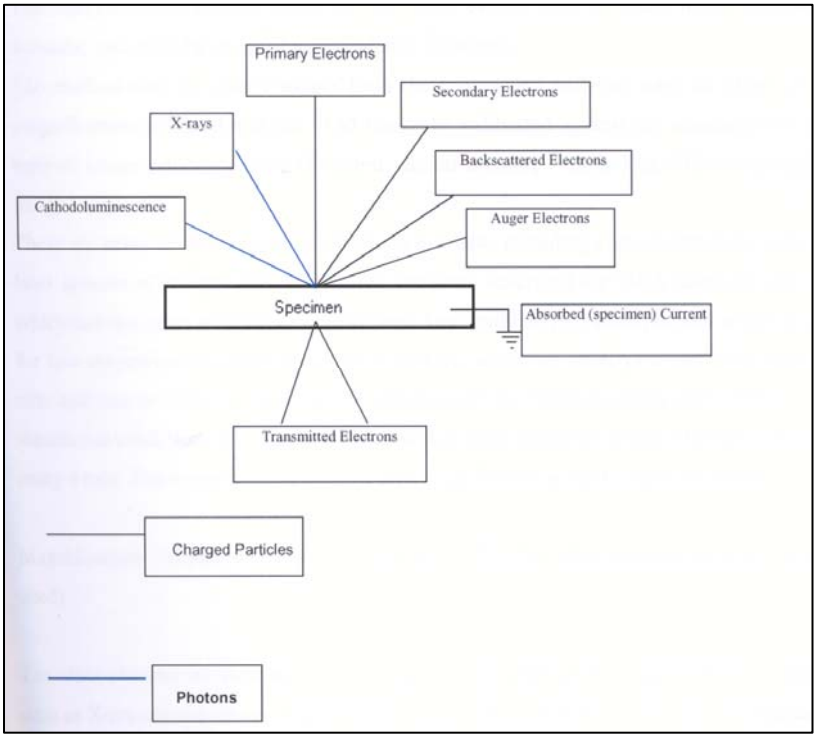


Figure 3: Schematic of interactions when a surface is bombarded with electrons.

The electron beam hits the sample, producing secondary electrons (specimen electrons that obtain energy by inelastic collisions with energy less than 50ev) from the sample. These electrons are collected by a secondary detector or a backscatter detector converted to a voltage, amplified and used to obtain standard images using SEM. The amplified voltage is applied to the grid of the cathode ray tube (CRT) and causes the intensity of the spot of light to change. The image consists of thousands of spots of varying intensity on the face of a CRT that correspond to the topography of the sample or specimen. The magnification of the image obtained is a direct correlation between the area scanned and the size of the CRT. This is explained by the equation below:

Magnification = area of CRT screen / area of the sample scanned

When SEM is used it must operates under vacuum. There are many reasons for this. If sample is in a gas filled environment, an electron beam cannot be generated or maintained because of the high instability in the beam. Gases could react with the electron source, causing it to burn out, or cause electrons in the beam to ionise, which produces random discharges and leads to instability in the beam. The microscope use to operate as an example at a minimum vacuum of 7x10-4 Pa.

SEM was used in this project for examining leather samples from ink soiling.

3.3.4 Chemical contamination by Attenuated Total Reflectance (ATR) [7, 8, 9]

Contaminants such as dirt, dust and mildew are easily seen with microscope. Sometimes, however, the contaminant is not apparent visually, and spectroscopy methods are required.

Attenuated Total Reflectance (ATR) is an important method for obtaining the infrared spectra of solids or films has been described as a beam of radiation traverses a prism so that it is reflected from the back face of the prism as shown as below:

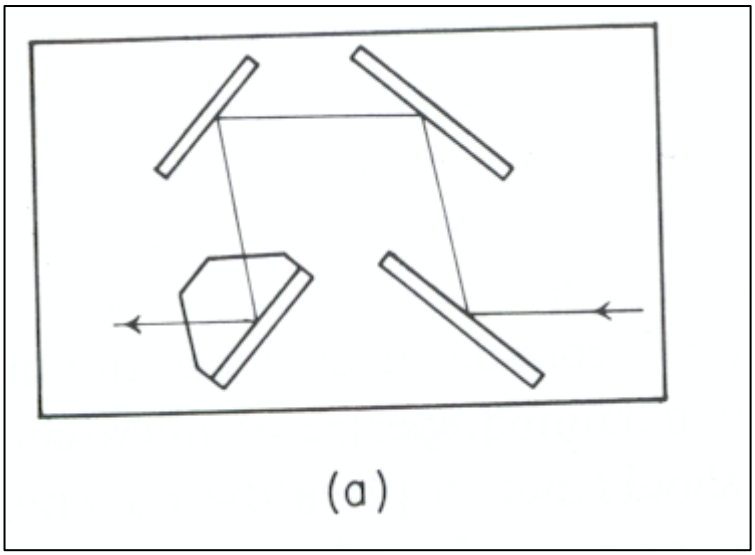


Figure 4: Schematic of the optical mechanism of ATR prism.

Some portion of the energy of the beam escape of the face and is returned into the prism. If an absorbing substance is placed on the reflecting surface, under suitable conditions the energy that escape temporarily from the prism is selectively absorbed. The transfer of energy is roughly proportional to the ratio of the indices of refraction of the prism material and the substance. Since the refractive index of the substance changes rapidly at wavelengths of the absorption the plot of the energy transfer versus wavelength is very similar to the conventional infrared absorption spectrum of the substance. The infrared band intensities are the equivalent of the penetration of a few microns into the substance and are independent of the sample thickness. To obtain suitable spectra the angle of incidence of the infrared beam on the internally reflecting face of the prism must be adjustable. In addition, the prism should have a higher index of refraction that the substance to be examined. Specially designed liquid and solid sample holders hold the sample against the reflecting surface of the prism. The sample is placed on the smooth side of the silver chloride plate. The other side contains a pattern of parallel prism (formed by pressing), which place a series of surfaces roughly perpendicular to the incoming radiation beam. Thus, the infrared radiation striking these faces penetrates the plate rather than being reflected from the top surface. Reflection with attenuation takes place at the rear surface.

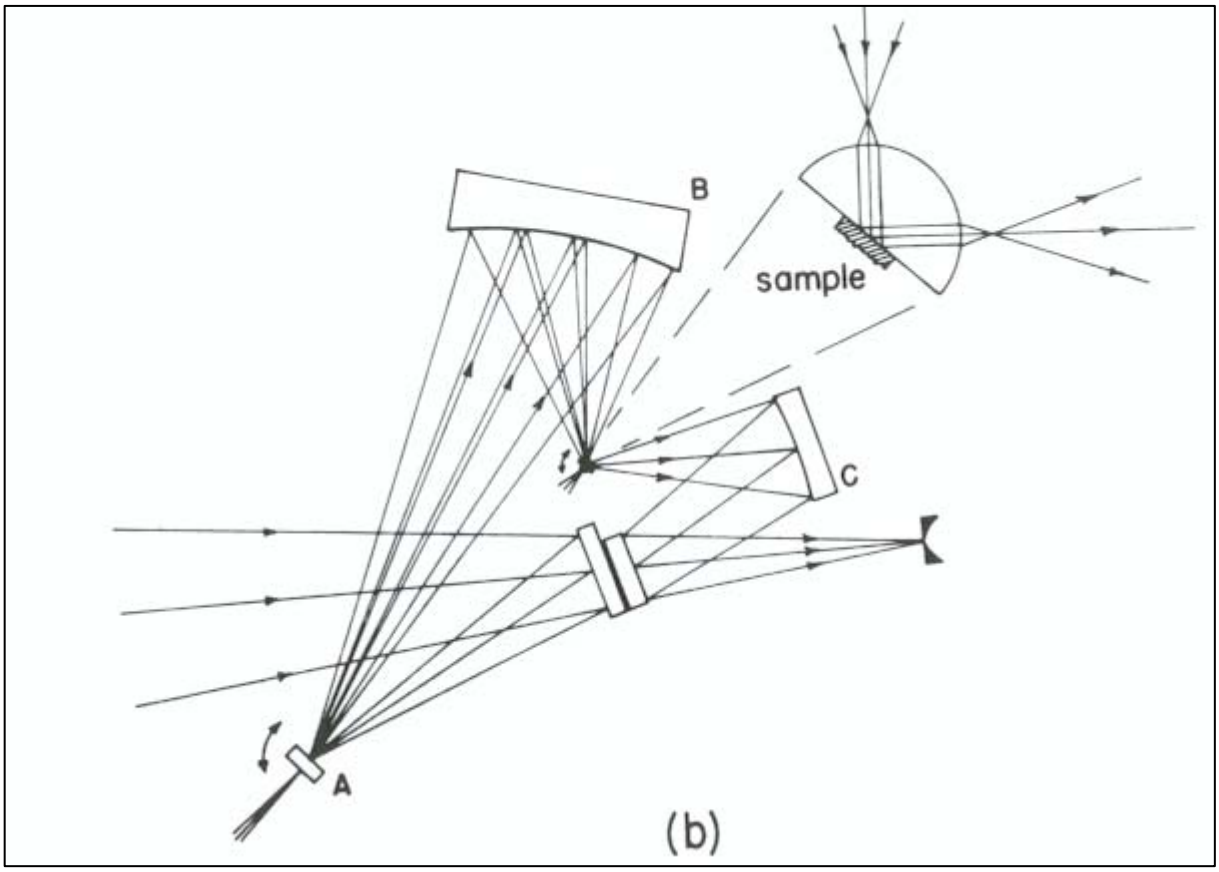


Figure 5: Schematic of the mechanism of attenuation of infrared radiation.

In this attachment the beam is first brought to focus on a source image mirror (A). An adjustable off-axis spherical mirror (B) condenses it at its sampling point. A second spherical mirror (C) refocuses it on the entrance slit of the spectrophotometer. The angle of incidence is adjusted by rotating the source image mirror (A) and the sample mount that is linked to a calibrated dial by precision gear train assembly. The angle of incidence may be varied from 30° to 60°, with setting reproducible to better than 1°. About 70% of the available energy in a typical spectrophotometer is transmitted by the unit.

The attenuated total reflectance technique is mainly valuable for all types of solid, plastic and highly viscous materials as well as aqueous solutions because the effective beam penetration of the sample is only a few microns.

In this project was used ATR in order to identify the residual chemical compounds onto the leather surface after the ink remover application. An approach if any of them can be responsible to damage or at least a chemical attack to the leather surface can be made.

3.4 Mechanism of Soiling [10]

The aim of this stage was to improve the knowledge on the mechanism of soiling; focusing on the leather surface through some of its properties.

The soiling presents itself in two forms:

- General soil/dirt transfer during normal use; easily removable but returns with further usage.

- Colour/dye transfer from clothing during normal use – specifically from blue jeans/ denims; extremely difficult to remove and essentially permanent.

Soiling can be developed due to contaminants, which are water soluble, oil soluble or non-soluble solids. Some factors that can affect it are shown below:

- Surface structure (aniline, semi-aniline, domestic pigmented, automotive pigmented, etc.).

- Type of finish (acrylic or polyurethane resin).

- The nature of the surface whether hydrophobic, hydrophilic, absorbent, etc, will again affect the degree of soiling.

- Surface Charge; Soil attraction by static electricity. More applicable to synthetic fibres such as nylon and polyester rather than natural fibres such as cotton, wool and leather.

- The type of soiling (dust/ dirt, organic materials from humans, fabric fibres, etc)

Different methods to simulate soiling were carried out, to identify the mechanism of soiling behaviour, linking this to some of the properties of the leather, as below:

- **Surface charge:** using charge indicator method for determinate charge surface.

- **Surface Tension:** Acetone/water mix method combined with Oil Repellency method using the Torsion Balance for surface and interfacial tension measurement.

- **Soiling by Martindale abrasion machine:** Standard method described by Jaguar cars limited was developed and soiling was graded for each leather upholstery sample tested by Standard Grey Scale to BS 1006.A03.

4. METHOD [11]

First of all, it must be mentioned leather is not homogenous product, therefore make especially necessary follow standard methods as physical testing. Moreover these results are completely depending on method used. For this reason all the samples and tests have followed strictly the same procedure, making possible to compare the results.

Sampling was made by normative ISO 2418. Samples preparation and conditioning by following normative ISO 2419 for all of them. Methods and instrumentation used in this work are shown in appendix 1 and 2 respectively.

4.1 Upholstery Leather Cleaners

Pieces of each leather sample were cut at 20 x 20 cm approximately. Physical testing was carried out using the standard methods explained previously. Leather sample were cut again at 20 x 20 cm approximately and leather cleaners were applied on to the leather. For liquid leather cleaners 1g ± 0.1g was applied onto the leather sample as recommended by the maker. The leather was conditioning at 20°C and 65 % r.h at least 48h in order to test the sample as normative reference; EN ISO 2419. The same procedure is developed for standard upholstery leather sample beige and black.

4.1.1 Upholstery Leather Samples

Leather samples were obtained from four companies, which participated on the project offering their leather samples.17 leather samples were studied; 7 Pigmented Automotive Leathers, 7 Pigmented Domestic Leathers, 2 Semi-Aniline Domestic Leathers and 1 Aniline Domestic Leather. Beige and black domestic pigmented leather were used as reference, in order to report the cleaner behaviour in light and dark colour. Leather samples types are shown as below:

Code Leather Sample	Company + name leather	Specification
CT Italy	Contour- Full grain Italy	Domestic Aniline
CT red	Contour- Corrected grain	Domestic Semi-aniline
CT split	Contour- Split Brazil	Domestic Pigmented
CT correct	Contour- Corrected grain	Domestic Pigmented
CT green	Contour- Corrected Europe	Domestic Pigmented
CT brown	Contour- Full grain Europe	Domestic Semi-aniline
MS ivory	Marks and Spencer- Ivory	Domestic Pigmented
MS brown	Marks and Spencer- brown	Domestic Pigmented
RR Pas	Rolls Royce- Pasubio	Automotive Pigmented
RR Box	Rolls Royce- Boxmark	Automotive Pigmented
RR Omega	Rolls Royce- Omega	Automotive Pigmented
BW 1	Bridge of Weir- 1	Automotive Pigmented
BW 2	Bridge of Weir- 2	Automotive Pigmented
BW 3	Bridge of Weir- 3	Automotive Pigmented
BW 4	Bridge of Weir- 4	Automotive Pigmented
Control Beige	BLC-Control Beige	Domestic Pigmented
Control Black	BLC-Control Black	Domestic Pigmented

4.1.2 Upholstery Leather Cleaners

Leather cleaners were obtained from different companies, which participated on the project offering their products.18 leather cleaners / kits were studied. Leather upholstery cleaners used are shown as below:

Number in control leather	Name Cleaner
1	Leather Master MAXI kit
2	Leather Master clean & protect kit
3	CleansUK leather cleaner & rejuventor kit
4	Leekes leather upholstery care kit
5	Phoenix leather care kit
6	Multimaster ultimate leather care kit
7	Bridge of weir leathercare
8	Contour Strong cleaner
9	Contour liquid leather safety solvent cleaner
10	Contour leather preserve gentle leather cleaner
11	Contour liquid leather gentle cleaner
12	Rolls-Royce sanftreiniger & Pflegecreme
13	LEATHERTEX Starter Pack
14	URAD shoe & leather cleaner
15	White Wizard
16	SAXON Leather Upholstery Ltd. Cleaner and Cream
17	PLS Special Leather.Cleaner,Cream and ink remover.
18	Biker Leather.Cleaner and Cream.

4.1.3 Leather / cleaner sample table

Leather cleaners were applied onto different leather samples. All leather cleaners were tested onto the standard upholstery leather samples. The relationships between leather cleaner applied and leather sample used are shown as below:

Sample	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
CT italy								X		X	X							
CT red								X	X	X	X							
CT split								X	X	X	X							
CT correct								X	X	X	X							
CT green								X	X	X	X							
CT brown								X	X	X	X							
MS ivory	X	X				X												
MS brown	X	X				X												
RR pas												X						
RR box												X						
RR omega												X						
BW1							X											
BW2							X											
BW3							X											
BW4							X											
C.beige	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
C.black	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X	X

X = Cleaner “n” applied to leather listed e.g. cleaner 8 is applied to leather CT italy.

4.2 Non-Typical Leather Cleaners (and possible contaminants)

Initially pieces of beige standard upholstery leather were cut at 20 x 20 cm approximately. For liquid non-typical leather cleaners 1g ± 0.1g was applied onto the leather sample and for the other product, e.g. sprays, as recommended by the maker. The leather is conditioning at 20°C and 65 % r.h at least 48h in order to test the as normative reference; EN ISO 2419. Physicals testing were carried out as standard method description.

4.2.1 Non-typical Leather Cleaners Table

Non-typical leather cleaners were obtained either different shops or companies, which participated on the project offering their products.13 products were studied; 1 washing up liquid, 2 furniture polishes, 3 stains removing, 1 hair gel, 1 hairspray, 2 general upholstery cleaners and 3 leather dressings. Leather samples types are shown as below:

Number	Name Product	Specification
1	2% Tesco Washing up liquid	Washing up liquid
2	Tesco Furniture polish	Furniture polish
3	Mr Sheen	Furniture polish
4	Shout Stain removing Spray	Stain removing
5	K2r Stain remover Spray	Stain removing
6	Troubleshooter 1001 stain Remover	Stain removing
7	Fructis Style Gel	Hair gel
8	Tesco extra firm hold hairspray	Hairspray
9	Simoniz Dri-cleen	General upholstery leather
10	CarPlan Kleen up	General upholstery leather
11	Lord Sheraton leather balsam	Leather dressing
12	Fiorelli leather cream	Leather dressing
13	Waterproofing leather dressing	Leather dressing

4.3 Ink soiling

As it was mention in the methodology, ink penetration was studied particularly over leather products. Moreover through maintainability test, which it will be shown later on, turned up quite obvious how strong effect ink soiling can produce and how difficult is remove it for leather cleaners. Therefore important studies at that point were carried on. Different ink removers were tested in order to understand how they work, and also which is their effect on the standard upholstery leather after their application.

4.3.1 Test ink penetration over time

Seven pieces of each control leather (Beige and Black) were cut at 20 x 20 cm approximately. Different inks were applied on to leather. The ink removers were used as per the maker's instructions to clean the surface of the ink soil, at different time after ink was applied; 10 min, 4, 6, 16 and 24 hours. The samples were kept at 20°C and 65 % r.h in the conditioning room.

4.3.1.1 Inks tested

Different inks were tested with the aim of produce ink soiling. The inks used and applied on to the upholstery leather are shown as below:

- Blue Biro ink (Bic medium)
- Black Biro ink (Bic medium)
- Red Biro ink (Bic medium)
- Green Biro ink (Bic medium)
- Black maker pen (Staedtler permanent M)
- Golden pen (Pentel Hybric Roller)

4.3.1.2 Inks remover tested

Ink remover cleaners were obtained either from different shops, which they can be found, or from different companies, which participated on the project offering their products.8 products were studied. Ink removers used are shown as below:

Ink remover number	Name ink remover
1	Ink away (Leather Master)
2	Ink away New (Leather Master)
3	Ink remover (World of Leather)
4	Ink Lifter (Guardsman)
5	Ink removing gel (Leathertex)
6	Ink remover (Perfect Leather Solutions)
7	Ink remover
8	Eucalyptus oil

4.3.2 Surface examination by optical microscope

The leather samples used for ink test penetration were observed at different time by light microscope to determine if any effect e.g. residual product or damage, was developed on the surface after use of ink removers. Each ink was observed at different magnifications and examined over different periods of time. Samples did not need to be prepared. A Leica Wild M10 binocular microscope was used for this project. Pictures were taken using a Nikon Digital camera.

4.3.3 Surface examination by Scanning Electron Microscope (SEM)

Leather samples were cut about 0.5 x 0.5cm choosing a region where ink remover was applied. Then it's placed to a sample holder microscope stick using a carbon tabs. Once the scanning electron microscope was conditioned, images were taken. A Hitachi S-2500 microscope was used in this project for examined all the Scanning electron microscope.

4.3.4 Chemical contamination by Attenuated Total Reflectance (ATR)

Control leather samples were cut at 7.5 x 2.5cm approximately and analysed before and after ink remover application by ATR according with BLC's ATR method. Spectrums were taken for each ink remover and also once applied on the surface. Thus they were compared in order to find out any similarity or different about chemical composts appeared on the leather surface. For this project a Polaris FTIR Spectrometer, Mattson instrument, inc. was used.

4.4 Mechanism of Soiling

As stated in the Methodology three tests were developed in order to find out which is affecting with more emphasis the mechanism of soiling on the surface of the leather.

Leather Upholstery samples were examined as below:

- MS Ivory (Domestic Pigmented)
- BW (Automotive Pigmented)x4
- RR (Automotive Pigmented)x3
- Beige Control (Domestic Pigmented)

4.4.1 Surface Charge

Determination charge on leather surfaces with charge indicator method.

Composition of the indicator:

0.05g Luganil Orange GGC, dissolved in		10 ml water
0.0025g Crystal violet, dissolved in		90 ml ethanol
	=	100 ml indicator

Test by dropping indicator solution on to the leather surface.

Cationic Charge: yellow inner circle surrounded by a blue ring.

Anionic Charge: blue inner circle surrounded by a yellow ring.

4.4.2 Surface Tension

Acetone/water mix method combined with Oil Repellency method using the Torsion Balance for surface and interfacial tension measurement.

Oil Repellency: Hydrocarbon Resistance Test (AATCC test method 118-1992) was carried out and applied to the leather upholstery samples. Drops of standard test liquids, consisting of a selected series of hydrocarbons with varying surface tensions, are placed on the surface of the leather and observed for wetting, wicking, and contact angle.

Different concentrations of acetone/water mixes (75, 80, 85, 90 and 95%) were prepared and placed as a drop onto the leather samples. Then the wetting, spreading or spotting was observed. The surface tensions from the different concentrations of acetone/water mixes were measured by the Torsion Balance. This method is not standard.

4.4.3 Soiling by Martindale Abrasion Machine

Jaguar Engineering Standard's Cleanability of Plastic Materials after soiling (JNS 30.14.23) was developed in order to assess the degree of soiling from the leather upholstery sample types.

A standard carbon (graphite) impregnated soiling cloth is applied on to the leather loaded of 9.05mN/m^2. After 6000 cycles, changing soiling cloth every 2000 cycles, using Martindale abrasion machine. Then soiling on the surface is graded according to Standard Grey Scale to BS 1006.A03.

5. RESULTS

Results obtained in this work are shown divided in every different stage. Leather cleaners results were taken from application of standard methods explained in Methodology stage. However two of them; Handle and gloss were not as standard testing. Handle consists taking note of the feeling that can be detected by hands from five different persons after the cleaner application and after a statistic process is obtained a result. Gloss is measured using a glossmeter instrument (Minigloss 101N, Sheen), which through a 60º light source measurement is taken. Range is from 0.1 to 100 gloss units. Calibration is realised using a reference standard obtained a 93.3 gloss units. Gloss results are the average of five measures. Results from Non- typical leather cleaners were obtained by physical testing (as Leather cleaners) and optical microscope meanwhile for ink soiling stage were used either optical microscope or electron microscope. Moreover spectra by Attenuated Total Reflectance analytical method were taken. Finally results from initial trial about mechanism of soiling were obtained from three test; Surface charge using an indicator method, Surface Tension; with application of Torsion Balance /Acetone mixes and Oil repellency method. The mimic soiling process was developed by Jaguar Engineering Standard's method; JNS 30.13.23. using a Martindale abrasion machine, which offered to asses surface soiling degree.

5.1 Leather cleaners results

First of all, leather samples were tested in order to know their properties before any trial. Physical testing were carried out following the standard methods chosen for each leather type; Colour fastness to rubbing, flex resistance, colour fastness to water spotting and finally measurement of leather softness and gloss. Results are shown as below:

TESTING PROTOCOL SAMPLE LEATHER

Sample	Rub Persp.	Rub Wet	Rub Dry	Flex	Water Spot 30min	Water Spot 16h	Gloss	Softness (mm)
CT Italy	X	X	X	Fail	severe ring	No change	3.3	35
CT red	Fail	Fail	Fail	X	slight ring	No change	3.6	38
CT split	X	Fail"	X	Fail	Spreanding.No spotting	No change	3.4	36
CT correct	X	X	X	Fail	No change	slight ring	2.5	44
CT green	X	X	X	Fail	No change	moderate ring	1	55
CT brown*	Fail	Fail	X	X	No change	No change	4.5	39
MS ivory	X	X	X	X	No change	slight ring	2.8	33
MS brown	X	X	X	X	No change	slight ring	1.3	36
RR pas	X	X	X	X	No change	slight ring	2.3	35
RR box	X	X	X	X	No change	slight ring	2.3	46
RR omega	X	X	X	X	No change	No change	1.9	39
BW1	X	X	X	X	No change	slight ring	2.2	19
BW2	X	X	X	X	No change	slight ring	1.6	36
BW3	X	X	X	X	No change	No change	1.5	39
BW4	X	X	X	X	No change	slight ring	1.6	42
Control beige	X	X	X	X	No change	slight ring	1.7	35
Control black*	X	X	X	X	No change	slight ring	0.7	42

* Change in colour due to the sample becoming glossier when rubbed. No finish removal.
" Fail wet rub due finish removal.
X = Pass

From the above table, it can be observed that samples from Contour company; CT italy, red, split, correct, green and brown, have failed either in rub fastness test or flex test. These results will be an important fact to consider for following testing.

Once sample leathers were tested. Leather cleaners were applied on to the standard upholstery leather beige and black and were tested as standard methods description. Results are shown below.

TESTING PROTOCOL CONTROL LEATHER

Sample	Rub Pers	Rub Wet	Rub Dry	Flex	Water Spot 30min	Water Spot 16h	Gloss	Softness (mm)	Handle
Beige1	X	X	X	X	No change	No change	1.6	35	stiffer
Black1*	X	X	X	Fail	No change	No change	0.8	43	stiffer
Beige2	X	X	X	X	No change	slight ring	1.7	35	hasher
Black2*	X	X	X	X	No change	No change	0.7	42	no change
Beige3	X	X	X	X	No change	slight ring	1.8	39	greassier
Black3*	X	X	X	X	No change	slight ring	0.8	43	greassier
Beige4	X	X	X	X	No change	No change	1.9	42	greassier
Black4	X	X	X	X	No change	No change	0.9	42	greassier
Beige5	X	X	X	X	Sticky ring	slight ring	1.6	43	greassier
Black5	X	X	X	X	Sticky ring	slight ring	0.8	39	greassier
Beige6	X	X	X	X	No change	No change	1.7	42	greassier
Black6*	X	X	X	X	No change	No change	0.8	41	greassier
Beige7	X	X	X	X	No change	No change	1.8	38	hasher
Black7	X	X	X	X	No change	No change	0.8	39	hasher
Beige8	X	X	X	X	No change	slight ring	1.6	43	greassier
Black8	X	X	X	X	No change	slight ring	0.7	40	no change
Beige9	X	X	X	X	No change	slight ring	1.5	40	no change
Black9	X	X	X	Fail	No change	slight ring	0.6	43	stiffer
Beige10	X	X	X	X	No change	slight ring	1.5	43	greassier
Black10	X	X	X	X	No change	slight ring	0.7	45	no change
Beige11	X	X	X	Fail	Spreading but spotting	slight ring	1.7	40	greassier
Black11	X	X	X	Fail	Spreading but spotting	slight ring	0.9	43	greassier
Beige12	X	X	X	X	No change	slight ring	1.9	46	greassier
Black12	X	X	X	X	No change	slight ring	1.1	42	greassier
Beige13*	X	X	X	X	No change	No change	1.4	36	greassier
Black13*	X	X	X	X	No change	No change	0.7	42	no change
Beige14*	X	X	X	X	No change	No change	1.9	32	no change
Black14*"	X	X	X	X	No change	No change	1.1	40	greassier
Beige15*	X	X	X	X	Spreading but spotting	No change	1.6	32	greassier
Black15*	X	X	X	X	Spreading but spotting	No change	0.8	40	greassier
Beige16*	X	X	X	X	Spreading not spotting	No change	1.6	34	greassier
Black16*	X	X	X	X	Spreading not spotting	No change	0.8	43	greassier
Beige17*	X	X	X	X	No change	slight ring	1.5	36	greassier
Black17*	X	X	X	X	No change	slight ring	0.7	42	greassier
Beige18*	X	X	X	Fail	No change	No change	1.4	37	greassier
Black18*	X	X	X	X	No change	No change	0.7	40	greassier

* Change in colour due to the sample becoming glossier when rubbed. No finish removal.
" When carrying out rub test, the cleaner was removed revealing the original surface.
X = Pass

After the application of the 18 upholstery leather cleaners, it can be regarded that rub fastness, gloss, softness and water spotting were obtained an expected results, although almost of them left a greasy feeling after their use. Moreover 4 cleaners applied on to standard upholstery leather made failed flex test. Just one leather cleaner did not produce blocking in the coated fabrics test.

After leather samples were tested and leather cleaners applied onto control upholstery leather tested as well. Leather cleaners were applied finally on to leather samples types. The results from the different applications are shown in the following table:

LEATHER CLEANERS APPLIED ONTO LEATHER SAMPLES

Cleaner	Sample	Rub Persp.	Rub Wet	Rub Dry	Flex	Water Spot 30min	Water Spot 16h	Gloss	Softness (mm)	Handle
1	MS ivory	X	X	X	Fail	No change	No change	2,9	32	no change
	MS brown*	X	X	X	X	No change	No change	1,5	38	no change
2	MS ivory	X	X	X	Fail	No change	No change	3,1	33	greassier
	MS brown	X	X	X	X	No change	No change	1,7	40	greassier
6	MS ivory	X	X	X	Fail	No change	No change	2,8	32	greassier
	MS brown*	X	X	X	X	No change	No change	1,6	39	hasher
7	BW1	X	X	X	X	No change	No change	2,7	17	no change
	BW2	X	X	X	X	No change	No change	1,7	34	no change
	BW3	X	X	X	X	No change	No change	1,5	38	no change
	BW4*	X	X	X	X	No change	No change	1,3	40	no change
8	CT Italy	X	X	X	Fail	severe ring	No change	3,2	31	smoother
	CT red*	Fail	Fail	X	X	Slight ring	No change	3.0	37	hasher
	CT split"	X	Fail	X	Fail	No change	No change	3,4	35	no change
	CT correct*	X	X	X	Fail	No change	Slight ring	2,1	45	smoother
	CT green*	X	X	X	Fail	No change	Moderate ring	0,9	54	smoother
	CT brown*	Fail	Fail	X	X	No change	No change	2,3	35	no change
9	CT red*	Fail	Fail	X	X	Slight ring	No change	3,8	37	greassier
	CT split"	X	Fail	X	Fail	No change	No change	3.0	34	no change
	CT correct*	X	X	X	Fail	No change	Slight ring	2,3	44	smoother
	CT green*	X	X	X	Fail	No change	Moderate ring	0,9	58	no change
	CT brown	Fail	Fail	X	X	No change	No change	3,6	40	no change
10	CT Italy	X	X	X	Fail	severe ring	No change	3.0	34	greassier
	CT red*	Fail	Fail	X	X	No change	No change	3,3	37	no change
	CT split"	X	Fail	X	Fail	No change	No change	3,1	38	no change
	CT correct*	X	X	X	X	No change	Slight ring	2,2	44	no change
	CT green*	X	X	X	Fail	No change	Moderate ring	0,9	54	no change
	CT brown*	X	Fail	X	X	No change	No change	2,8	39	no change
11	CT Italy	X	X	X	Fail	severe ring	Slight ring	3,8	30	no change
	CT red*	Fail	Fail	X	X	Spreading but spotting	No change	2,9	35	greassier
	CT split"	X	Fail	X	Fail	Spreading.No spotting	No change	3,4	35	no change
	CT correct*	X	X	X	X	No change	Moderate ring	2,2	43	no change
	CT green*	X	X	X	Fail	Spreading but spotting	Moderate ring	0,9	50	no change
	CT brown*	Fail	Fail	X	X	No change	No change	3,4	42	no change
12	RR pas	X	X	X	Fail	No change	Slight ring	2,5	35	smoother
	RR box*	X	X	X	Fail	No change	Slight ring	2,5	44	greassier
	RR omega	X	X	X	X	No change	Slight ring	2,1	37	no change

* Change in colour due to the sample becoming glossier when dry rubber. No finish removal.
" Fail wet rub due finish removal.
X = Pass

Any significant difference was developed in the gloss, softness, handle and water spotting test. However, 4 different combinations between cleaner/ sample leather failed flex resistance test than were expected.

Specific results obtained in the colour fastness to rubbing for leather cleaners applied onto standard upholstery leather and also onto leather samples are shown below with more detail. The change of the colour leather surface (ISO 105-A02) and possible colour soiling stained on the pad (ISO 105-A03) are graded according to Standard Grey Scale to BS 1006.A03. Where number 1 means higher visual change and contrast, meanwhile 5 means all the opposite.

LEATHER CLEANERS APPLIED ONTO LEATHER CONTROL

		Rub Persperation		Rub Wet		Rub Dry	
Cleaner	**Sample**	**Leather**	**Pad**	**Leather**	**Pad**	**Leather**	**Pad**
1	Beige	5	5	5	5	4/5	5
	Black	4/5	4/5	4/5	4	4*	5
2	Beige	5	5	5	5	4/5	5
	Black	4	4/5	4/5	4	4*	5
3	Beige	5	5	5	5	4/5	5
	Black	5	4/5	5	4	4/5*	5
4	Beige	5	5	5	5	4/5	5
	Black	5	4/5	4/5	4	4/5	4/5
5	Beige	5	5	5	5	4/5	5
	Black	4/5	4/5	4/5	4	4/5	5
6	Beige	5	5	5	5	4/5	5
	Black	4/5	4/5	4/5	4	4*	4/5
7	Beige	5	5	5	5	5	5
	Black	4/5	4/5	5	4/5	4/5	4
8	Beige	5	5	5	5	4/5*	5
	Black	5	4/5	5	4	4/5*	5
9	Beige	5	5	5	5	5	5
	Black	4/5	4/5	5	4/5	4/5*	5
10	Beige	5	5	5	5	5	5
	Black	5	4/5	5	4	4/5*	5
11	Beige	5	5	5	5	5	5
	Black	4/5	4	4/5	4	4/5*	5
12	Beige	5	5	5	5	5	5
	Black	4	4	4/5	4	5	5
13	Beige	5	5	5	5	4/5*	5
	Black	4/5	4/5	5	4	4*	5
14	Beige	5	5	5	5	5*	5
	Black"	4	4/5	4/5	4/5	4*	5
15	Beige	5	5	5	5	5*	5
	Black	5	4/5	5	4	4*	5
16	Beige	5	5	5	5	5*	5
	Black	5	4/5	5	4	4*	5
17	Beige	5	5	5	5	5*	5
	Black	5	4/5	5	4/5	4*	5
18	Beige	5	5	5	5	5*	5
	Black	5	4/5	5	4/5	4*	5

* Change in colour due to the sample becoming glossier when rubber. No finish removal.

" When carrying out rub test, the cleaner was removed revealing the original surface.

None control leather were failed, although 15 samples change in colour when they were drying rubbed. Much more appreciated in black upholstery leather.

LEATHER CLEANERS APPLIED ONTO LEATHER SAMPLES

		Rub Persperation		Rub Wet		Rub Dry	
Cleaner	**Sample**	**Leather**	**Pad**	**Leather**	**Pad**	**Leather**	**Pad**
1	MS ivory	5	5	5	5	5	5
	MS brown*	4/5	5	4/5	5	4/5	5
2	MS ivory	5	5	5	5	5	5
	MS brown	4/5	5	5	5	4/5	5
6	MS ivory	5	5	5	5	5	5
	MS brown*	4/5	5	4/5	5	4/5	5
7	BW1	5	5	5	5	5	5
	BW2	5	5	5	5	5	5
	BW3	5	5	5	5	5	5
	BW4*	5	5	5	5	4/5	5
8	CT Italy	3/4	4	2/3	3/4	5	5
	CT red*	2	1/2	2	1/2	4	4/5
	CT split"	5	5	3	5	5	5
	CT correct*	5	5	5	5	5	5
	CT green*	5	5	5	5	5	5
	CT brown*	3	2/3	2	2/3	4/5	5
9	CT red*	1/2	1/2	1/2	1/2	4	4/5
	CT split"	5	5	3	5	5	5
	CT correct*	5	5	5	4/5	5	5
	CT green*	5	5	4/5	4/5	5	5
	CT brown	3	3	2/3	2/3	4/5	5
10	CT Italy	2	4	2	3/4	5	5
	CT red*	2/3	2	1/2	1/2	4	4/5
	CT split"	5	5	3	5	5	5
	CT correct*	5	5	5	5	5	5
	CT green*	5	5	5	5	5	5
	CT brown*	3/4	2	2/3	2/3	4/5	5
11	CT Italy	3	4	3/4	4	5	5
	CT red*	2	1	2	2	4	4/5
	CT split"	5	5	5	5	5	5
	CT correct*	5	5	5	5	5	5
	CT green*	5	5	4/5	4/5	5	5
	CT brown*	3	3	2	2/3	4/5	5
12	RR pas	5	5	5	5	5	5
	RR box*	4/5	5	4/5	5	5	5
	RR omega	5	5	5	5	5	5

*Change in colour due to the sample becoming glossier when dry rubbed. No finish removal.
" Fail wet rub due finish removal.

Any unexpected result was obtained. Leather samples failed in previous tests also failed after leather cleaner application. During rub fastness test some leather samples developed changes in their appearance, as is commented above the table.

MAINTAINABILITY

Maintainability is a no standard method created by Ikea company, which consist specified contaminants as a tomato, oil, coffee, for mention a few, are applied to the leather. The resulting stain is removed using a proper cleaner. Leather is assessed for stain removal and any colour change after cleaning process using standard grey scale. First column for each product shows grade of stain effect onto leather and second column after cleaner application.

Cleaner	Leather sample	Soil		Red ink		Blue ink		Tip pen		coffee		Red wine		Grease		Ketchup	
1	Beige	3	4/5	1	3/4	1	2/3	1	1	1	3/4	1	4/5	4/5	5	1	5
	Black	4/5	5	1	3/4	1	5	1	4	3	5	3	4/5	3	5	1	5
	MS ivory	3	5	1	4	1	2/3	1	3	1	4	1	4/5	4/5	5	1	5
	MS brown	4/5	4/5	2	3/4	2	3/4	3	4	3	4	3	5	3	5	1	5
2	Beige	3	4/5	1	3/4	1	3	1	1	1	2/3	1	4	4/5	5	1	5
	Black	4/5	5	1	5	1	5	1	4	3	5	3	4/5	3	5	1	5
	MS ivory	3	5	1	3/4	1	2/3	1	3	1	4	1	4/5	4/5	5	1	5
	MS brown	4/5	4/5	2	3	2	3/4	2	4/5	3	5	3	5	3	5	1	5
3	Beige	3	4	1	3	1	2/3	1	1/2	1	3/4	1	4	4/5	5	1	5
	Black	4/5	4/5	1	4	1	4	1	4	3	4/5	3	4/5	3	5	1	5
4	Beige	3	4/5	1	1	1	1/2	1	1	1	4/5	1	4/5	4/5	5	1	5
	Black	4/5	5	1	3	1	3/4	1	2/3	3	5	3	4/5	3	5	1	5
5	Beige	3	4/5	1	3/4	1	4	1	1/2	1	4	1	4	4/5	5	1	5
	Black	4/5	5	1	5	1	5	1	2/3	3	4/5	3	4/5	3	4/5	1	4/5
6	Beige	3	4/5	1	3/4	1	3	1	1/2	1	3/4	1	3/4	4/5	4/5	1	5
	Black	4/5	5	1	5	1	4	1	4	3	4/5	3	4/5	3	5	1	5
	MS Ivory	3	5	1	3/4	1	2/3	1	3	1	4	1	4/5	4/5	5	1	5
	MS brown	4/5	4/5	2	4/5	2	2/3	3	2	3	5	3	4/5	3	5	1	5
7	Beige	3	4/5	1	3/4	1	3	1	1	1	4	1	4/5	4/5	4/5	1	5
	Black	4/5	5	1	4	1	4/5	1	2	3	4/5	3	4/5	3	4/5	1	5
	BW1	4	5	1	1	1	1	1	1	1	4	1	4/5	4/5	5	1	5
	BW2	4	5	1	3	1	3	1	3	1	4	1	4/5	4/5	5	1	5
	BW3	4/5	5	1	2/3	1	2/3	1	2/3	1	4/5	1	4/5	4/5	5	1	5
	BW4	4/5	5	1	2	1	2	1	2	1	4/5	1	4/5	4/5	5	1	5
8	Beige	3	5	1	3/4	1	2	1	1/2	1	4/5	1	4/5	4/5	5	1	5
	Black	4/5	5	1	4/5	1	4	1	2/3	3	5	3	5	3	5	1	5
	CT italy*	4/5	3/4	2	4/5	2	3	1	4	2/3	4/5	3	4/5	2	1/2	1	2/3
	CT red*	4	4/5	2	3	3	3	2	3	3	4/5	3/5	4	3/5	1/2	2	4/5
	CT split	3	4/5	1	3	1	2	1	2/3	1	4/5	1	4/5	4/5	5	1	5
	CT correct	3	4/5	1	4	1	1/2	1	2	1	4	1	4	4/5	5	1	5
	CT green	3	4/5	1	3	1	2	1	2	2	4/5	2	4/5	4/5	5	1	5

Cleaner	Leather sample	Soil		Red ink		Blue ink		Tip pen		coffee		Red wine		Grease		Ketchup	
9	Beige	3	4/5	1	3/4	1	2/3	1	2	1	1	1	4/5	4/5	5	1	5
	Black	4/5	5	1	3/4	1	5	1	5	3	3	4	4/5	5	5	1	4
	CT red*	4	4/5	2	2	3	2	2	2	3	4/5	3	2	3/5	1/2	2	4
	CT split	3	5	1	3/4	1	2	1	3	1	3	1	4	4/5	5	1	5
	CT correct	3	4/5	1	4	1	2	1	3/4	1	4	1	1	4/5	5	1	5
	CT green	3	4/5	1	3	1	2	1	2	2	3	2	3/4	4/5	5	1	5
	CT brown*	4/5	4/5	2	1/2	2	1/2	3	1/2	3	3	4	4/5	4/5	5	2	5
10	Beige	3	4/5	1	3	1	2/3	1	1	1	4	1	4	4/5	5	1	5
	Black	4/5	4/5	1	2/3	1	4	1	2	3	5	3	5	3		1	5
	CT italy	4/5	5	2/3	4/5	2	2	1	2/3	3	4/5	3	4/5	2	1/2	1	2
	CT red*	4	5	2	2	3	4	2	3/2	3	3/4	3	4	3/5	1/2	2	5
	CT split	3	5	1	2	1	2	1	2/3	1	4/5	1	4/5	4/5	5	1	5
	CT correct	3	4/5	1	4	1	2	1	3	1	4	1	4	4/5	4/5	1	5
	CT green	3	4/5	1	2	1	2	1	2	2	4	2	4	4/5	4/5	1	5
	CT brown*	4/5	5	2	4	2	4	3	3/4	3	5	4	4/5	4/5	5	2	5
11	Beige	3	4/5	1	2	1	2	1	1	1	4/5	1	4/5	4/5	5	1	5
	Black	4/5	5	1	2/3	1	5	1	2	3	4/5	3	5	3	5	1	4/5
	CT italy	4/5	4/5	2	3/4	2	2/3	1	1/2	2/3	4/5	3	4/5	2	1	1	2
	CT red*	4	5	2	5	3	3	2	3	3	4	3	4/5	3/5	1/2	2	4/5
	CT split	3	5	1	2/3	1	2	1	2/3	1		1	4/5	4/5	5	1	5
	CT correct	3	4/5	1	4	1	2/3	1	2/3	1	4	1	4	4/5	4/5	1	5
	CT green	3	4/5	1	3/4	1	2	1	2	2	4/5	2	4/5	4/5	4/5	1	5
	CT brown*	4/5	4/5	2	4/5	2	4/5	3	4	3	5	4	5	4/5	5	2	5
12	Beige	3	5	1	1/2	1	1	1	2	1	3/4	1	3/4	4/5	5	1	5
	Black	4/5	5	1	5	1	4	1	4	3	4/5	3	4/5	3	5	1	5
	RR pas	3	4/5	1	1	1	1	1	1	1	3/4	1	3/4	4/5	4/5	1	5
	RR box	3	5	1	2/3	1	1	1	1	1	2/3	1	2	4/5	4/5	1	5
	RR omega	3	4/5	1	1	1	1	1	1	1	3	1	4/5	4/5	5	1	5
13	Beige	3	5	1	3	1	2/3	1	1/2	1	4	1	4	4/5	5	1	5
	Black	4/5	5	1	4	1	4	1	2	3	5	3	5	3	5	1	5
14	Beige	3	5	1	3/4	1	4	1	1	1	4	1	4	4/5	5	1	5
	Black	4/5	5	1	4/5	1	5	1	4/5	3	5	3	5	3	5	1	5

15	Beige	3	5	1	3/4	1	3	1	1	1	3/4	1	3/4	4/5	5	1	5
	Black	4/5	5	1	5	1	5	1	3/4	3	5	3	5	3	5	1	5
16	Beige	3	5	1	3	1	2/3	1	1	1	3	1	3	4/5	5	1	5
	Black	4/5	5	1	5	1	4/5	1	3	3	5	3	5	3	5	1	5
17	Beige	3	5	1	4	1	3	1	3/4	1	4	1	4	4/5	5	1	5
	Black	4/5	5	1	2/3	1	4	1	4	3	5	3	5	3	5	1	5
18	Beige	3	5	1	3/4	1	2	1	3/4	1	4	1	4	4/5	5	1	5
	Black	4/5	5	1	4/5	1	4/5	1	4/5	3	5	3	5	3	5	1	5

* The finishing was removed

Maintainability showed how leather cleaners performance against typical soiling. The more significant information was produced when it was detected how difficult was removed biro ink onto the leather samples. More appreciated on automotive upholstery leather samples when Grey scale values were lowest and even in some cases any removal was produced. Moreover, it's important to mention that in some dark colour samples were no appreciated to grade any change.

5.2 Non-Typical leather cleaners results

Physical testing were carried out after non-typical cleaners and possible contaminants applied onto beige upholstery leather following the standard methods chosen; Colour fastness to rubbing (Wet and dry), flex resistance, measurement of leather softness, gloss and handle. Results are shown as below:

	Rub Wet		Rub Dry					
Sample	**Leather**	**Pad**	**Leather**	**Pad**	**Flex**	**Gloss**	**Softness (mm)**	**Handle**
1	5	4/5	5	5	X	1,5	3,8	greassier
2	5	5	5	5	X	1,4	3,6	stiffer
3	5	5	5	5	X	1,7	3,6	greassier
4	4/5	4/5	4/5	5	X	1,6	3,9	No change
5	4	4/5	4/5	5	Fail	1,4	3,5	hasher
6	4/5	4/5	4/5	5	X	1,5	3,4	No change
7	4/5	5	4/5	5	X	2.0	3,5	greassier
8	4*	4	4/5	5	X	2.0	3,8	stiffer
9	5	5	4/5	5	Fail	1,5	3,9	No change
10	4/5	4/5	4/5	5	X	1,4	3,6	No change
11	4/5*	5	5	5	Fail	1,9	3,4	stiffer
12	4/5	4/5	5	5	X	1,9	3,4	stiffer
13	5	5	5	5	X	2,3	3,4	greassier

* Scuffing of finish
X = Pass

Aesthetics test gave a considerable changes in the leather feelings. From the 13 samples, 3 of them failed on flex resistance. And finally in rub fastness just mention that 2 products produced scuff on the leather surface when they were wet rubbed.

5.3 Ink soiling

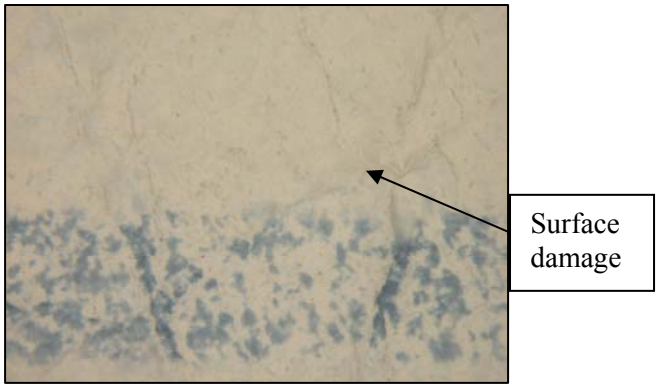
As a result of maintainability test showed, ink soil appears as more difficult stain to remove using leather cleaners. At that point was necessary to investigate more deeply in this aim. Different ink types were applied onto standard upholstery leather for clean them up later on with ink removers, specific cleaners. Then a surface examination was observed by optical and electron microscope. Moreover a chemical contamination developed by the cleaners was examined using ATR (Attenuated Total Reflectance).

5.3.1 Surface examination by optical microscope

The leathers treated with ink cleaners were examined using the optical microscope. On examination damage was found in five samples from seven in total. Further investigation identified loss of finish in three of them. Figures 6 and 7 compare an untreated sample against a sample treated with ink cleaner. The untreated sample has an undamaged surface whereas the treated surface is exhibiting partial removal and scuffing of the finish.

x12.5 magnification

Figure 6: Control leather



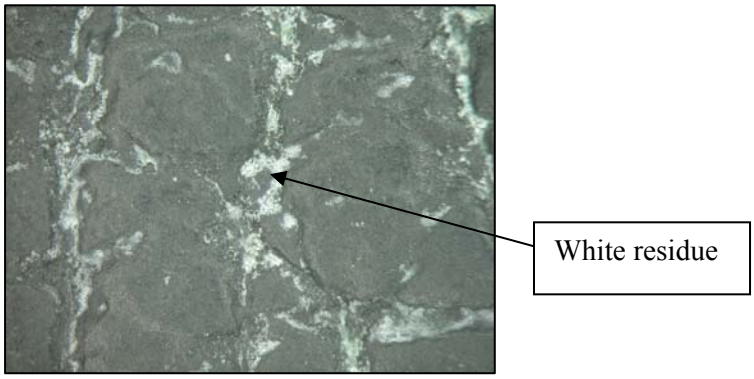
x12.5 magnification

Figure 7: Leather ink remover 2 application onto marker pen

Another effect produced by ink cleaners was a white residual lying on the surface of the leather, appeared in five samples from seven. Obviously, residue is more evident in dark leather. Figure 8 and Figure 9 compare an untreated sample against a sample treated with ink cleaner. The untreated sample has an undamaged surface whereas the treated surface is exhibiting partial residual product on the surface.

X63 magnification

Figure 8: Control leather

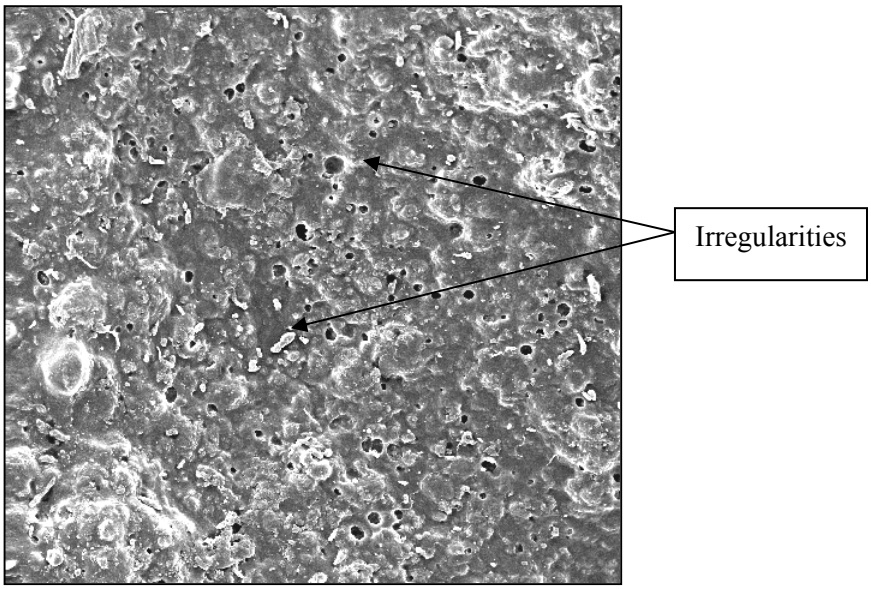


X63 magnification

Figure 9: Leather after application of ink remover 4

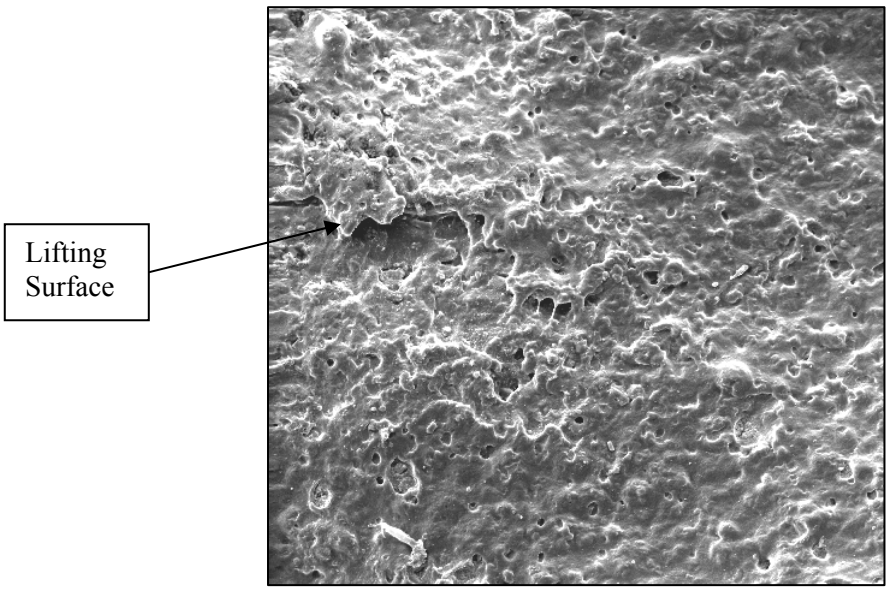
5.3.2 Surface examination by SEM

The samples were examined using the Scanning Electron Microscope (SEM) to observe the surface in more detail and micrographs were taken. Examination of the samples indicated that some of the ink removers cause partial lifting of the finish. They can also alter the surface leaving it with a smoother appearance. This could be due to residual cleaner or removal of some of the finish layers. Figure 10 shows leather surface untreated that can be compare with figure 11 and 12, which are showing different effects produced by ink remover application.



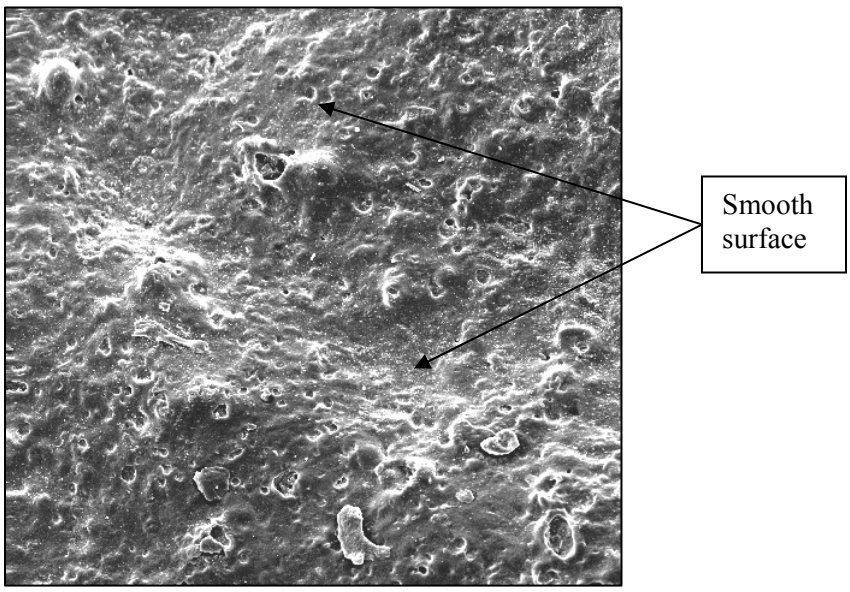
X500 magnification

Figure 10: Leather surface untreated.



X500 magnification

Figure 11: micrograph surface leather after ink remover 4 was applied lifting surface.



X500 magnification

Figure 12: micrograph surface leather after ink remover 5 was applied making a smoother surface.

5.3.3 Chemical contamination by ATR

With application of BLC ATR method results were taken from control samples and samples after ink remover were applied. Spectrums obtained are shown in appendix 3.

5.4 Mechanism of Soiling

For a better understanding about mechanism of soiling produced on to the leather was investigated one of its properties; Surface Tension and later on compared with soiling produced for each leather sample used.

5.4.1 Surface Tension

Surface tension was measured applying Acetone/water mix method combined with Oil Repellency method using the Torsion Balance for surface and interfacial tension measurement.

Acetone/water mixes

Different concentrations of acetone/water mixes (75, 80, 85, 90, 95 and 99%) were prepared and placed as a drop onto 9 leather samples. Then spreading or spotting was observed.

Sample	**Acetone Concentration**					
	75%	**80%**	**85%**	**90%**	**95%**	**99%**
Beige control	drop	spread	spread	spread	spread	spread
MS ivory	drop	drop	drop	drop	spread	spread
BW1	drop	drop	drop	drop	spread	spread
BW2	drop	drop	spread	spread	spread	spread
BW3	drop	drop	spread	spread	spread	spread
BW4	drop	drop	spread	spread	spread	spread
RR pas	drop	drop	spread	spread	spread	spread
RR box	drop	drop	drop	drop	spread	spread
RR omega	drop	drop	drop	spread	spread	spread

Surface tension Acetone/water mixes measures by Torsion Balance

The surface tensions from the different concentrations of acetone/water mixes were measured by the Torsion Balance.

Concentration	Surface tension (mN/m)
75%	28.5
80%	28.0
85%	26.9
90%	26.3
95%	25.7
99%	23.5

Oil Repellency

Hydrocarbon Resistance Test (AATCC test method 118-1992) was carried out and applied to the leather upholstery samples. Drops are placed on the surface of the leather and observed for dropping and spreading.

Sample	Kaydol	65:35Kaydol	n-hexadecane	n-tetradecane	n-dodecane
Beige Control	drop	drop	spread	spread	spread
MS ivory	drop	drop	drop	spread	spread
BW1	drop	drop	spread	spread	spread
BW2	drop	drop	spread	spread	spread
BW3	drop	drop	spread	spread	spread
BW4	drop	drop	spread	spread	spread
RR pas	drop	drop	spread	spread	spread
RR box	drop	drop	drop	spread	spread
RR omega	drop	drop	spread	spread	spread

Surface tension Oil Repellency [12]

Theory surface tension for each hydrocarbon used was found by bibliography:

Hydrocarbon	Surface tension (mN/m)
n-hexadecane	27.05
n-tetradecane	26.16
n-tridecane	25.55
n-dodecane	25.00
n-undecane	24.21
n-decane	23.37

Surface Tension Leather upholstery samples

Once results from the 2 methods were obtained, experimental surface tension for leather samples were calculated:

Leather Samples	Surface tension (mN/m) experimental.
Beige Control	28.3
MS ivory	26.3
BW1	?
BW2	27.5
BW3	27.5
BW4	27.5
RR pas	27.5
RR box	26.2
RR omega	26.9

5.4.2 Soiling by Martindale Abrasion Machine.

Jaguar Engineering Standard's Cleanability of Plastic Materials after soiling (JNS 30.14.23) was developed in order to assess the degree of soiling from the leather upholstery sample types and observe if any relation between soiling and surface tension can be concluded.

Asses the degree of soiling according to grey scale

Then soiling on the surface is graded according to Standard Grey Scale to BS 1006.A03.

Leather Sample	Grain surface
Beige Control	2/3
MS ivory	4
BW1	4
BW3	3/4
RR pas	3

6. DISCUSSION

Obviously, during and after methods were carried out and also once results were obtained, it can produce first impressions and even some complications and discussions. This stage is about that points which divided in the different contents from this work paper.

6.1 Leather cleaners discussion

The physical testing showed that most of the leather cleaners and after care systems did not have a severe effect on the physical properties of the leather tested. Even thought it should be mentioned:

- 7 cleaners require further examination for their effect on flex.
- 3 combinations of leather and leather cleaners failed flex testing after cleaner application.
- 14 leather products polished when leather is dry rubbed from 18, and also some of them produce changes in aesthetics, giving in most of the cases a greasy feeling; and if the leather is rubbed; it is possible that become glossier, changing the appearance of the leather. As is shown in the following pictures:

Figure 13: leather cleaner treated sample.

Moreover maintainability test showed the performance of the leather cleaners tested.

- Soiling cloth stain (mimic dust or dirt) was easy to remove for all cleaners, possibly due has non-penetrative effect on the surface.
- Grease, red wine and ketchup were easy to remove except in leather types where they are able to penetrate e.g. aniline and semi-aniline upholstery leather.
- Ink soiling is the most difficult stain to remove, especially in automotive upholstery leather rather than domestic upholstery.
- Blue ink is apparently more difficult to remove than red ink. In marker pen trials only 2 cleaners of the 18 products removed significantly the ink.

6.2 Non-Typical leather cleaners discussion

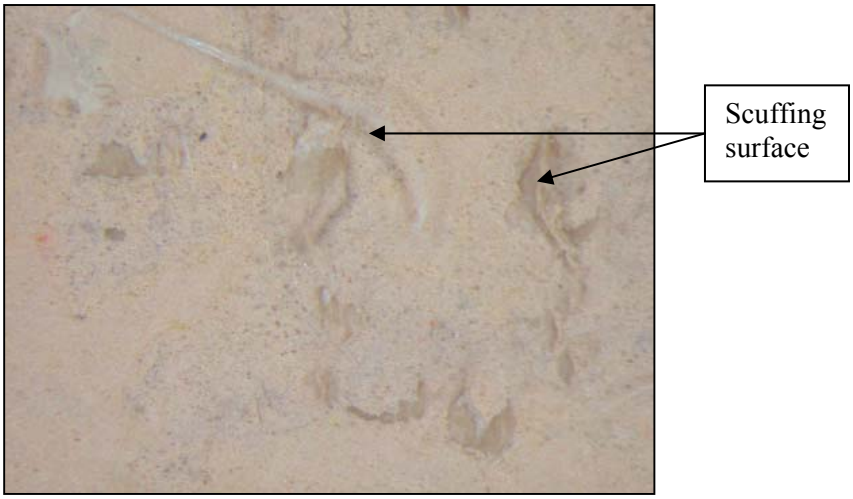
The physical testing showed that three products led to flex failure:

- A stain removing spray
- A general car upholstery cleaner
- A leather dressing.

No products in the trial had any effect on dry rub fastness, although 2 products caused scuffing of the surface of the finish:

- Hair spray
- Leather dressing

As is shown in the following picture:



X50magnification

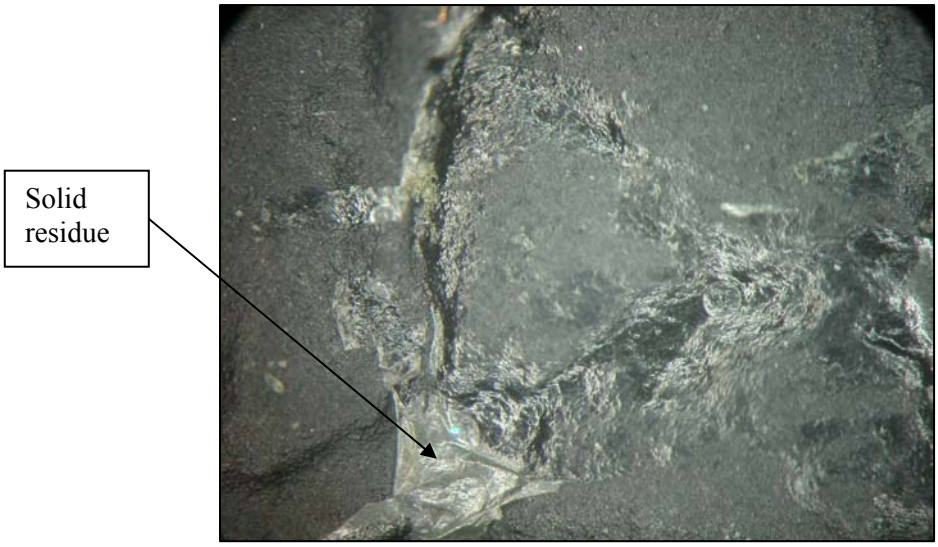
Figure 14: hairspray scuffing upholstery sample.

3 products affected the aesthetics of the leather:

- **Furniture polishes:** One left the surface feeling like it had an extra-coating. Another left the surface with a slightly greasy feel.
- **Hair products:** Hair gel product left the surface feeling tacky, glossy and greasy. Hair Spray left the surface glossy and tacky.
- **Leather dressings:** One left a glossy looking and a plastic feel, meanwhile other left a glossy appearance, greasy and tacky handle.

6.3 Ink soiling discussion

It was observe that ink becomes progressively more difficult to remove. Once ink soil penetrates it become difficult inefficiently to clean. Most of the ink removers left a stain surrounding cleaning area. Of 7 ink removers, 5 left a white residue on the surface. For 2 of them, the residue appeared after two days. One of them give a glossy look to the surface and another a slightly greasy feeling. An image was taken, as is shown below:



X63 magnification

Figure 15: Control Black after ink5 remover was applied

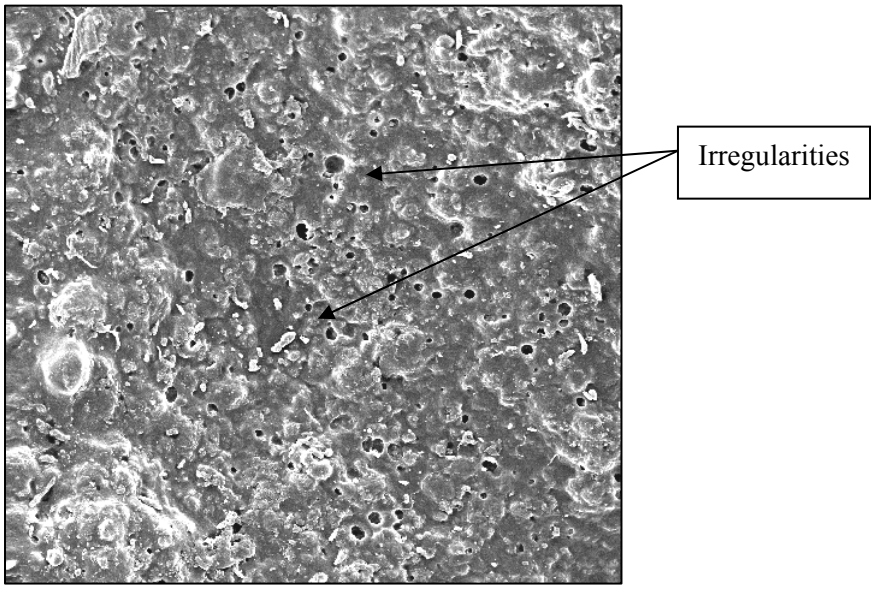
Also it was observed that:

- Green biro ink was the easier ink to remove, and the marker pen was more difficult. Because of that, cleaning and rubbing are applied with more emphasis to remove it causing in most of the cases, increase of damage on the surface (showed by optical microscope).

- For the Control Black it was not possible to make any distinction about ink removers evaluation due as it was difficult to identify changes or even detect some cases ink mark as occurred with marker pen. Dark leather just masks the ink soiling. It was much easier to identify white residues on the upholstery leather control black than on the Beige control.

Using SEM it was possible to observe samples at higher magnification and 3 dimensional.

Figure 16 shows leather surface untreated that can be compared with figure 17, 18 and 19, which are showing different effects produced by ink remover application.



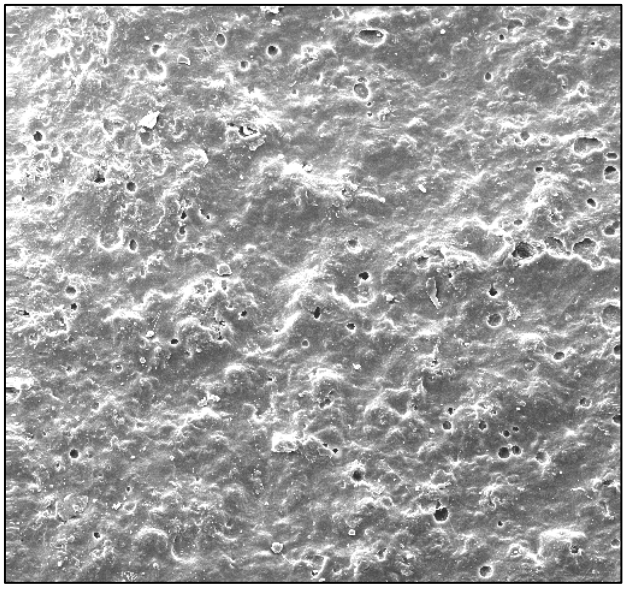
X500 magnification

Figure 16: Upholstery leather control

Some observations are required to comment:

Ink1: None Damage on the leather surface was detected by optical microscope. Observing micrograph obtained by SEM is appreciable similar with the upholstery leather control. So, low impact with the leather surface.

Ink2: Damage and white residual on the leather surface was detected by optical microscope. Observing micrograph obtained by SEM appeared a smoother surface. Ink remover product could fill the irregularities of the leather surface giving a smooth surface.



X500 magnification

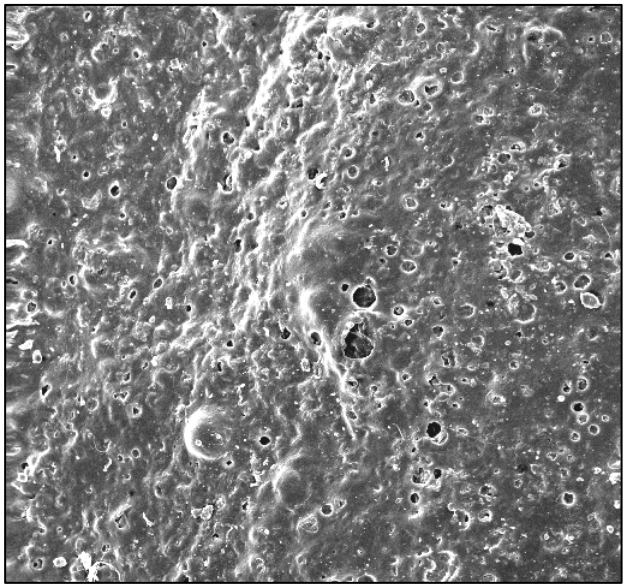
Figure 17: micrograph surface leather after ink remover 2 was applied

Ink3: It was not found damage but ink remover residue on the leather surface by optical microscope. In SEM image is observed ink product erase parts of irregularities and making smooth the surface of the topcoat.

Ink4: Damage and white residual on the leather surface was detected by optical microscope. SEM image show a lifting surface, taking place a removal surface.

Ink5: No damage was detected by light microscope but a solid residue appeared on the surface two days after, giving a slightly greasy handle. Image obtained by SEM show a smooth surface with lower irregularities.

Ink6: No damage appeared on surface using optical microscope. At first sight ink remover didn't effect ink soiling. Although 2 days after ink soiling was lightly removed. Micrograph obtained it can be appreciated as similar image compare with control. Irregularities are keeping intact; so lower effect from ink remover to leather surface. Therefore this ink remover, a water-based product, can give results but waiting in the process.

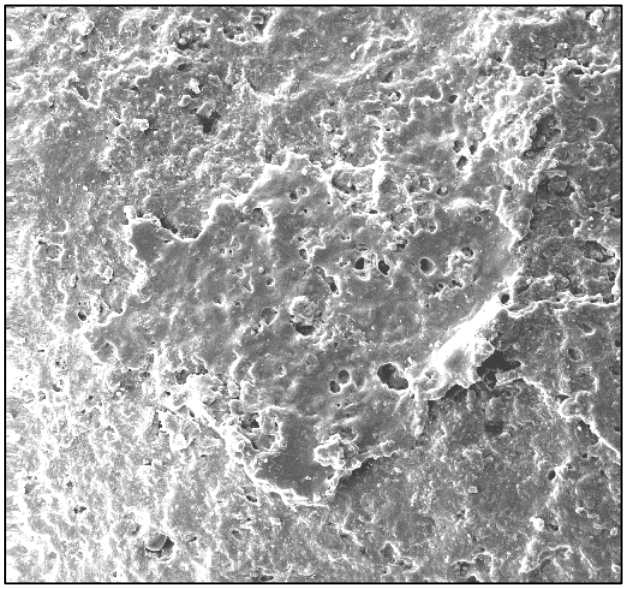


X500 magnification

Figure 18: micrograph leather surface after ink remover 6 was applied

Ink7: Damage was found on the surface by light microscope. A residual solid like little drops of product was detected after two days, giving a glossy looking to the leather. SEM image obtained show lift surface although appreciable irregularities on the surface.

Ink8: This sample was just examined by SEM. Appreciated a lifter surface, which is a part left from the removal surface action produced by ink remover.



X500 magnification

Figure 19: micrograph surface leather after eucalyptus oil was applied

As a part of the ink soiling investigation an analysis of the chemical contamination on the surface was carried out using ATR technique. Inks spectra show different composition for each separate ink remover. Especially spectra of ink 6 compared with the others. Ink 6 was identified and confirmed as a water-based product. However, the spectra which ink removers were applied it hasn't show significance differences in the chemical composition between surfaces analysed. It was no possible to identified any compost due the poor ATR software library that it was available.

6.4 Mechanism of soiling discussion

The first stage was to determinate charge surface for each leather samples using a charge indicator method. Unfortunately, no conclusion was possible. A probable reason is that, this method has been based for unfinished leather, making unsuitable for finished leather. Next step was to measure the surface tension of the leather upholstery samples. Between results obtained through acetone/water mixes tensions, measured by Torsion balance, and oil repellency method, it can be interpolated surface tension for each leather sample. It should be mentioned, in some cases, repetitions of the methods were required for some samples to obtain conclusions. One leather sample obtained incongruent results. Giving a surface tension between 25.7 – 26.3mN/m for acetone/water mixes method but for oil repellency obtained a surface tension > 27.05mN/m. Then a Soiling by Martindale method was carried out in order to find out if exist any correlation between surface tension, and soiling resistance. Results show that Beige control with higher Surface tension (28.25mN/m), was the more affected by soiling (2/3 graded by grey scale). Meanwhile, MS ivory with lower surface tension (26.30mN/m), resulted less soiled.

7.CONCLUSIONS

Conclusions are a part important in any work paper. For this reason conclusions taken from every stage are written following.

7.1 Leather cleaners conclusions

Through the Physical testing obtained it can be concluded:

- Of the 18 cleaners tested none could be universally applied to the 17 leathers tested.
- 14 leathers were affected on aesthetics from 33 possible combinations between leather cleaners and leather types.
- 7 cleaners require further examination for their detrimental effect on flex.
- A cleaner that has no effect or produces some alteration on one leather, may effect or produces different alteration in another based on the chemical type of the finish.
- Just 1 leather cleaners from 18 did not produce blocking in the coated fabrics tested.
- If stain soaks on the leather as was produced for grease, red wine and tomato ketchup in aniline and semi-aniline upholstery leather, it is more complicated to remove the stain for the cleaners due to penetration of the product.
- Unsuitable Cleaners and products can be found in the shops.

7.2 Non-Typical leather cleaners conclusions

Through the results obtained it can be concluded:

- Of 13 non-typical leather cleaners (and possible contaminants), 3 failed flex tested.
- Hair Spray and leather dressing tested produced scuffing surface on the domestic pigmented upholstery leather.
- Leather dressings, furniture polishes and hair products examined affected aesthetics of the leather.
- One coat of a typical contaminant can have a detrimental effect on the performance of leather.
- Contaminants/typical household products can adversely affect the aesthetics of the leather.
- Off the shelf leather dressings/creams are not always suitable for purpose.
- Leather dressings and hair spray can affect leather surface stronger than some leather cleaners with just one application.

7.3 Ink soiling conclusions

- Increasing ink application time, allows more penetration making it more difficult for the cleaning process.
- Once, ink stain penetrates the leather, ink removers can not remove ink soiling without surface removal.
- By optical microscope, of 7 ink cleaners, 5 left a residue on the surface and for 3 leather samples finish removal was detected.
- By SEM, of 8 ink removers, 3 produced smoother surface (less irregularities), and 3 produced removal surface.
- During cleaning process a loss surface and residual product can be produced. Although finish is still performance, obviously with multiple applications of ink removers, damage will be produced.
- Ink remover product could fill the irregularities of the leather surface changing aesthetics.
- Water-based ink removers have less impact on the surface leather than organic.

7.4 Mechanism of soiling conclusions

Through results obtained, it can be concluded:

- Initial observations seem to describe a relation between surface tension as a leather property and resistance to soil. However it's necessary to carry on with the work in order to affirm it and make it reliable.

7.CONCLUSIONS

Les conclusions són part important de qualsevol treball tècnic. Per aquesta raó les conclusions obtingudes per a cada apartat son descrites a continuació.

7.1 Conclusions netejadors per cuir

A partir dels resultats obtinguts en els assaigs físics realitzat a 72 combinacions possibles entre les 17 diferents mostres de cuir i els 18 netejadors (taula leather / cleaner sample table, pàgina 18) es pot concloure que:

- *Dels 18 netejadors examinats, cap pot ésser aplicat universalment a les 17 pells utilitzades.*
- *De les 72 possibles combinacions entre netejador i cuir 14 pells van ser afectades en la seva estètica.*
- *7 netejadors requereixen una anàlisi més profunda pel seu efecte perjudicial en la resistència a la flexió continua.*
- *Un netejador que no produeix cap efecte o cap alteració en una pell, pot afectar o produir alteracions a una altra basat en el tipus d'acabament que tingui.*
- *Només un netejador dels 18 no va produir adherència en l'aplicació del mètode de resistència a l'adherència de contacte.*
- *Si la taca es absorbida per la pell, com es va produir per l'oli, el vi i la salsa de tomàquet en tapisseries de cuir amb acabats d'anilina i semianilina, l'eliminació d'aquesta taca pels netejadors és presenta molt complicada.*
- *En les botigues es poden trobar netejadors i productes per tapisseria de cuir que són inadequats.*

7.2 Conclusions productes per cuir i altres

A partir dels assaigs físics i observacions al microscopi òptic realitzats a 13 productes; 2 netejadors multi ús per tapisseries, 3 betums, 2 abrillantadors de mobiliari, 3 lleva taques, 1 gel pel cabell, 1 laca, i 1 renta plats líquid, aplicats a un cuir domèstic pigmentat (Control Beige) es pot concloure que:

- *Dels 13 productes assajats, 3 van afectar la resistència a la flexió continua; un lleva taques, un netejador multi ús per tapisseria i un betum.*

- *La laca pel cabell i un betum per cuir examinats van produir esquerdes en la superfície de tapisseria de cuir domestica pigmentada.*

- *Betums per cuir, abrillantadors per mobiliari, productes pel cabell i els productes domèstics poden afectar negativament l'estètica de la pell.*

- *L'aplicació d'alguns d'aquests productes, pot tenir un efecte perjudicial en la actuació i rendiment del cuir.*

- *Els betums no son sempre adequats pel seu propòsit.*

- *Amb només una aplicació, els betums i les laques pel cabell poden afectar més negativament a la superfície del cuir que alguns netejadors per cuir.*

7.3 Conclusions embrutiment per tinta

A partir dels resultats obtinguts en els assaigs físics i les tècniques de microscopía òptica, microscopía electrònica d'escombrat i reflectància total atenuada realitzat a 8 netejadors per taques de tintes, aplicats a una mostres de cuir domèstica pigmentada (Control Beige i Black), es pot concloure que:

- *Incrementant el temps d'aplicació de la tinta, s'obté més penetració ,i per tant, menys efectiu és el procés de neteja.*

- *Una vegada que la taca de tinta penetra, els netejadors no poden eliminar l'embrutiment produït sense eliminar la superfície de l'acabament .*

- *A través del microscopi òptic, de 7 netejador de tinta, es va detectar que; 4 van deixar residu en la superfície, 2 d'ells van causar eliminació de l'acabament i 1 tant residu com eliminació de la capa d'acabat de les mostres.*

- *A través del SEM (microscopía electrònica d'escombrat), de 8 netejadors per tinta, es va detectar que; 3 van produir llisament de la superfície (menys irregularitats), 3 van produir eliminació parcial de la capa de l'acabat, i 2 no es va detectar cap canvi significatiu.*

- *Durant el procés de neteja es pot produir una pèrdua parcial de la capa d'acabament del cuir i/o que quedi producte residual a la superfície. Encara que l'acabament pot realitzar la seva funció, òbviament amb múltiples aplicacions es produiran danys irreparables.*

- *Els productes per la neteja de tintes assajats poden omplir les irregularitats de la superfície del cuir canviant l'aparença i el tacte de la pell.*

- *Els netejadors de tintes basats en compostos aquosos tenen menys impacte en la superfície del cuir que els orgànics.*

7.4 Conclusions del mecanisme d'embrutiment

A partir del assaigs físics realitzats (Torsion Balance i resistència a l'abrasió; Martindale) a 9 mostres de cuir per tapisseria, es pot concloure que:

- *Les observacions inicials semblen descriure una relació entre la tensió superficial com a propietat del cuir i la resistència a l'embrutiment. Tot així, és necessari continuar amb el treball fins que sigui realment fiable, abans d'afirmar-ho.*

8. FUTURE WORK

In any paper work future work should be included. Here there are some ideas that could be interesting to walk through.

- Extend this work to another finish types, e.g. garments, vegetable finishes, nubuk, etc.
- Increase number of non-typical leather cleaners and contaminants for studies.
- Application non-typical leather cleaners and contaminants to leather product types.
- Carry on about investigation of chemical attack by leather cleaners onto leather types, improving ATR instrument and library.
- Affirm initial results of mechanism of soiling obtained in surface tension.
- Extend work of mechanism of soiling to different leather properties.

9. PUBLISHED WORK

This work was published by BLC Leather Technology Centre including in its journal publications, edited in March of 2003. This published work is shown in appendix 4.

10. REFERENCES

1. Landmann A.W.. Soil is a four letter word. British Leather Confederation (BLC), Northampton. BLC Journal. September 1993, 203-204.

2. Gerhard J. Possible defects in the leather production. Druck Partner. Rubelmann GmbH. 1996, 340-359.

3. Morley D. How to grow the upholstery leather market. World Leather Journal. Oct/Nov 1991. 38-40.

4. Bacardit A., Ollé Ll. El acabado del Cuero. Escola universitaria d'enginyeria técnica industrial d'Igualada. EUETII.2000. 201-217.

5. Hudson A, Langridge D and Obeso I.Leather Finishing Soiling. BLC Leather Technology Centre Journal. May 2002, 88-91.

6. Langridge D.A.. The Microscope as a research tool for leather and related substrates. 2002. Dip RMS. 4-18.

7. Colthup N.B, Daly L.H & Wiberley S.E.. Introduction to Infrared and Raman Spectroscopy. Academic Press.1964, 67-69.

8. Smith A.L. Applied infrared Spectroscopy. Chemical Analysis. Vol. 54.1979.84-94.

9. Weldon D.G. Failure Analysis of Paints and Coatings. Wiley 2001.27-28 and 160-165.

10. NAHB Research Center, Inc. Investigation of Carpet Soiling in Selected Homes. Final Report. August 2000.

11. Font i Vallès J. Análisis y ensayos en la industria del curtido. Escola universitaria d'enginyeria técnica industrial d'Igualada. EUETII.2002. 1-39.

12. Lide D.R. CRC, Handbook of Chemistry and Physics.74th Edition. 1993-1994. 6-147.

Websites:

http://www.blcleathertech.com
http://www.lattnet.co.uk/news.htm
http://mse.iastate.edu/microscopy/home.html
http://www.school-for-champions.com/science/static.htm
http://www.basf.de/basf/img/produkte/farbmittel/leder/

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