Present and future of (not only) rope making technologies.

R. Faborsky **(Sining Rock)**

Chapter 1: Present times.

People: challenging the elements of nature.

When I look at the textile outdoor industry at the start of 21st century I see lot of remarkable achievements. Leaps in developments of synthetic fibres in last decades gave a lot both to the end user and manufacturer. Users of garments gained enhanced comfort, possibility to carry less weight and enjoy more being outside while staying much more protected from the harsh sides of nature. User can stay dry, shielded from cold winds and piercing raindrops. User can also stay better protected from fire or can even stay alive after being hit by a speeding bullet. Fabrics are more abrasive resistant, stain repellent. *List of all we gain seems to be endless.* Garment outdoor industry is tempting end-user with attractive products. It has surely allowed outdoor going people to challenge the elements: air, water, earth and fire (mind you that last mentioned element has still got it's way).

Is climber or caver or any other textile rope user tempted is similar way? I believe answer is: Very much so! Natural organic fibres have been abruptly pushed out of all outdoor rope and cord making areas by man-made organic fibres. Future has become bright for rope user. New era of multifilament synthetic polymers made it's natural predecessors, like hemp and sisal, stay forgotten probably forever. Modern rope and cord designer has a lot to choose from. Fibre tenacities are more than sufficiently covering safety requirements on final products. There are fibres with high modulus and low stretch, fibres with built-in elasticity, modulated shrinkage, fibres that are fire resistant and spin finished in order achieve variety of properties. Festival of fibre treats is not finished yet. Molecules are getting parallel! Engineers of leading fibre manufacturers worked hard on enhanced physical properties. Parallel molecular orientation and high crystalinity have opened new horizons for man-made fibres. Amount of weight saved by using such a rope, cord or webbing is remarkable.

Does above said make you think that it is then up to rope manufacturer to pick up almighty fibres and "only" spin them, twist them, plait them, braid them, and that is it? You would be very much wrong.

Nature (and customers): challenging textile engineering.

For whom and what are we designing anyway? As we all know, with climbing and caving ropes we have to look out for a various items of interest. When gravity starts to remind us about its everlasting presence modern designer prepares a rope according to the cushioning low-impact-force recipe. High number of falls helps to use the rope longer. Cavers and workers want to be comforted by high strength-in-the-knot and want no dangling on the rope while jumaring. They also want their rope to weigh as less as possible. Also it does not help if static rope after being pulled out of cave is as stiff as steel wire cable. Shielding rope sheaths are here in order to keep tiny particles of minerals out of load bearing core. Ropes should be tough to stand dragging on the face or through groves and holes in rock and yet they must be soft to handle. Rope designer is then left in his laboratory with rather complex task. He or she has to blend all this into all-doing all-solving rope. And customers are so demanding that their requirements are sometimes contradicting each other.

Past and present of rope design.

Some of today's ropes (climbing and static) of few major manufacturers are remarkably tuned pieces of fine textile engineering and I guess also of good internal continuous quality. These ropes are doing all they should. They absorb energy, can stand tremendous loads even in the knot, weight less and less, are nice to handle and pleasant to look at (at least the climbing ones); repel water, grit and dirt. I will not name and introduce all the fine features climbing ropes have to offer, because this presentation is heading somewhere else.

(Power Point) Chapter 2. Future: bright or otherwise?

Textile facts of today.

As the rope designer and a person engaged in outdoor activities I have been, for quite a while, thinking about following.

What is the sense of all my designing, what is the mission of ropes and cords leaving our braiding machines daily in thousands of meters? Is it "only" serving best our customer? Doing it better than competitor?

Knowing exactly what we export to the whole world, we know almost nothing about what happens with these ropes after they are condemned to retirement. *Is there a list of what we loose?*

Mostly used material in outdoor rope production is PA6. Let us concentrate on this one then. Even though it's pricey comparing to other polymers, polyamide's physical-mechanical features are worth this extra expense. For getting scale of volume of consumption, allow few numbers:

These days 13% of world wide consumed man-made fibres are polyamide (including textile and industrial fibre). Estimated capacity of PA6 is at 5,1mio tons *(fibre output source: Saurer Group annual market report).* The fact is also that only in the USA annually almost 0,5mio tons of polyamide carpet waste goes into landfill sites.

How big is the outdoor rope industry then? Allow please some margin of error; it could be around 2000 tons annually. I am not a marketing expert but this rough estimate will do. Textile fabric industry, carpet industry, tire cord production and others dwarf the portion of outdoor rope making. I admit. But even knowing these numbers still I feel responsibility for what we produce.

(Power Point) Chapter 3. Wolf 351: technologies with mission.

Wolf is independent creature, sleek in shape, devoted to go a long way in order to reach it' s goal. Within wolf's organism not a joule of energy gets wasted. All is thoughtfully used with one thing on mind. *For better tomorrow I have to think what I do today.*

Wolf 351 is an organization, which has one thing on mind, and that is to gather manufacturers of outdoor products (yes, not only ropes), who are interested in following *Principles*: **(Power Point)**

- Recyclable raw material recourses.
- Renewable material or spare part recourses.
- Reusable or recycled packaging material.
- Educational activities aimed at end user to really help in "production-distributor-end user" product cycle. **(Power Point)**
- Sophisticated technologies for gaining maximum performance from minimum material used.
- Sophisticated chemicals for biodegradability.
- Manufacturer's involvement in local environmental issues.
- Manufacturer's involvement in keeping the climbing or caving environment in tact.

Wolf 351 is not only marketing project of one company to get attention of the general public. Within this organization we are interested in projects that have clear benefit. Benefit displaying real savings and true results that at the end will help to lift off the heavy lid of pollution from our living environment. I hope that idea behind all this will be attractive enough for some manufacturers to forget for a while that it is all about competition. World of technology is moving fast. Conservative ways should give way to new, bright and smart solutions. Some projects demand top secrecy behind closed doors. But some projects need joint forces of more companies in order to achieve the goal, like for example latest steps in recycling PA6 multifilament yarn. If carpet industry can use benefits of ever-evolving textile technology and can make new carpet from old one, we, in outdoor industry, also have to do something.

How does Wolf 351 work? Truly each manufacturer is invited to apply for the membership in this organization by introducing a particular project, which complies with before mentioned *Principles.* All existing members of Wolf 351 will evaluate each project and the project will be either accepted or rejected. Accepted project automatically gives to the applicant a status of the Member. After that new Member is entitle to list this project under Wolf 351 for next years and also can use a logo of Wolf 351 on their products. I will not be too specific over all details in this short presentation. Anyone, who would

be interested to join, can get full update on these subjects presented on Wolf 351 web site. **(Power Point)**
Web page www.wolf351.org is the main window to the activities and results of work of Wolf 351; it is easy to access for everyone and easy and flexible to update. There is and will be no information passed over to manufacturer or end user otherwise than through this web site.
Now, let me guide you through architecture of the web site. **(Power Point x 8)**
Updates are accessible within days after decision was made, anyone can see details of every project, date of start, basics of this project and its benefits. Membership fee is EUR 30 annually and is here only to cover costs of creating and updating the web page.
This project will certainly get attention of general public (meaning people who buy our products), because not everyday are competing companies working on something together. And attention of these people out there is what Wolf 351 needs. Because, it must be said, that both sides in manufacturer/end user cycle must bear share of responsibility and costs in environmentally friendly behaviour. Ecology costs money and effort.
Anyone who wants to get more information on membership or even to go straight and apply for membership with existing project can speak with me here at this conference or can visit our web site and simply fill in the application form.
What does the manufacturer gain by joining the Wolf 351 organisation? **(Power Point)**
Benefits:

- Much higher transparency of involvement in environmental issues.
- Possibilities of help with sometimes-straightforward unseen solutions or help with complicated issues.
- Being part of larger projects where voice of one is too weak, but joint force of more companies is useful tool in negotiation.

(Power Point) Chapter 4. First steps in Wolf's footprints.

Step 1. **(Power Point)**
This information is very fresh, but real. Latest negotiations are showing that there is the way of recycling our multifilament fiber (of which our braided ropes are made of). That means that used ropes will not have to end up in the landfill site or be burned in the furnace. I can just name some project we are currently working on.

- Processing of production-waste multifilament PA6 fibre (ropes, cords, webbings).
- Processing of multifilament PA6 fibre from used products (ropes, cords, webbings) and making secondary products from it.
- Future prospects of recycling of multifilament PA6 fibre (making new from old).

Step 2. **(Power Point)**
Let me introduce one and first project, which is the application of Singing Rock to Wolf351.
Project is presenting braiding technology with trademark Route 44. This project has two major benefits. One is improved quality of the product and second is raw material reduction.
Route 44 technology applies both for braiding of dynamic ropes and static ropes. Let me start with first mentioned group of ropes.
Great benefits of this technology for dynamic ropes are only for the group of single ropes 10,5mm (and about). **(Power Point)** Sheath of the typical rope today in the category of single ropes 10,5mm consists of 48 yarns. Braiding design is occupation in pairs. With very high demand on performance of the sheath, 48-yarn sheath construction was and still is mostly used construction of 10,5 single rope.
Note: to describe the technology I am using fiber density units (dtex), but numbers are not real, only to give a example of scale and percentage of reduction).
If designer wants to make more competitive rope these days, uses lighter sheath and maybe lighter core. Lighter sheath means, that instead of using let's say 100 dtex per each carrier (48 x 100 dtex = 4800 dtex), manufacturer will use 88 dtex per each carrier (48 x 88 dtex = 4224 dtex). Using non-conventional number of yarns in sheath (44) gives much more versatility in finding just right mechanical construction of sheath for 10,5mm rope. Designer has an option to create durable sheath with yarn count (let's use above example) 100 dtex per each carrier (44 x 100 dtex = 4400 dtex) or can go for light

sporty version 88 dtex per carrier (44 x 88 dtex = 3872 dtex). **(Power Point)** In both cases there is sheath material reduction by 8,3%. Of course, in order to fulfill most critical parameter (= desired number of falls) on this new 44-carrier sheath rope, there must be very fine braiding process involved as well as advanced fiber treatment procedures. Results are rather satisfactory: with this new unconventional method of braiding single climbing ropes manufacturer can get well handling and compact rope with sheath material reduction of about 8%.
Latest tests in CE and UIAA approved laboratory with Singing Rock 10,5mm single dynamic rope show that it is fairly within capabilities of this technology to manufacture 8 to 11 falls (EN 892) rope.
(Power Point) Only hypothetically, if there was sold annually 4 million meters of 10,5mm single climbing ropes made with 44-carrier sheath instead of conventional 48-carrier sheath, sheath raw material savings would level 10 tons (annually).

(Power Point) As was mentioned before, Route 44 braiding technology applies also for static ropes. As with dynamic ropes, also with static ropes this technology is suitable only for 10,5mm (EN 1891 Type A) ropes. Here, the technical story is little bit different. Gain in performance is clear and material saving is not so straightforward as with dynamic ropes. But hear the evidence first. As we know, one of few aspects defying the static ropes construction is the sheath-core ratio. With static rope 10,5mm Type A; sheath percentage must be above minimum 34,47% of rope weight, so that rope will be durable enough. With this limitation on mind, 44 yarns in the sheath create mechanically suitable construction, which complies fully with EN 1891 and as the result has extremely high safety ratio for PA6 kernmantel rope. **(Power Point)** 35,6kN in straight pull; 22,4kN in figure 8 knot; great knot tying and untying characteristics. Still it weighs only 72 g/m. The benefit here is that for some applications where 11mm 78g/m (over 35kN strength, over 22kN in the knot) rope was needed, customer can use 72g/m 10,5mm rope, saving minimum 6g of quality industrial polyamide per each meter of the rope.
(Power Point) And, forgive me; again only hypothetically, if there was sold annually 1,5 million meters of 10,5mm Type A ropes made with 44-carrier sheath instead of conventional 11mm Type A ropes, raw material savings would level again 10 tons (annually).

Singing Rock is now pioneering this braiding technology and so far theory has lead to clear results. I have to say that this 44-carrier technology has evolved and adapted around ever increasing properties of today's industrial fibers. I think that as the performance of synthetic fibers is improved, also construction of ropes can (and should) shift to more technically advanced state.
Let me give you some examples how the performance of synthetic fibers elevated to new levels and thus allowed the use of unconventional braiding technology, ending in material reduction. **(Power Point)**
In years 1955-1960, tenacity was at 55-60 cN/tex (standard level), which was much higher than the previous natural yarns used for ropes. Around 1965 tenacity moved to 70-75 cN/tex due to improvements in polymer processing. After that: 1970-1975, tenacity at 80 cN/tex. Increase to this level could be achieved mainly with the introduction of spin-draw technology (at 1-step). From 1985 we are having high-level tenacities at 83-84 cN/tex. Further improvements are discussed from 1995 and maybe there are possibilities to have tenacity at 85-90 cN/tex with PA6 (partly introduced already, but only with PA6.6).

Chapter 5. Closing the story. (Power Point)

We owe something to this planet. In mountaineering and spelaeology we are getting close to, or even under the skin, of nature. Let us make sure that we are not carrying poison on our bodies. I feel we are at the crossroads of outdoor gear-making technology. New advanced technologies are coming or will come soon. Let us develop new materials and constructions, let us reduce material consumption and use degradable chemicals. Let us produce disposable or reusable products and if we do so, let us make sure that these products are really recycled or disposed of properly. Let us give information to the end users, that they are as responsible as manufacturers for discarding of the product in a way harmless to our environment. I hope that some manufacturers will join Wolf 351's activities and will contribute with work and results, in order to make the whole issue transparent to everyone involved in exploring of our Nature. Thank you for your kind attention.