List of Keynote Lectures

Table of Contents

FUNDAMENTALS OF LEATHER SCIENCE

Anthony Covington
Institute for Creative Leather Technologies,
The University of Northampton, Boughton Green Road, Northampton
NN2 7AL, United Kingdom Email: tony.covington@northampton.ac.uk

Leather science provides the understanding of technology, to allow modification of current processes and progress to be made in creating new technologies.
Processing must be considered as interactions within a three-component system: substrate, reagent, solvent. The series of processes should be treated as a continuum, in which each step should relate chemically to the step before and the step after.
The mechanism of tanning is currently best described by the lock-lock theory; there is much supporting evidence, but direct confirmation would be useful.
Developments in leather science and consequently in leather technology can be defined in terms of increasing complexity and longer timelines: development, innovation, revolution. In each case, leather science must also monitor unintended consequences such as the alleged formation of chromium(VI) from chromium(III) tanning agents.
The future of leather science depends on the availability of leather scientists from a changing cohort of supporting researchers.
Keywords: science, technology, development, innovation, revolution

1. INTRODUCTION

The purpose of leather science is to create knowledge that can be turned into technology for the benefit of the leather industry. In the context of this IULTCS Congress, this means contributing to the sustainability of the sector, which is also part of the purpose of leather science.

The Oxford Dictionary of English defines ‘sustainable’ as follows (1):
…able to be maintained at a certain rate or level
…conserving an ecological balance by avoiding depletion of natural resources
…able to be upheld or defended

We in the leather industry might take issue with the narrowness of the first element of the definition, since it omits the notion of progress or reacting against competition from other sectors of industry. For us, the second element refers to the consumption of a byproduct of the meat industry and invokes the notion of environmental impact. The third element could be interpreted in terms of retaining market share, preferably by maintaining our technological lead in quality, performance and innovation in our material products. Each of these elements requires progress from leather science.

2. Whither leather science?

The leather industry has a major problem: it does not understand how the technology works. Whilst it is clear that some of the fundamentals are understood at a level at which the technology is practicable, there is not enough scientific understanding to allow significant changes to be made in the certain knowledge of the outcomes. In other words, we can make leather and make money, but we are limited in our future options. Those options on our wish list might include: complete use of reagents with consequent zero discharge to effluent, development of new approaches to manufacturing methods, creation of new processing chemistries and products with new and extreme properties and performance, the transfer of knowledge into other sectors to create new biomaterials and composites. The reason this is not available to the industry is the lack of scientific models as to how our systems work.

2.1. Processing as a system

It is conventional thinking to regard process steps in isolation: this means viewing the fixation of a reagent onto pelt or leather as the interaction between the reagent and protein, whilst perhaps taking some account of the pH and temperature on the kinetics, because the thickness of the substrate affects the outcome. This is one dimensional thinking. All process steps should be treated as changes within a system. In our case, the system has three components: the substrate, the reagent, the solvent. All three are important and the technologist cannot disregard any of them (2).

The properties of the substrate are defined by the accumulative effects of previous steps. Physically, penetration of reagents is controlled by the opening up steps. Chemically, the fixation steps can alter the hydrophobic/hydrophilic balance and move the isoelectric point, which in turn defines the charge on the substrate dependent upon pH. Those latter two parameters determine the affinity of the substrate for reagents. The consequence is the effect on the stepwise mechanism of fixation: transfer of the reagent from solution into the protein structure, followed by electrostatic interaction which might be the final chemical interaction or the mechanism might then progress to covalent reaction, if the chemistry allows. The properties of the substrate at any point in the manufacturing process can be manipulated to optimise subsequent fixation reactions.

The chemistry of the reagents might be manipulated, but more likely will be chosen to optimise fixation, dependent upon the previous reaction on collagen. Combinations must be evaluated on the likelihood of the consequences of the combination. There are only three possibilities. First, the reagents react independently, because the reaction sites are different, although there may be physical or steric interactions. Second, the reagents react antagonistically, because they are competing for the same sites on the substrate: here, relative affinity and mass action effects will determine the winner. Third, the reagents react synergistically, creating a new chemical entity within the collagen structure: this is the basis for high hydrothermal stability.

The role of the solvent is typically ignored, because it is always water. However, it plays a vital part, because the solvent controls the transport of the reagent into the substrate: the affinity between the solvent and the reagent defines the relative affinity between the reagent and the substrate. The properties of water in this regard are already controllable in current technology by the presence of other solutes, such as electrolyte or organic species. Simply reducing the amount of water, to increase concentration and hence the kinetics of penetration and fixation has limited impact on the efficiency of processing, but there is technology under development to gain significant benefits from including chemically inert beads as a contributor to mechanical action.

Alternatives to water are well known in the literature, but unknown in tanneries: the problems and shortcomings are also well known in the art. Here, the technology of the future is the application of ionic liquids and deep eutectic solvents. But not before the leather scientists have created the technology.

2.2. The mechanism of tanning

Up to the end of the last century, the received wisdom was that tanning is the product of reactions which crosslink collagen, much in the way that sutures close a wound. This is a flawed model, unsupported by any experimental evidence and, moreover, limits the thinking as to how the technology might advance. The link-lock theory (3) provides an alternative model, a simpler model for which there is much supporting evidence. It is based on the idea of a primary reaction between a reagent and collagen, then a secondary reaction from another reagent capable of crosslinking the first reagent. However, confirmation by direct experimental evidence is lacking. Nevertheless, the theory is workable, since it can predict the outcome of all tanning reactions, known and unknown, in terms of their impact on hydrothermal stability. More than that, it can predict the effects of combinations of tanning reagents. This is important, because all leather making processes must be regarded as a series of fixation reactions, in which the affinity of a reagent for the substrate depends on the nature of all previous reaction and how they interact with the substrate.

It should be noted that the only difference between pretanning, tanning, retanning (probably several different steps) is the relative timing of the additions: they constitute a (usually consecutive) combination tanning system. Also, the effects of dyeing must be taken into account, since dyes interact with the leather using the same range of chemical bonding types as tanning agents. In addition, the effects of fatliquors or lubricating reagents must be considered in the same way.

Leather science should view processing as a continuum of substrate modification, in which there is a natural progression of reactions based on matching the reagents of each step with the properties of the substrate. Whilst we have some notion of the relative effects of the parameters at play in the fixation reactions, we cannot predict at any time during the process and at any point on the pH scale what the charge on the leather is. This is a solvable problem.

2.3. Directions of development

In 2014 I reviewed scientific and technological progress towards sustaining the global leather industry (4). There, I identified three levels of change: development, innovation, revolution.

Developments are technologies which arise from current and accepted practice, which might be adopted in tanneries without major changes to plant and procedures. Such modifications to typical operations might also be characterised as natural or logical progressions from received and current understanding of leather science and technology. Examples are: use of tanned waste, chromium chemistry, wet white processing, materials science, rethinking processing and closed loop manufacturing. In each case, there is some understanding of the principles underpinning the technologies, but it is also clear that the understanding is incomplete and there remains a clear need for more work from leather science to make adoption easily and universally practical.

Innovation refers to technologies which constitute a step change in thinking and ways of doing things: they would be part of a longer term strategy of development. Such changes may include plant and equipment, but not radical change. Examples are: theory of processing, rawstock preservation, new organic tanning chemistries, enzyme targeting, solvent processing, 'reinventing the wheel', new products from collagen and leather. Such topics, requiring longer term research, can only become mainstream when the understanding from leather science has been established.

Revolution means technologies in the pipeline, already at the point of proof of concept, which could radically change the face of the leather making industry: they would constitute a paradigm shift, 'thinking outside the box'. Such developmental transformations are necessarily for the long term sustainability of the sector. Examples are: bead assisted processing, ionic liquids and deep eutectic solvents, self-destructive leather for end of life, growing collagen for materials or biomaterials applications. These technologies are important for the long term sustainability of the leather industry, because they offer the possibility of more effective processing, the development of new chemistries for new biomaterials and composites with new properties and performance. In this way, leather science will keep the leather industry ahead of the competition from other materials.

2.4. Unintended consequences

As with all technologies, there is a danger of unintended consequences, of which the most important for the leather industry is the alleged conversion of chromium(III) to chromium(VI), whether in the tanning procedure, in the leather in wear or in the environment from tannery waste or discarded leather. Current research at the University of Northampton aims to define unequivocally the extent or otherwise of the problem. This can only be achieved by leather science.

In proposing a raft of leather technological developments, it is important to recognise that unintended consequences are possible. One of the roles of leather science is to monitor the application of science into technology: this means both the positive and the negative aspects of the effects on the process, the manufacturing conditions and the environmental impact.

3. THE FUTURE

There can be no discussion of the role of leather science in industry without addressing how it might function: the continuation of service from leather science into the global leather industry depends on the availability of leather scientists. In an analysis (5) of the state of leather science, in particular the availability of appropriate education, active research centres and leading leather scientists, I determined that the structure and pattern of international research in leather science is changing. The old guard is gone or going and the new guard is coming in.

I concluded that leather science is not a luxury, it is the vital way forward. Consequently, if the leather industry does not nurture leather science, progress will be slow, new products and ways of making them will be few and far between, pressure from environmentalists will increase faster than

improvements in environmental impact can be generated and profitability will be squeezed. It should always be borne in mind:
it is easier and more effective to turn a scientist into a technologist than it is to turn a technologist into a scientist.
So, it is only through leather science, based on chemistry, that the industry will have efficient 'technology translators'.

In a Seminar on sustainability, sponsored by Cotance and the European Union in 2015, I stated (6):
We are at a point of paradigm shift. Processing and product development is being put on a more theoretical base and the chemistry of processing is widening, because innovative methods of delivering new reagents are being developed. There is a revolution coming: at least, it is coming if the industry embraces change and if there are enough qualified people to make it happen.

We would do well to heed the words of Lewis Carroll (7):
…said the (red) Queen. 'Now, here, you see, it takes all the running you can do to keep in the same place. If you want to get somewhere else, you must run twice as fast…'

ACKNOWLEDGEMENTS

The author thanks the organising Committee of the Congress for their kind invitation to attend and address the participants and acknowledges with gratitude their Sponsors, the Council for Leather Exports (CLE) and the Indian Finished Leather Manufacturers and Exporters Association (IFLMEA) for supporting my visit.
Thanks are also due to Mrs. Rachel Garwood, Director of ICLT, for allowing my continuing participation in the education of the new guard of leather scientists.

REFERENCES

1. Oxford Dictionary of English, accessed via Kindle 15.12.17.
2. Covington, A.D., J. Soc. Leather Technol. Chem., 2011, 95, 231.
3. Covington, A.D., Tanning Chemistry. The Science of Leather, 2009, Royal Society of Chemistry Publishing, Cambridge, UK.
4. Covington, A.D., Asian Int. Conf. on Leather Science 2014, Okayama, Japan
5. Covington, A.D., J. Amer. Leather Chem. Assoc., 2012, 107, 258.
6. Covington, A.D., Proc., Cotance/EU Seminar 2015, Glasgow, Nov.
7. Carroll, L., Through the Looking Glass 1872.

KN-ACSIL

TANNING STRATEGIES FOR SUSTAINABLE LEATHER PRODUCTION

Heinz-Peter Germann

Wet-green GmbH, Erwin-Seiz-Str. 7, 72764 Reutlingen, Germany

Email: heinz-peter.germann@wet-green.com

Sustainable development, more and more, has become a major guideline concerning our life and industrial production. In manufacturing companies as e.g. in the leather sector, it is mainly cleaner production constituting a practical way for protecting human and environmental health, and for supporting the goal of sustainable development. This includes measures such as pollution prevention, source reduction, waste minimization and eco-efficiency, which involve e.g. substitution of toxic and hazardous materials, process modifications, and reuse of waste products.

In this spirit, in the field of leather production, the wet-green® tanning technology constitutes a really sustainable alternative to conventional tanning methods. The use of the patented wet-green® tanning system based on a purely aqueous olive leaf extract allows the production of high-quality leathers for the most different applications. At the same time, the use of environmentally and health relevant conventional chemical tanning agents like chromium(III) salts or organic synthetic reactive chemicals (i.e. glutaraldehyde and others, which are based on fossil resources) is waived. This sets new standards regarding sustainability.

As a tanning agent, the olive leaf extract combines the advantages of organic synthetic reactive agents by creating stable covalent chemical bonds with those of the usual vegetable tanning. The deposition of vegetable polyphenols (via hydrogen bonds) additionally generates a better fiber separation and filling effect as well as a pleasant round feel. As there is no traditional pickling process needed, application of the new tanning system also permits reduction of salt content in the effluent. Due to good fullness and the good dyeing behavior of the wet-green® based material, considerable savings of retanning products and dyes are possible compared to the usual chrome-free tanning process based on wet-white technology.

Production of the olive leaf tanning agent is not in any competition to food production. The olive leaves are obtained in great quantities in connection with the olive harvest and especially, the subsequent trimming of the trees (pruning) in the Mediterranean, where they accumulate as a residual material that is simply burned, in many places. The tanning extract is produced from the olive leaves, similar the tea production, and it is actually manufactured in plants, which comply with the high standards of the food industry. The special quality of the eco-effective tanning agent is not least reflected in the very good performance in the dermatological test, and in being awarded the Cradle to Cradle® certificate in Gold as well as Material Health certificate in Platinum.

In the production of Olivenleder® (the olive-leaf-tanned leather), sustainability and environmental compatibility are respected across the entire process chain by taking account of the most current findings. For the first time, by a vegetable tanning process, it became possible to produce leathers showing good shape retention but also exceptional softness, lightness and durability. Olive leaf tanned leather is suitable for applications in all kinds of areas like furniture for the residential and commercial/public sectors, automotive as well as shoes/leather goods, watch straps and clothing.

In contrast to conventional tanning technologies, the wet-green® system, additionally, opens up new possibilities of leather production via a novel type of universal intermediate by allowing drying and subsequently wetting-back without problems. This new type of dry leather intermediates (green crust®) will bring about more flexibility in processing and permit avoidance of fungicide application.

KN-IVL

STUDY OF THE VARIATION OF CHROMIUM (VI) CONTENT INSIDE LEATHER

Jean-Claude CANNOT*, M FONTAINE, M JOUINEAU, Nicolas BLANC, Claire DEMESMAY

CTC, Comité professionnel de Développement Economique, Cuir, Chaussure, Maroquinerie, 4 rue Hermann Frenkel, 69367 Lyon cedex 07, France
Emails : mfontaine@ctcgroupe.com jccannot@ctcgroupe.com

ISA, Institut des Sciences Analytiques, Université Claude Bernard de Lyon 1, 5 rue de la Doua, 69100 Villeurbanne, France

1. Chromium (VI) and leather — the current situation

Currently 85% of the leathers in the world are tanned with chromium. The tanning agent used is a basic sulphate of trivalent chromium (Cr(III)). The Cr(III)found in leather is a chemical form that poses no risk to consumer health. However, under certain conditions, a fraction of this Cr(III) can oxidise to hexavalent chromium (Cr(VI)).

Cr(VI) is an allergen, which can cause skin rashes. For this reason, since 1st May 2015, the European Union has introduced a restriction on the quantity of Cr(VI) permitted in leather coming into contact with the skin. The fixed threshold is 3 mg Cr(VI)/kg leather (without volatiles matters). The Analysis is carried out in accordance with ISO EN 17075. Work on this standard has been extensive since 1993.

1.1 Development of standards related to the determination of Cr(VI)

The first standard describing a method for analysing Cr(VI) content was published by the International Union of Leather Technologists and Chemists Society (IULTCS). IUC 18: 1993 described the preparation of the leather by crushing and extraction with a buffer at pH 8, followed by a colorimetric analysis after a characterisation reaction with diphenylcarbazide. The limit of quantitation (LoQ) was given between 2 and 3 mg Cr(VI) per kilogram of leather (mg/kg).

This standard was adopted by Germany, which published it under the reference DIN 53314, and later at the European level, where it was included in EN 420: 1994 (General requirements for safety gloves). The notified bodies responsible for the certification of protective gloves quickly found that this method was not robust, and did not allow such low concentrations to be determined. A corrigendum was introduced and the LoQ was raised to 10 mg/kg.

IUC 18 was revised in 1996 to define the test with greater precision, and again in 2000 to allow the analysis of strongly coloured leathers. Nonetheless, these improvements proved insufficient, and notified bodies continued to apply the LoQ of 10 ppm. In 2003, European standards published the experimental norm CEN TS 14495, a copy of IUC 18: 2000 This text was reproduced in several key regulations (EN 420: 2003, EN ISO 20344: 2004 for safety footwear, German legislation, etc.). The European Commission nonetheless decided that a reduction in the LoQ was necessary.

After several years of work, ISO and CEN jointly published EN ISO 17075: 2007. The major technical data remained close to the initial method, but a number of improvements were made (dye purification cartridge, colorimetric analysis conditions, etc). The changes finally made the application of a LoQ at 3 mg/kg possible.

The subject is still a topic of discussion today, and research organisations, at the request of public authorities, continue to work on the problem. At the end of 2016, the standard will be revised and split into two parts. Further changes are being made to improve reproducibility between laboratories. For example, the leathers will no longer be crushed, but cut. EN ISO 17075-1 will revert to the old method. The new reference method will be EN ISO 17075-2, in which ionic chromatography is the required analytical technique. This is a major development, which reduces the risk of errors (false positives). Interlaboratory validation trials have confirmed the LoQ at 3 mg/kg for both methods. These complex developments serve as a case study, indeed few subjects have generated as much normative or legislative work.

1.2 Previous studies, "good practice"

Several publications have studied and discussed the best manufacturing conditions for minimising the formation of Cr(VI) in leather:

- avoiding the use of oxidizing agents before and after tanning (bleaching agent);
- finishing the process at a pH between 3.5 and 4;
- maturing after tanning;
- rinsing at the end of tanning, and again at the start of the currying process;
- limit or avoid the use of ammonia for the penetration of dyes;
- use of saturated (non-oxidisable) food oils;
- not using chromate pigments;
- use of vegetable tannins in retanning (1 to 3%).

The addition of antioxidants in the wet phase is a complementary method of ensuring compliance with the threshold of 3 mg/kg Cr(VI) in leathers. Many chemical suppliers have antioxidants for sale to the industry

The objective of this work is to validate the numerous hypotheses offered to date concerning the presence of Cr(VI) in leather, to estimate which major parameters have the strongest contributions, and to develop new practices or new substances that will help to limit the appearance and/or development of hexavalent chromium in leather.

2. Cr(VI) and leather, the CTC study

2.1 Is the EN ISO 17075 test standard reliable?

An inter-laboratory test (ILT) was organised between all the European laboratories, to reassess the relevance of this test method, and to avoid certain conclusions being challenged by controversies around EN ISO 17075.

This standard is currently being revised, in particular with the inclusion of a new Cr(VI) detection technique using ionic chromatography. CTC, in collaboration with CEN TC 289 and IULTCS, piloted the ILT implementing the two methods for future norms, which are expected to be published early in 2017:

- pr EN ISO 17075-1 (IUC 18-1): colorimetric detection (old method)
- pr EN ISO 17075-2 (IUC 18-2): chromatographic detection (new method).

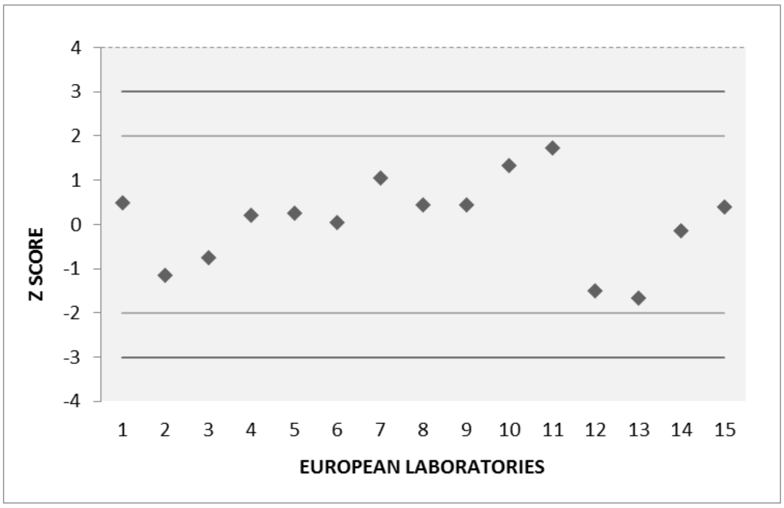


Figure 1: Results of the 2015 inter-laboratory test
(Mean value 3.4 ppm standard deviation of reproducibility 1.1 ppm)

The results of the ILT (see Figure 1) show that:

- the two methods lead to equivalent results;
- the new method of preparing the leather by cutting improves reproducibility (results between laboratories);
- with a panel of 16 laboratories, the result remains consistent and confirms the previous studies and the applicability of the two methods
- the limit of quantitation remains at 3 ppm with both methods. The homogeneity of the leather, along with its preparation and extraction, remain the critical phases of this method. Although ionic chromatography has many advantages over colorimetry, the ILT revealed no gain in the limit of quantification (recall, the LoQ is the concentration corresponding to a measurement uncertainty of 50%).

2.2 Development of Cr(VI) in leather — the influence of tanning

The bibliography raises two interesting lines of inquiry:

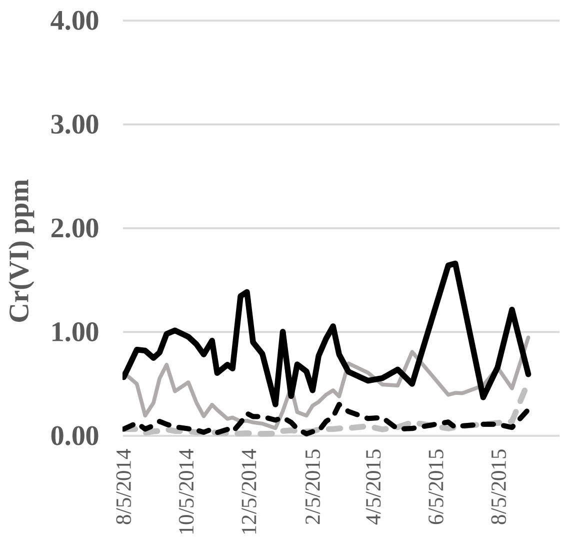
- leathers that contain unsaturated food oils (such as fish oils) appear to be more prone to the development of Cr(VI);
- leathers that have been retanned with vegetable tannins seem less affected by this problem.

It must also be taken into consideration that Cr(VI) levels are not constant over time. All the laboratories found this to be the case, but the parameters allowing the development of Cr(VI) levels with time to be predicted remain to be determined. The Leather Department of CTC has prepared a protocol, starting from a single batch of wet-blue bovine leather:

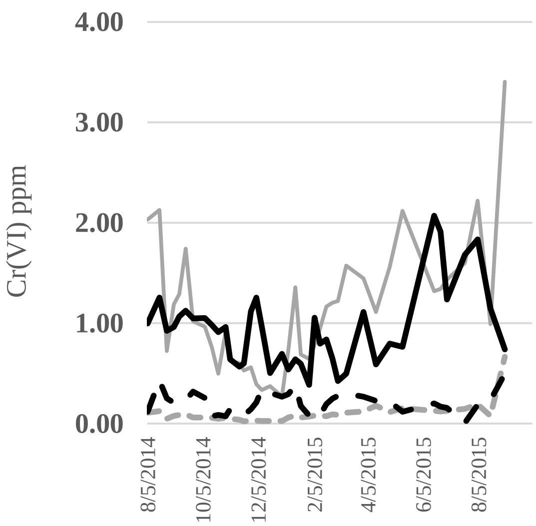
- **leather A**, prepared in accordance with all good tanning practices, with a reducing agent and vegetable retanning. This leather should not therefore develop Cr(VI);
- **leather B**, identical to leather A but using unsaturated food oils (an oxidised and sulphated fish oil);
- **leather C**, prepared in disregard of all good manufacturing practice. This leather should therefore see a development of Cr(VI);
- **leather D**, identical to leather C, but with vegetable retanning.

Each of these leathers was cut in two, longitudinally. One half of the leather was stored in a cold room (protected from light at 4 ±3 °C), the other in the CTC tannery on a frame with no special precautions (exposed to daylight at between 15 and 25 °C, at ambient relative humidity).

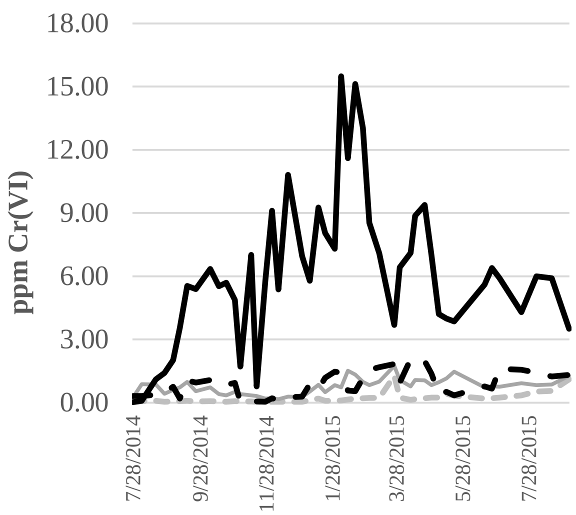
These four leathers were analysed regularly to track the development of Cr(VI) content as a function of time. For each leather, four analyses were made across tannery/cold room leather and crushed/cut leather (see Figure 2).



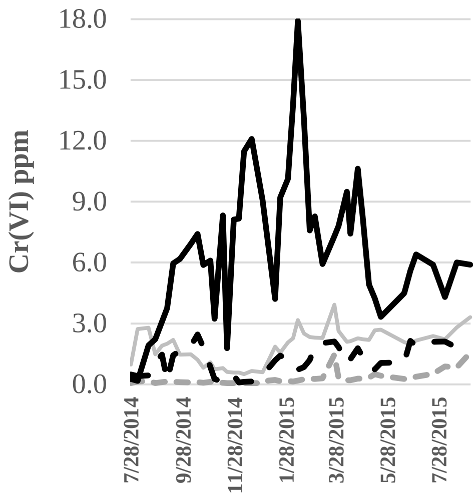
Leather stored in a dark refrigerator at 4 °C then cut



Leather stored in a dark refrigerator at 4 °C then crushed



Leather preserved the tannery in the dark then cut



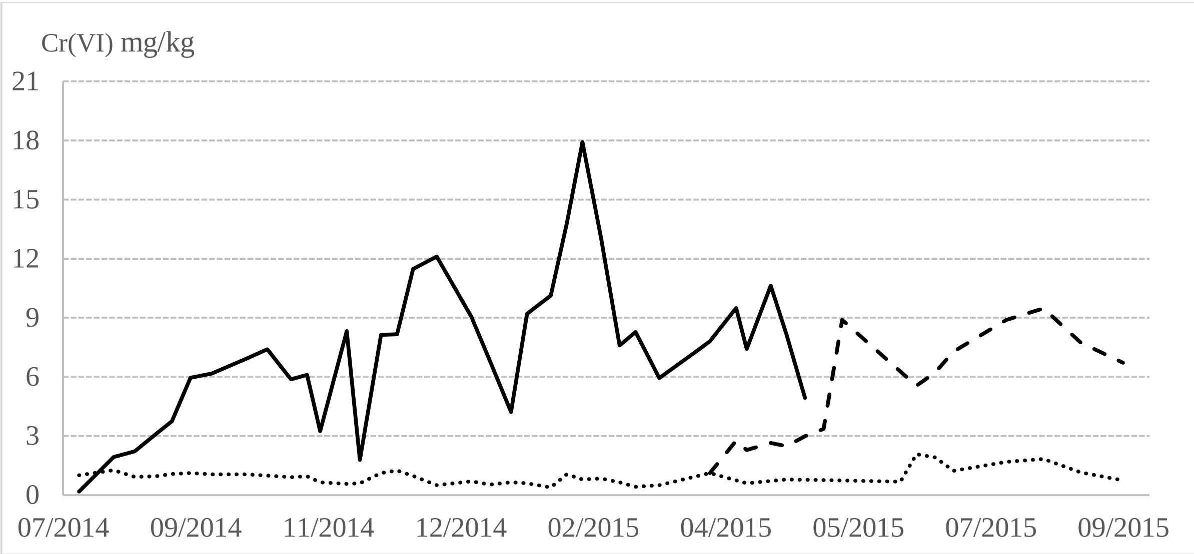
Leather preserved the tannery in the dark then crushed

leather A leather B leather C leather D

Figure 2 development of Cr(VI) over time in the four leathers

The first results show that:

- **leather A**, after more than one year of storage, does not develop, and has never contained, Cr(VI), which confirms the previous studies and confirms the importance of applying good tanning practices (including a reducing agent and vegetable retanning);
- **leather B** confirms the potential impact of food oils.-Simply using them use (in the absence of reducing agent) leads to the quasi non-compliance of this leather, which oscillates around the 3 ppm mark;
- **leather C** developed a significant Cr(VI) content. rinsing during its production was summary and probably yielded a highly heterogeneous leather (hence the fluctuations on the curves as a function of time). This leather, stored in a cold room, developed virtually no Cr(VI). After six months, it was removed from the cold room. A piece of this leather was moved to the CTC tannery platform (ambient temperature, relative humidity and light variations). The Cr(VI) content developed in the same way as the leather at t=0 on the tannery platform (see Figure 3);
- **leather D** confirms the beneficial effect of vegetable retanning. Simply using this treatment allows the 3 ppm ceiling to be respected, even thought the rest of the tanning protocol was knowingly defective.



In the tannery since 07/2014

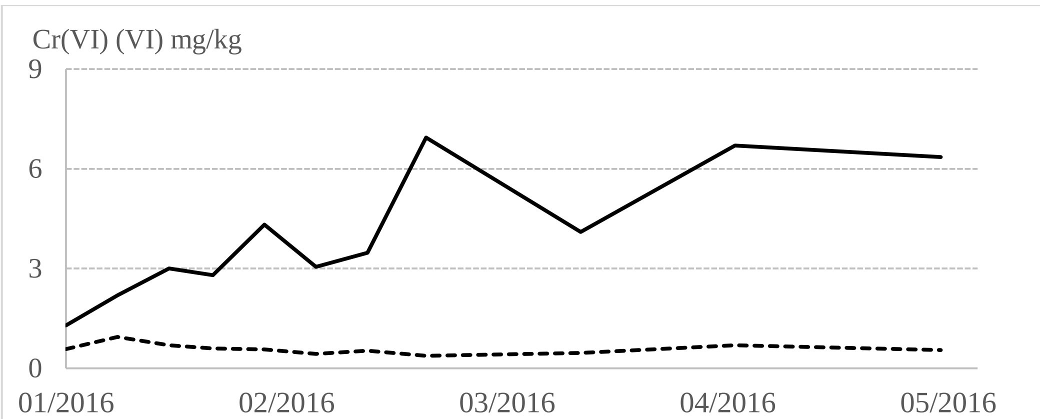
In the cold room since 07/2014

In the tannery since 03/2015

Figure 3 Development of Cr(VI) content as a function of storage

Nevertheless, fluctuations are recorded: vegetable retanning does not solve everything. The results of crushed leathers are almost always superior to those of cut leathers. For the lower Cr(VI) levels (between 0.3 and 4 mg/kg), a difference exists, but remains limited. For samples where the content is more marked, the values determined remain at the same order of magnitude. The study revealed no major effect due to this "sample preparation" parameter.

A similar study was carried out by CTC on reptile leathers (crocodile) the same behaviour was demonstrated (see figure 4)



Real time ageing at 4 °C, in the dark   Real time ageing in the tannery

Figure 4 :the development of the Cr(VI) content depending on storage in a reptile leather

2.3 Ageing

The Cr(VI) content in a leather is not constant over time, having an upward trend. Manufacturers of leather increasingly wish to be able to predict the development of Cr(VI) levels in their leather products. Such an approach would ensure the compliance of the leather throughout its life cycle. Many European laboratories are working on this problem by simulating an accelerated ageing of the leather over a few hours in climatic chambers, by acting on two factors: temperature and relative humidity. These experiments have shown that a high temperature and a dry atmosphere favour the formation of Cr(VI) in the leather. However, ageing practices are not yet standardised and each laboratory imposes its own particular conditions. Moreover, few currently running studies take into account the influence of exposure to light.

The four bovine leathers (A, B, C, D) were aged under different conditions in a climatic chamber (xenotest), with variations in the following parameters:

- time (24 hours and 48 hours);
- relative humidity (20% and 50% RH)
- temperature (40 °C and 80 °C);
- Light (with and without).

Ageing with the presence of light was performed using an Alpha xenotest.

The first results show that:

- **leather A** shows no development and remains below 3 mg/kg whatever the ageing conditions applied. It confirms the importance of respecting good manufacturing practices;
- **leather B** reacts to the high temperature (80 °C) and the dry atmosphere (20% RH) with values greater than 3 mg/kg. The presence of light accentuates the phenomenon and results in the formation of Cr(VI) at a concentration of more than 10 mg/kg.
- **leather C** follows the same trend as leather B, responding to the high temperature (80 °C), the dry atmosphere (20% RH) and the presence of light.
- **leather D** also developed Cr(VI) under the most severe ageing conditions (80 °C, 20% RH, with UV). The addition of a vegetable retanning agent does not seem to completely "neutralise" the formation of Cr(VI).

These tests confirm the influence of the four selected parameters: light, low relative humidity, temperature and time.

On the basis of these accelerated ageing tests, the rest of the study consists of a comparison of these results with 16 months of real-time ageing in the four bovine leathers stored at room temperature at the CTC leather platform. The objective is to verify that accelerated ageing is indeed representative of the ageing that occurs under "natural" conditions. The comparison of the results is presented in figure 5.

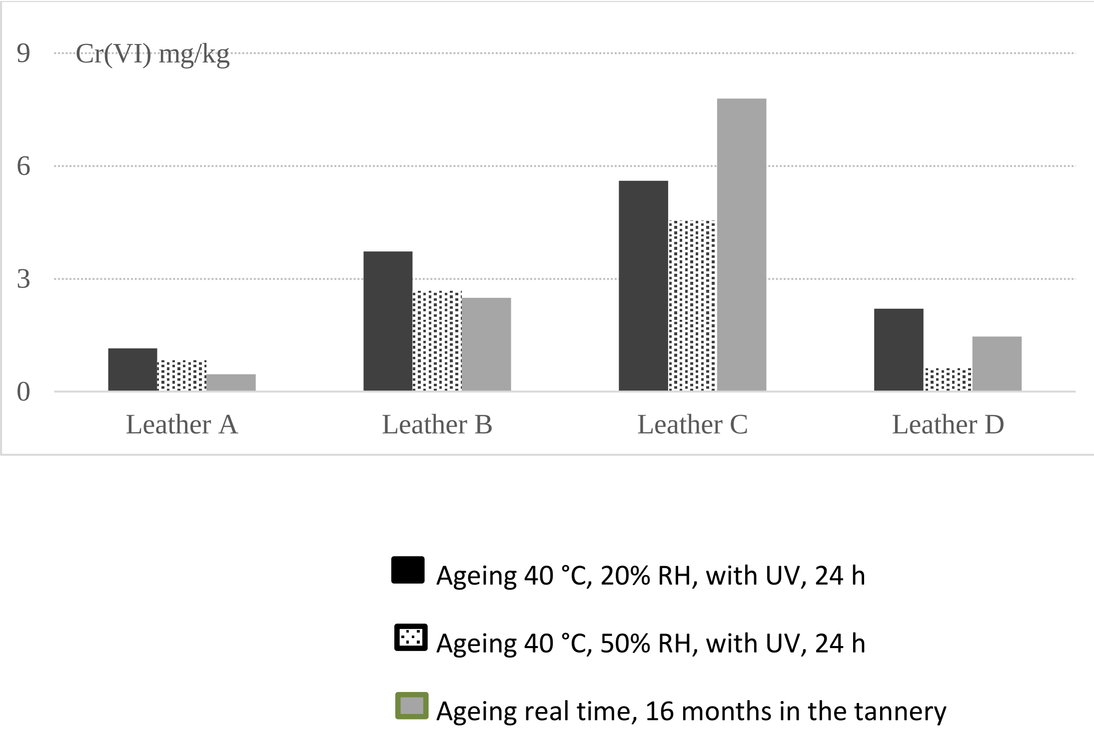


Figure 5: Comparison of accelerated and natural ageing

A similar trend is observed at 40 °C with the presence of light for 24 hours.

These first results on accelerated ageing demonstrate that light is an important factor, especially on non-finished leather. Tests on other leathers are under way in order to confirm which accelerated leather ageing process is most representative of reality.

2.4 Validation of the new ageing test norm prEN ISO 17075-3

An ILT was organised by CTC in collaboration with CEN TC 289 and IULTCS, with all the laboratories involved in validating the relevance of the test method, and imposing light as an essential parameter.

Conclusions:

- The Interlaboratory trials provided good results, no wrong assessments with 5 leathers 3 preparations and 7 lab (only 2 exclusions for 96 results)
- Thermal effect seems to be slightly more severe but for finished leather the results with Thermal and Light ageing are very close.
- The results for Light Ageing are slightly better than for Thermal Ageing. The dispersion of results for light is smaller.

The method retained provides for leather treatment at 80 °C, with a relative humidity of less than 10% and an ageing time of 24 hours.

Following this study, the test method prEN ISO 17075-3 (IUC 18-3): "Leather - Chemical determination of chromium (VI) content in leather - Part 3: Thermal pre-ageing of leather and determination of hexavalent chromium" has been prepared, and will be put to public inquiry in 2017.

2.5 Leather manufacturing parameters and Cr(VI) content.

Good and bad practices that may have an impact on Cr(VI) content have been published [1]. This study aims to assess the impact of ageing on these practices. Of all the parameters capable of promoting the formation of Cr(VI), not all have an influence. It was essential to evaluate those presenting the maximum risk.

Different practices have been identified and tested:

- ✓ No rinsing after chromium tanning
- ✓ No maturing after chromium tanning
- ✓ No rinsing during wet currying
- ✓ Use of ammonia
- ✓ Use of oxidisable nutrition
- ✓ Finishing the wet process at pH = 5/5.5

and comparisons

- All good practices are respected
- All bad practices are applied

This study was also carried out simultaneously on pickled sheep and cattle skins. Neither production has a dyeing or retanning process.

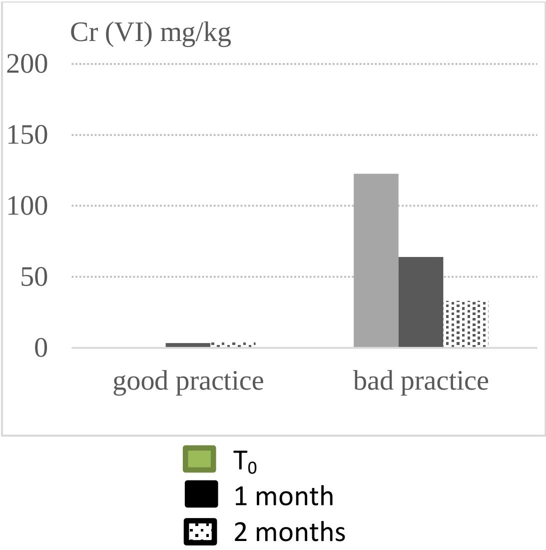
The results show the skins of sheep and cattle behaving in a similar manner. There is no major difference, it is nevertheless noted that sheep skins tend to develop a little more Cr(VI) under identical conditions in our study. We also tested the influence of ageing at the tannery and accelerated ageing on these leathers (see Figure 6).

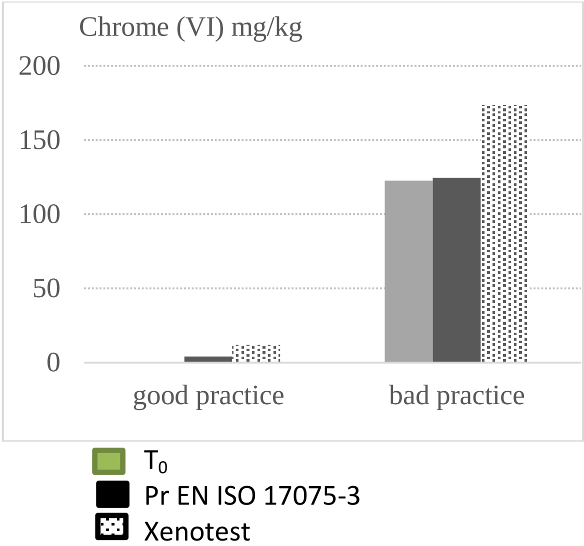
On this "good practice" phase of the study we propose the following remarks:

- At T_0, immediately after manufacture, good practices make it possible to make a leather with no Cr(VI)
- It can be seen that “fat matters parameter: Use of oxidisable oils" is the most important parameter, confirming our starting hypothesis (leathers B and C)
- There is a synergy between the parameters, leather “bad practice” having a higher Cr(VI) content than all the others.
- Light is a critical factor on unfinished leather.
- After ageing (whether accelerated or not), some of leathers produced in this study generate Cr(VI), even with good practice

This last remark is particularly important, it is for this reason that our next investigations will be dedicated for the most part to the study of antioxidants:

- ➢ their nature, mineral or organic
- ➢ optimal concentrations
- ➢ possible combinations





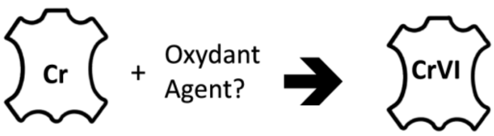
Leather: Sheep Development of Cr(VI) content at tannery

Leather: Sheep Development of Cr(VI) content after accelerated ageing

Figure 6: Influence of manufacturing parameters on the appearance of Cr(VI) in the leather

3. Conclusion

To recapitulate the information obtained during this investigation, we can write a schematic chemical equation:



Our main conclusions:

- Nature of the chromium reaction is currently unknown. In a previous communication[1] we showed that there is no correlation between free chromium or total chromium with the presence of Cr(VI).
- The presence of oxygen is paramount. When carried out under nitrogen, ageing tests revealed no appearance of Cr(VI)
- An increase in temperature favours the appearance of Cr(VI)
- The presence of unsaturated fats appears to be an essential (perhaps even the essential) parameter
- Light also promotes the development of Cr(VI) in unfinished leathers.
- An increase in humidity makes it possible to reduce Cr(VI) levels.[1]

Should a chemical reaction be considered "catalytic" where the unsaturated sites associated with light and oxygen allow the formation of an oxidant capable of reacting with the chromium II in leather?

Upcoming studies on antioxidants should help us to understand these phenomena.

4. References

1. CANNOT JC , BLANC N, FONTAINE M, DEMESMAY D, Study of the variation of chromium VI content inside the leather used in footwear , IUTIC 2016 Chennai

ADVANCES IN BIO-BASED POLYURETHANES FOR LEATHER FINISHING

Michael Costello

Director of Sustainability at Stahl

Much of the current research into leather chemicals is focused on providing tanners with solutions that reduce their environmental footprint at each step in the leather manufacturing process. Less water consumption, effluent quality, the elimination of restricted substances and the introduction of naturally occurring ingredients are just some of the areas on which chemical companies like Stahl are working.

Coatings technology for the finishing step of the leather process has, until recently, been largely been based on petroleum feedstock chemicals, like ethylene and propylene. Yet new product development has been driven more by compliance to specific substances, like NMP and NEP, than a desire for bio-content. However, as this paper summarizes, recent advances in biotechnology have allowed a new class of polymers to be developed. Made from renewable raw materials, these bio-based aqueous polyurethanes also demonstrate superior film performance to their fossil-fuel based predecessors.

From Nitrocellulose to Polyurethanes

There are many polymer technologies, both solvent- and water-based, that can be used as binders in leather finish formulations: polyurethanes, acrylics, nitrocellulose and butadiene for example. Typically these polymers are combined with additives in a compound to provide the characteristic touch, surface appearance and durability of the final leather.

Nitrocellulose was widely used in the past for finishing leather but the elimination of solvents from tanneries and the need for more durable coatings, especially in the automotive industry, has meant that water-based polyurethanes have since become the standard for high performance leather finishing. Polyurethane films are both durable and flexible and they protect the leather from staining, abrasive damage and from the long term effects of weathering.

Polyurethane Dispersions

Polyurethane dispersions (graph 1), also known as water-based polyurethanes, are produced by first reacting polyols with isocyanates, in the presence of an acid, to make a pre-polymer. This pre-polymer is neutralized, dispersed in water and this is followed by a chain extension step. The final product is an opaque white liquid. A polyurethane-based finish is typically applied by roller or by spraying onto the leather, then dried. As the water evaporates from the coating, the polymer coalesces and the cured polyurethane film is left on the surface.

Graph 1: Polyurethane Dispersions

Building Blocks

The main chemical building blocks for the manufacture of polyurethane dispersions are isocyanates and polyols (graph 2).

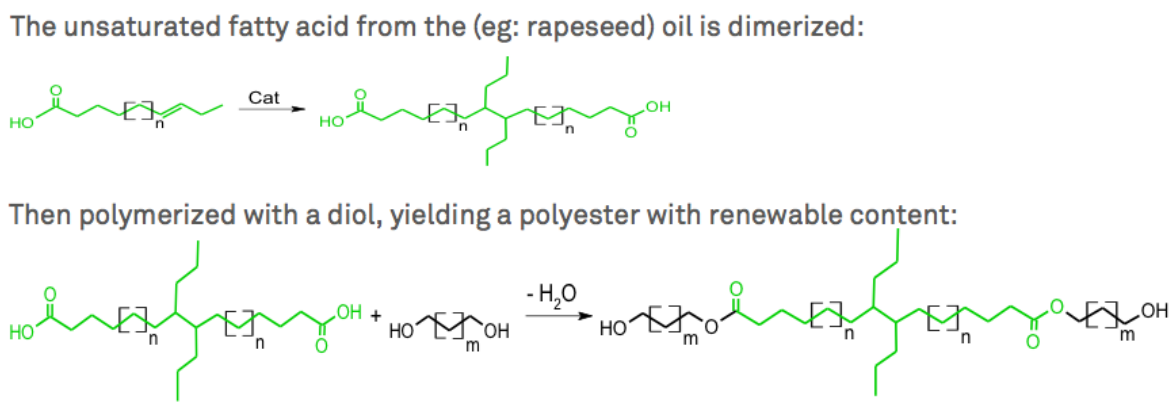
Ingredients	%
Polyol	**60 - 80 (on solids)**
Isocyanate	**10 - 15 (on solids)**
Solvent	5 - 10
Water	60 - 70
Others	0 - 5 (on solids)

Graph 2: building blocks Polyurethane Dispersions

The polyols used for polyurethane-based finishing are typically polyether (for basecoats), polyester or polycarbonate (for topcoats). The choice of polyol (and isocyanate) depends entirely on the final properties required for the end article.

Bio-based Polyols

Certain polyols can be made using plant-based (renewable) resources instead of petroleum-based raw materials. In these cases, natural oils are extracted from the plant and transformed into polyols - the unsaturated fatty acid from the oil is dimerized then polymerized with a diol to produce the polyol, in this case a polyester diol (graph 3).

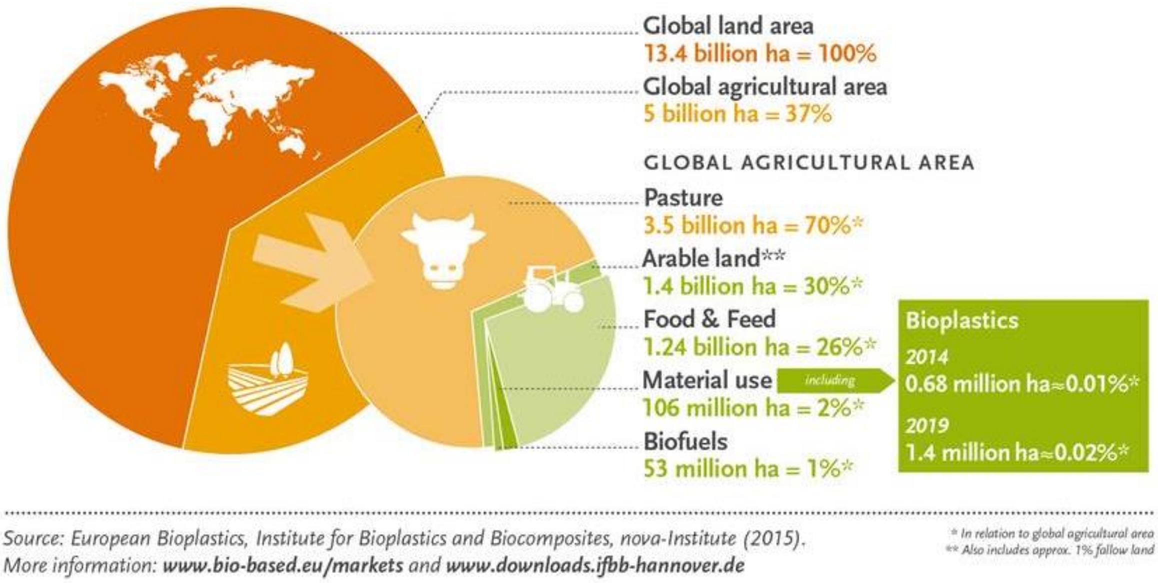


Graph 3: bio-based Polyols

Many different plant oils can be used to make these bio-polyols, like canola (rapeseed), soy, palm or linseed. Some advantages of using renewable oils versus fossil fuel-based materials are:

- Plants can be re-grown, avoiding depletion of the earth's crust
- Wide availability of the plant resource in all regions
- Lower carbon footprint vs extraction and transport of fossil fuels
- Some plant oils already used in animal feedstuffs and biodiesel (eg: Rapeseed)

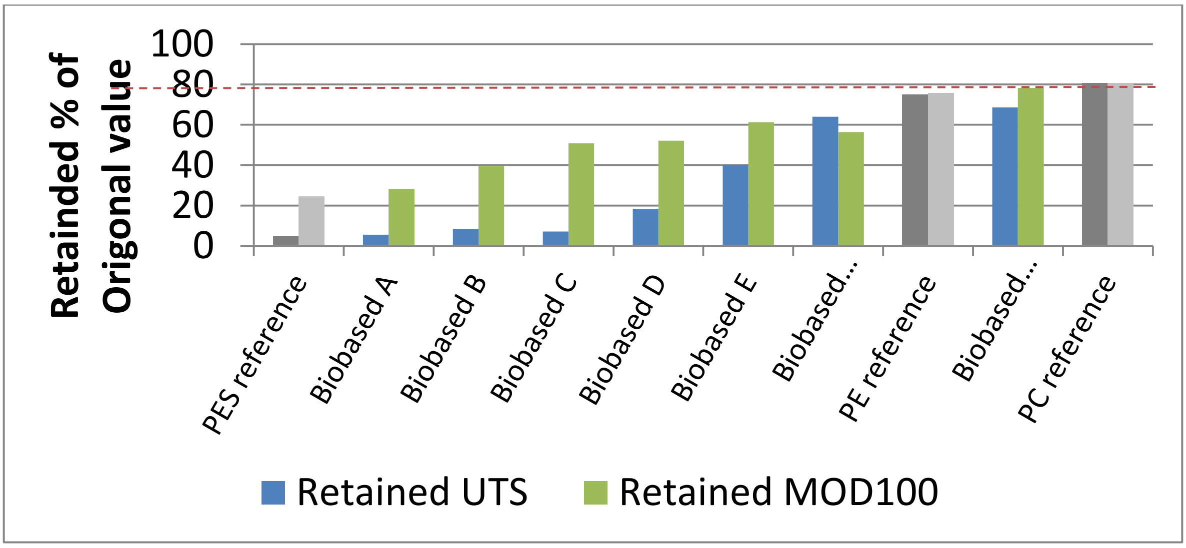
The overall land-use required for biopolyols is a small portion of the total land use for bioplastics, as illustrated in graph 4.



Graphic 4: Land use for bioplastics 2014 and 2019

Performance

Recent advances in biotechnology have made it possible to formulate high performance polyurethanes using polyols derived from plant-based oils. Although Stahl has been researching bio-based polyurethanes for several years, only recently have we observed the high performance characteristics illustrated in graph 5.



Graph 5: Bio-Polyurethanes: Film Performance after Hydrolysis

<u>Test conditions</u>: 50 C, 95% Humidity, 14 days

UTS :	Ultimate Tesile Strength
MOD100 :	Tensile strength at 100% modulus
PES:	Polyester Polyurethane Dispersion
PE:	Polyether Polyurethane Dispersion
PC:	Polycarbonate Polyurethane Dispersion

Explanation graph 5:

Dried films of water-based polyurethanes were subject to the hydrolysis test and tested for tensile strength. Graph 5 is a comparison of the retention values of the films tested. Higher retention of tensile strength means that the polyurethane film in question is more resistant to the test. The conclusion of this data is that films made with the latest bio-polyurethane technology (Biobased EXP-1 and Biobased EXP-2) are more resilient than previously studied polyester and polyether-based alternatives. Indeed the properties come close to the level of polycarbonate-based polyurethanes, considered the gold standard for automotive finishing.

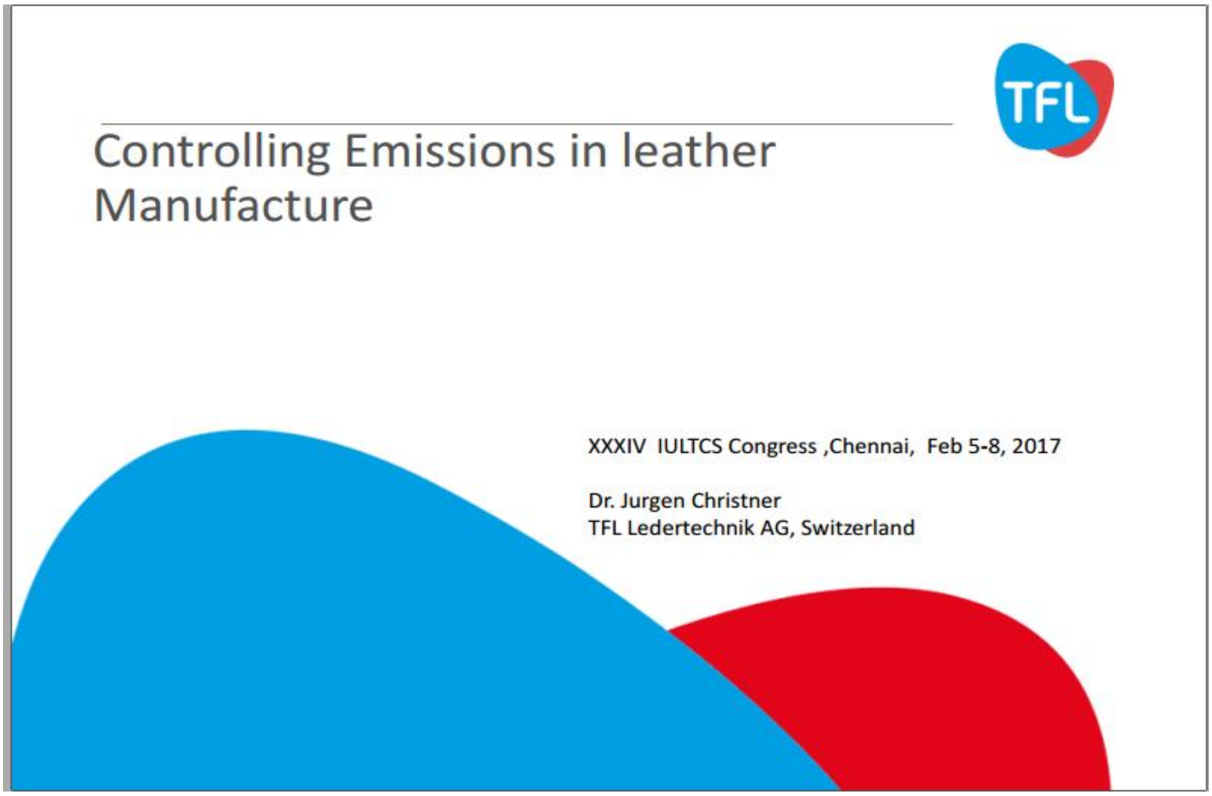
The future: higher performance, more bio-content

The described work is exciting and still developing. The biocontent level achieved so far can range from 10-35% depending on the final product design. Given that only a few years ago we were observing lower performance with a relatively small biocontent percentage in finishes for leather, we strongly believe that polyurethanes can be developed with higher biocontent and even higher performance in the future.

CONTROLLING EMISSIONS IN LEATHER MANUFACTURE

Jurgen Christner

TFL Ledertechnik AG, Switzerland



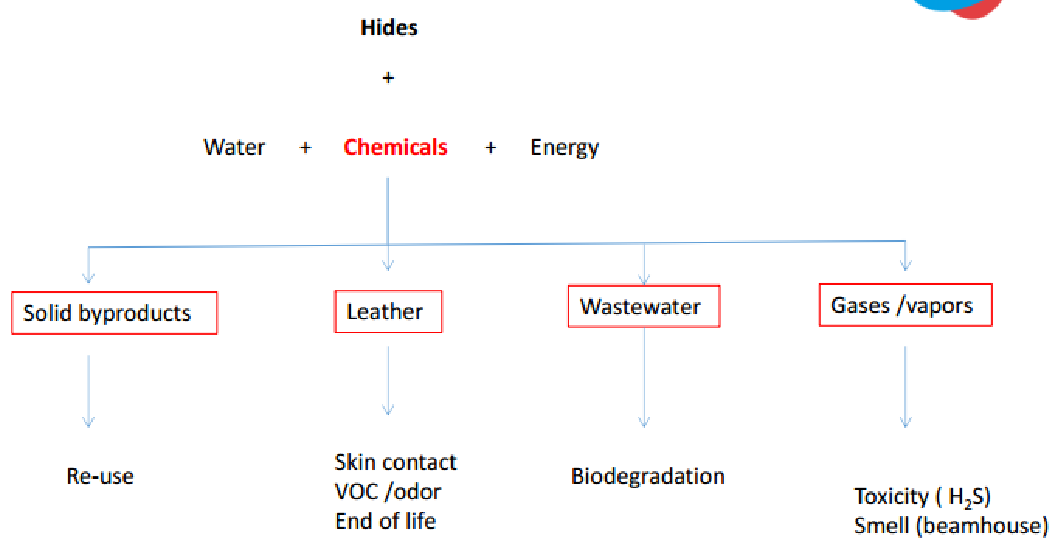
Basic assumptions & facts

- Animal hides are a valuable co/by(?) –product from leather manufacture
- Many consumer are sensitive to animal welfare issues
- Leather is perceived as a durable, natural product
- Leather as a material is facing increased competition from synthetic materials and possibly in future from bio-engineered collagen (leather like) material
- Above facts must lead to a CLEAR strategy for leather manufacture and marketing:
- **Hides need to be processed with best available techniques with regards to performance (quality) , ecology and sustainability**

Basic strategies for controlling emissions

- → Selection of chemical
- → Reduction of chemical input (offer, application technology)
- → Improving the uptake of chemical (efficacy of chemical; i.e. ease of fixation, equipment, machinery)
- → Removal of hide byproducts at early stages
- → Post Treatment of final waste water and gaseous emissions

What is the problem?



Selection of chemicals

Chemicals play a key role

→ Toxicity → environment, human beings (chemical management measures)

→ Biodegradation (or bio-accumulation / persistence in environment)

→ Renewable

→ Compliance with various regulations (i.e. RSL,MRSL)

Safe Chemicals by Input Stream Management

RSL requirements
Eco Labels
NGO
Brands
Manufacturers

MRSL
(i.e. by ZDHC)

Chemical Manufacturer

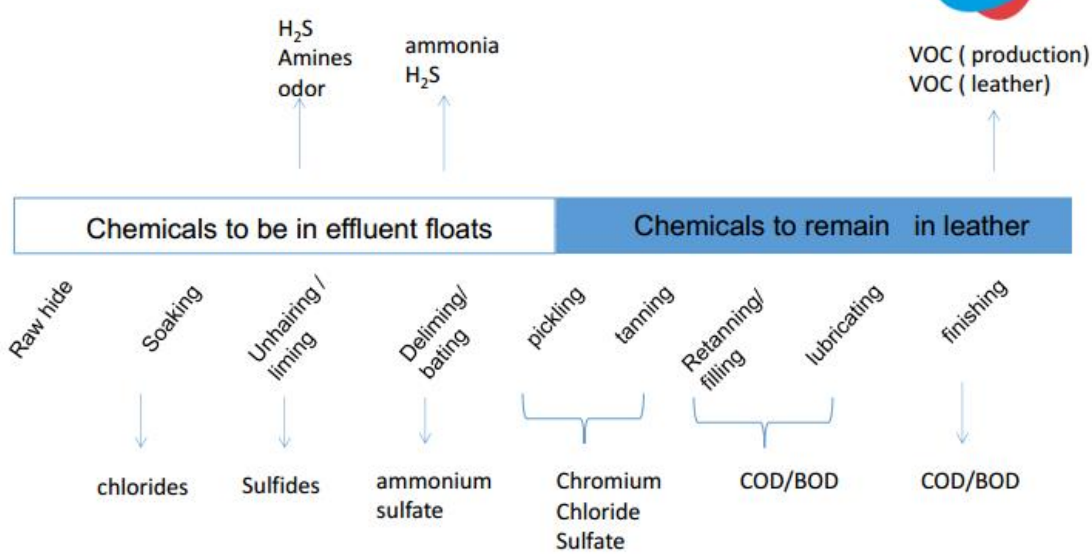
For restricted chemicals

Tannery

Excluded:

- Chromium VI
- Form(acet)aldehyde)
- Biocide

Main polluters



Salts (chlorides, sulfates)

- Prevention is easier than post treatment
- Salt has many positive effects (i.e fiber separation, humidity control, penetration of dyes)

→ Fresh hide processing (large processing units)
→ Low/ no float tanning processes w/o pickling
→ Chemicals with low salt content (i.e. liquid syntans , etc.)
→ Deliming w/o ammonium sulfate
→ Salt reduction by Reverse Osmosis
→ 'dilution'

Sulfides ,H_2S

- Sulfide is most toxic and hazardous chemical in leather manufacture with regards to human beings and environment

- Enzymatic unhairing (no reliable **100%** sulfide free process available)
- Organic sulfides like mercapto-compounds (still hazardous chemicals)
- Newly designed low sulfide liming process using proprietary degreasing and unhairing enzyme technology to achieve:
  - **≥ 60% reduction of sulfides in wastewater and air emissions (deliming/pickling)**
  - **1/3 reduction in COD /BOD and total nitrogen in soaking& liming (in combination with a hair saving liming process)**
- Post treatment b y catalytic oxidation (fumes!)

Ammonium

- Ammonium (NH_4) has high COD/BOD demand, it is eliminated by nitrification process which is sensitive to chemical disruptors (i.e. certain biocides) and bears risk of nitrite emissions; ammonia (NH_3)is toxic to fish

- Substitute ammonium salts by organic acids / esters
- CO2 deliming
- Biological ammonia elimination : requires sufficent capacities in waste water treatment plants

Reducing Chromium emissions

- Emission of chromium into the environment is via leather, wastewater(sludge) & shavings ; only if Cr is recovered chrome tanning is a sustainable tanning technology
- **Good Cr exhaustion from tanning floats** (use of masking agents , low /no float tanning ,optimized application via pH, T, time)
- **Good fixation of chromium** to reduce Cr leaching & lower risk of Cr 6+ formation: masking agents, pH, T, time
- **'Light Blue'** Tanning (reduced Cr offer)
- **No use of chrome in retanning**
- **Recycling of chrome tanning float** (counter cycle principle)
- **Chromium recovery (re-use)** a). Cr-precipitation from tanning floats, b) Hydrolysis of Chrome shavings c). Hydrolysis of leather

COD/BOD reduction

- COD/BOD covers all organic and oxidisable inorganic pollution coming from chemicals and hide components

Beaming/Tanning	WE/FIN
70-80% of total COD	**20-30% of COD**
Emulsified natural grease , dissolved hair & hide proteins, Processing chemicals , biocides	Fatliquors, Wet End -polymers, Finsihing polymers phenolic syntans, veg. tannins Biocides

Uptake of chemicals

Good uptake of chemicals is a key element and is facilitated by

- → **Early removal of hide components** in a native state (grease, hair)
- → **nature of chemical** (ability to penetrate, sensitivity to changes in pH , presence of amphoteric additives etc.)
- → **Presence of cationic binding sites** in wet blue /wet white
- → **Application parameters** (pH, running times, temp. ...)
- → **Type of drums** (i.e. to facilitate low /no float processes)
- → **(partial) substitution of water** by recoverable solvents
- → **Substitution of spray applications** by Roll Coating or Transfer Coating Technologies

Gaseous emissions

Reductions are achieved by

- **Fresh hide processing** (pungent beamhouse smell due to formation of amines)
- **Low sulfide liming technologies** (alternative: oxidative unhairing....)
- **Low (no) ammonium deliming /bating**
- **Low VOC finishing products** (replacement of NMP, NEPO , hazardous glycolethers)
- **Collection and purification of exhaust air**

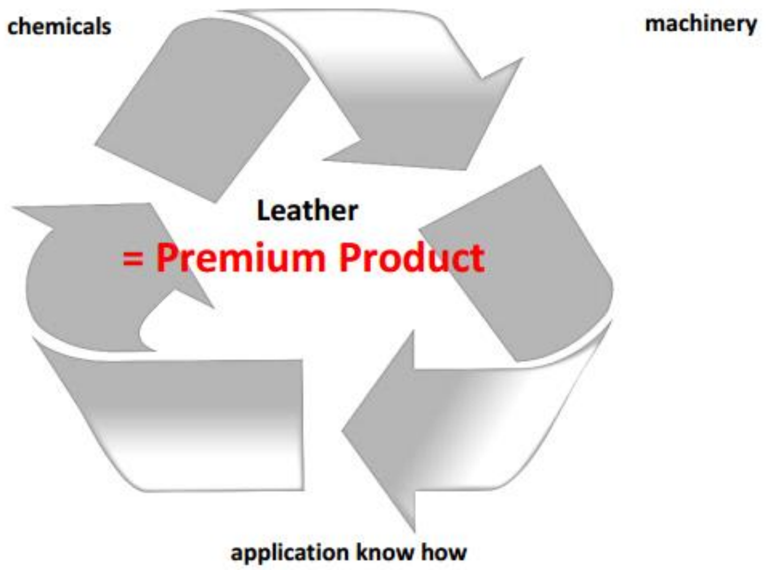
Water Management

- Water is a precious element and saving of water makes sense, but
- **Careful with lime liquor recycling** (reduced opening up, accumulation of bad odor emitting substances, etc…)
- **Float recycling technologies** need very good analytical controls
- **Float recycling** should start earliest after bating
- **Biological waste water treatment** of concentrated floats is more difficult

Wastewater Treatment

- No chemical nor any application technology will results in effluent which can go directly to streams
- **Common treatment plants** need ample capacities to cope with variations in effluent leads
- **Hard to biodegrade waste waters** often need extra treatment (i.e.ozone treatment, Fenton's reagent)
- **Stand alone treatment units** often operate more robust and develop less emissions (odor)
- **Understanding of presence of disruptive chemicals** which can harm biological treatment

Developing a clear vision is a matter of choice



Pictures from the past

CO-OPETITION IN LEATHER ENGINEERING EDUCATION - A STRATEGY FOR A WIN SITUATION FOR CONCERNED STAKEHOLDERS

Prof. Dr. Sayeed Sadulla

Chennai, India

Email: sadullams@hotmail.com

Leather continues and will continue to play a decisive role in the growth of many countries over the next few decades. Engineering education in leather in the countries/continents across the globe caters to the demand for the technical talent to run and manage the leather and allied industries. Globalization is now reckoned a big factor in education as it is in an eminent position in business and finance, throwing open new challenges mostly in higher education administration and management. Partnerships and twinning seems to be the answer at national and international levels. Co-opetition (short for "Cooperative Competition") in which different leather engineering institutions spread across the globe work towards a common goal of sustainable leather industry but at the same time seek to achieve and maintain individual objectives and "vision and mission" accomplishments, seem to be in perfect order, A mechanism to sustain healthy co-operation and simultaneous competition, in which the academic and research and other strengths of the individual institutions will be maintained will be highlighted.

Keywords: Leather Engineering Education, Globalisation, Coo petition, Global Alliances, Networking Strategies

LEATHERMAKING AND LEATHERCRAFT

Leather making and Leather craft are known in many countries since time immemorial and they have been mostly traditional, employing methods based on age old empirical techniques and experience gained over a period of time, passed on from one generation to another until the middle of 20th century. The traditional leather industry has blossomed into a modern scientifically based industry. Over the years, leather has firmly established itself very well in the economics of the developing countries, offering itself as an opportunity sector for best leveraging by linking technology to trade advantages. It is contributing significantly to the economic development, employment generation, export earnings and equity building for these countries, though of late environmental issues cause social concerns to a certain extent. Leather will continue to play an important part in the economic growth of many countries, particularly the developing ones, over the next few decades.

TRAINING IN LEATHER

Though leather making and leather craft are time immemorial, the imparting of formal training in leather is of relatively nascent origin. Trade guilds in most of the countries kept alive the leather craft. Formal education and training in leather and allied industries dates back to the first decades of 20th century in Europe and in India. Unfortunately there is no proper documentation on leather technology education and training available in different parts of the word except for a few countries such as India and Turkey.

ENGINEERING EDUCATION IN LEATHER

Preparing the youth for the future and enabling them acquire knowledge and productive skills for career in any of the professions have always remained in the forefront in any society, developed or developing. Engineering professional education in any field including leather is to cater to the human resource needs of the particular sector at the tertiary level by preparing the youth for the future, enabling them acquire knowledge and productive skills for a career in their chosen professions . The three major objectives of education whether it is in humanities, social sciences, science or technology are cognitive, psychomotor and affective, corresponding to knowledge, skills and the affiliation/commitment. The first two objectives will vary in case of training and education Countries like India, Bangladesh, Turkey, Sudan, Ethiopia, Kenya, China, U.K., Spain, Czech Republic, Russia and a few other European countries offer full-fledged graduate engineering/science education in leather. The aim of the leather engineering educational systems in these institutions vary depending on the social and economic conditions of the concerned countries and the degree of modernization and sophistication reached by these countries. The engineering education needs to find harmony with the social ethos and work culture of the society. The aims of these systems too vary with course of time and change with the environment and within the system itself. Nevertheless, the basic aim remains the same – to provide adequate trained quality human resources to the industry to make it productive and competent and competitive to meet the ever popping up issues like quality raw material availability, more and more stringent environment regulations desired by the community and trusted by the Government, technological dynamics, market forces and the very question of the sustainability of the industry itself. As of now, there is limited coordination with academic institutions, universities, research bodies, industries and other stakeholders.

CHALLENGES AND OPPORTUNITIES FOR LEATHER TECHNOLOGY AND EDUCATION

Leather engineering is a multi-disciplinary course involving many branches of science and engineering. New emerging scientific, technological and industrial developments like ICT, biotechnology, nanotechnology and modern instrumental techniques are impacting the leather science and technology/research, industry and trade and thus leather offers itself as an exciting and exhilarating field of study. Throughout the history of leather technology, once can see how new scientific ideas and novel technologies have been and are put into practice in the leather industry making it more eco-friendly and these get reflected in the education and training programmes offered by the teaching/training institutes.

The first and foremost effort on the part of educational institutions offering leather technology programmes is just how to equip the students with the practical skills needed by the employers. “Ready to employ” graduates! That is what most industries prefer to have and expect from the institutions. How to equip these students with the practical skills needed by the employers? Competency – based teaching approach that prepares students to be productive in the workplace immediately after graduation.

Now is the time for the educators in leather technology stream to take a close look at the content, form and method of education in leather, that too in the background of globalization sweeping every human activity. Technological advances in the fields of communication systems, transformation and information processing have brought the human communities nearer in an unprecedented manner. Emerging technologies have changed the very character of the education and research requiring trans disciplinary team work approach. In the case of leather research too, prior to 1950, the emphasis was on scientific discoveries and elucidations at an individual or at the utmost a small group of individuals and the projects were more science oriented. Post 1950 saw development of products and systems through multi-disciplinary approach. Scientific efforts of Central Leather Research Institute established around this period in India is a classic case study. Scientists drawn from multi-disciplines from chemistry, biology, leather, polymer, engineering etc. have successfully tackled the problems of leather industry. New paradigm shifts in R&D encompassing and emphasizing networking and collaborative alliances resulted in successful implementation of international projects such as EU funded silicic salt project and ACIAR (Australian Cooperation for International Agricultural Research) funded "Salinity Reduction in Tannery Effluents in India and Australia “Project.

NEED TO REENGINEER LEATHER TECHNOLOGY EDUCATION

What is expected of at the under-graduate level is competence to attain individual excellence, a sense of values to serve the society and the capacity for continuous learning and continued growth, ability to innovate and optimize the design and development of the engineering system and to develop competence with real life problems. The undergraduate programme in leather engineering should be structured to present a broad and balanced perspective of the subject and should expose the students adequately to basic and engineering sciences. The under-graduate programme should also give ample scope to the students to select a variety of elective subjects that interests him. Learning is likely to be more effective if it grows out of what interests the learner rather than what it interests the teacher. Grater flexibility in the curriculum structure which is more students – centric brings out greater involvement, a sense of participation and achievement on the part of the students. The post-graduate education should aim at imparting specialist knowledge – research, marketing, management etc., with much focus on these. The leather education and training course have to be re-oriented to suit the emerging needs.

GLOBALISATION

Globalization is now as big a factor in education as it is in an eminent position in business and finance. Both teaching and research can be carried out, delivered and consumed internationally. This throws open new challenges for the higher educational institutions. Partnership and twinning seems to be the answer – at institutional, national and international levels. In the field of tertiary education in technology, the globalization plays a vital part.

GLOBAL ALLIANCES

A select body of professional institutions in leather across the globe are offering leather technology programmes. Some institutions ceased to operate or close down their programmes. Yet a few nascent institutions are springing up, particularly in African countries to meet their aspirations of developing the leather industry as media of their national growth. These institutions have one to one interaction, cooperation and collaboration with each other for one reason or other. Globalization has changed the very nature of international cooperation. Today, institutions form linkage with one another in order to compete in the international arena. Globalization now eventually leads to more and more strategic alliances among multiple partners transcending national barriers. Any cooperation programme is intertwined with an element of competition. Co-opetition (

Cooperative Competition) is the buzz word today. A judicious balancing act of healthy cooperation and simultaneous and supplementary competition is what is required.

ISSUES TO BE ADDRESSED

1. What are the models and approaches to international institutional cooperation in the current globalisation era? The Erasmus + Programme and the COMESA-LLPI Programme are two cooperation programmes worth watching and studying. The former is the largest project of European cooperation in the area of higher education while the latter serves the interest of leather sector in the COMESA Region of Africa including human capacity building and enrichment, thus primarily limiting their scope with specific Regions, with limited interaction with other Regional Groups.
2. Under what circumstances are the institutional linkages most likely to succeed or otherwise fail?
3. What are the strategies that may be attempted to create mutually beneficial relationships between the institutions?
4. What is the mechanism to maintain the strength of the individual institutions? How to sustain global reach, maintaining at the same time individual traits and local flavour?
5. What kinds of organisational structures are involved?

COOPERATION, COMPETITION, COOPETITION

What has really made human race to survive for long is its ability to use its common sense to cooperate with others to get things done by group or team work. Cooperation presents potential collaborators with achievable goals that are likely to be accepted by each and every individual member of the team. Cooperation in the education sector enhances the quality of education by peer to peer learning and comparison with different educational systems. Each educational system may have its own unique trait worth emulating by others too to a certain desirable extent, if not the entire framework of the system, which too may not be required in the given situation and context. The trinity academy-research-industry at its best is exemplified by the Department of Leather Technology of a University (Anna University) administered by a Research Unit (Central Leather Research Institute)(CLRI) with active collaboration of industry. Cooperation between different institutions not only facilitates development of appropriate as well as international curricula and award of joint degrees/ diplomas improves the quality of service to the student community and the teaching profession through mutual learning, comparison and exchange of good practices.

As in other fields of activity, educational institutes too compete for attracting student community into their fold. With quality education and "foreign degree" glamour tag attached to it, many European institutes were very much sought after. With dwindling interest in leather technology education amongst the local student community, these institutes have gone in for the mode of twinning programme with institutes in other geographical locations , by which the students will be carrying out parts of course work in the twinning institutes. As for as leather education is concerned, this arrangement had fewer takers due to reasons more than one.

What is more relevant at this juncture would be a mix of healthy cooperation and simultaneous competition in which the academic, research and other strengths of the individual institutions will be maintained . A case that attracts the attention of global leather engineering education watchers is the twinning programme between CLRI and the Leather Industry Development Institute (LIDI) of

Ethiopia. The twinning process as such has led to the empowerment of LIDI in education and research activities that can be gauged by LIDI's output in recent times in the form of international research publications and participation in international scientific conferences. In the long run, one can foresee the aspirations of LIDI to play a more significant role in human resources development activities of the newly emerging institutes in the African continent. This may involve competing with its mentor which is a welcome sign. Thus, cooperation turned coo petition is sure to bring in richer dividends benefitting the various stakeholders in the leather sector.

Within the larger framework of working towards a common unifying goal of a sustainable global leather industry, the individual institutions will be aiming to achieve and maintain individual objectives and vision and mission accomplishments. How to go about it?

STRATEGIES

In the long run, a network of the leather engineering institutions in different countries has to be worked out. To start with, in the first step, regional networks of institutes of leather technology in Africa, Asia, Europe and America may be promoted and later these regional networks could form an international network, a Network of Institutions of Leather Engineering (NILE). Though the education is universal and global in character, the delivery mechanisms are region-specific and country specific. Every country builds its local competence to utilize its resources. The need for local competence is all the more greater because of the raw material resource - hides and skins is largely country and site specific. Each country should consider providing the necessary infrastructure and trained personnel. All the institutions in specific regions could join in a regional network to exchange information, experience and expertise in order to supplement and complement the competence of an individual institution/ country. There is a great need for pooling the knowledge and for experience – sharing of these institutes in order to achieve rapid development of global leather sector as a whole.

The membership of the Network would consist of the participating institutions and centres of research in leather. The Network could have a General Body constituting all the participating members and an Executive Board consisting of 6 to 8 members elected on a rotational basis by the General Body. The Executive Board would consist of a chairman, a vice chairman and 4 to 6 members. The Executive board would formulate and approve the plans, programmes and budgets for the co-operative endeavours and would set guidelines for training and education and research. The Board would meet 3-4 times per year by rotation in each participating country. The networking helps in exchange of ideas, sharing of experiences on educational activities, talents, facilities etc., working as a trans-national team for excellence in education.

The Executive Board would be assisted by a very small secretariat (one or two persons). The secretariat could move with the chairman from year to year or be located in one place or agreed by the General Body. The job of the secretariat is only to assist the Executive Board and individual institutions in their joint endeavours.

FUNDING

How to fund the network?

Through it may be too much to expect the participating institutes to fund the Network, funds for the Network, funds can be generated by tapping prospective donors from the various stakeholders such as industries / governments/international funding agencies such as UNIDO to support programmes that are mutually beneficial to countries on a sub-regional or regional bases.

CONCLUSION

The presentation is an attempt to flag off certain issues in international coo petition in leather engineering education and this is only a tip of the ice-berg. With the prevailing trend of dwindling of institutions providing for leather technology education globally, how best the existing institutions can nurture leather education by way of cooperation, competition or coo petition?, The leather engineering education is a challenging, exciting, interesting and stimulating field of study for “willing minds” with passion and flair for leather. To maintain this interest in leather, there needs to be a continuous re-engineering mode of leather technology education. The coo petition in leather engineering education is found to nurture and maintain the interest in leather.

NOTE:

The views expressed are the author’s own personal ones and do not reflect the views of the organizations with which he is associated, either in the present or past.

ACKNOWLEDGEMETNS

1. Mr. RamjeeYogasundaram and Mr. Mohan Goenka, Chairman and Executive Member (respectively) of Indian Leather Products Association, Chennai for their support.
2. Mr D. Chandramouli, Chief Scientist (Rtd), CLRI, Chennai for fruitful discussions.