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DIY: polar fleece as a new material for handmade artefacts.

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Abstract: The paper deals with a cultural and didactic experience regarding textile world, its history and traditions, its manufacturing processes and its innovative possible uses. The experience, that involved different actors from academic and commercial fields as well as interested people from citizenry, was organized in two directions: a workshop and a thesis in Design (Bachelor Degree). In both cases, the object of the design process was the polar fleece, a technical fabric made from polyester (PET). The aim of the presented actions was to reassess the fabric, considered as a well-known fabric and not as a technical one, despite its high technical requirements (insulating, lightweight, etc.). Specifically, the aim was to investigate how designers, thanks to learning by doing, “do it yourself” and participatory design methodologies can help manufacturing industries to define new possible market fields and new products or semi-finished products.

Keywords: Material Expressiveness, Textile Word, Participatory Approach, Learning By Doing, Material Expressiveness, Textile Word, Innovative Production.

1. Introduction

The specific aim of the paper and of the cultural and didactic experiences here presented, a workshop and a thesis in Design (Bachelor Degree), is the expressive and functional revaluation of a technical textile, the polar fleece, applying the Do It Yourself (DIY) methodology, investigating new possible uses of this material and testing its improved technical properties. This revaluation was explored involving both a SME (that produces the analysed material) and citizenry (that learns how to make a product without the use of specific equipment). Moreover, thanks to the work on the two directions, expressive and technical ones, it is possible to individuate opportunities to exchange knowledges and therefore to define new possible markets for manufacturing SMEs.

The workshop challenge was to transform the polar fleece in a home accessory, using hands as unique instrument: in this way arise artefacts that reinterpret traditional nodes and web techniques. The didactic action, developed in the thesis, was therefore headed to increase the technical properties of the fleece to define new possible market fields. Thanks to a particular coating and specific testing phases, new properties of fleece were investigated such as its flame retardant power,

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in order to define application fields not yet explored, such as contract or complementary furniture.

2. DIY: a brief introduction

DIY, Do-It-Yourself, is a widespread activity defined by Kuznetsov and Paulos (2010) as “any creation, modification or repair of objects without the aid of paid professionals”. It’s an emerging activity, “a wellbeing where the ‘user’ is actively involved. Where he/she is, in some way, the coproducer of the results he/she wants to achieve (and is able to do so because he/she has many of the necessary intellectual and practical resources). Finally, a kind of wellbeing where the involved subject, facing a problem, is not only part of the problem, but also part of the solution” (Manzini, 2007): thanks to the DIY, people can be the main actors of the designing and productive process. At the same time within these processes can be involved other actors, such as product designers, service designers or productive companies.

As suggested by Salvia (2013), “despite periodic ups and downs, spending on DIY/decorating has been growing at a fairly steady rate of around 7-8% per year since the late 1990s (Mintel 2003; Mintel 2005). Around 62% of the UK adult population claim to participate in DIY, including decorating – a separate category defined as “internal and external painting, staining or wallpapering. Such activities account for around 13% of the time spent on house related activities in 2000 and generate a market for related products that is currently worth around £12 billion per year in the UK”.

Our historic time is particularly favourable to the diffusion of DIY, in fact, as described by different authors (Ahde, 2007; Campbell, 2005), a “growing number of users express the need for customized artefacts, even taking into account their direct involvement in the design process and/or production (an interesting example can be given by the “Knit Like a Latvian Knitting Kit”, where are got all the wool, instructions and handy colourful charts needed to create a pair of traditional Latvian mittens). Designers are trying to find meaningful solutions that meet these needs. The DIY approach and the revaluation of a crafts and self-production approach in product design is also supported by the democratization of technological practices (Tanenbaum, Williams, Desjardins, & Tanenbaum, 2013) in terms of commonly used production labs, low cost and accessible fabrication tools, and open and shared knowledge about production processes” (Rognoli, Bianchini, Maffei, & Karana, 2015).

2.1 DIY: a new possible path for manufacturing companies

DIY was the centre of the workshop that was organized to investigate new possible uses of a specific textile, the polar fleece, thanks to the support of a manufacturing company, Italian leader in the production of this material. The workshop that will be presented below, engaged citizens as part of the productive process, in a participative way using the learning by doing methodology: learning through reflection on doing and experiential learning involved workshop participants reflecting on the products they were creating. The workshop was developed using a technical textile, polar fleece, well known by people, a textile that needs to be renewed. Thanks to the workshop experience, it was possible to define new possible paths for the use of polar fleece and new possible productive results: polar fleece scarps (deriving from the production of products such as clothing and fashion accessories) can be used to produce new semi-finished products that will be used to create, thanks to DIY, new products (such as home furniture, as described in workshop results). In this way, manufacturing companies individuate new cues for an alternative use of materials already used and get ideas for new future products.

3. The polar fleece

Technical textiles are defined as indicated by Scott (2005) and by the Textile Institute (Smith, 2009) “technical materials and products manufactured primarily for their technical performance and functional properties rather than their aesthetic or decorative characteristics. A non-exhaustive list of end-uses includes aerospace, industrial, military, safety, transport textiles and geotextiles”.

Technical Textiles are used in different fields, from agricultural, farming to construction, civil engineering to clothing and home furnishings. These last two application fields have been chosen for analysis and investigation of new possible paths that will be presented in this paper.

Comparing technical textiles used in the product and home furnishing fields with technical textiles used in clothing (fashion, sport, workwear) it is possible to notice that all of them have similar characteristics, such as, for example, chemical resistance, antibacterial, antistatic, flame retardant properties, tear strength, water resistance, breathability, thermoregulation (Desandrè & Quarato, 2015). The researchers involved in the present work paid serious attention to a specific technical textile, the polar fleece, thanks to its huge popularity, its technical properties, its history and its current applications. Polar fleece as defined by Fabrics International, is a “soft, napped synthetic fabric with thermal insulation properties. It is much lighter than wool but has some of the same properties as wool. It resists water absorption (i.e. it is hydrophobic) and retains its thermal insulation even when wet. The fabric breathes well, also. However, it is quite flammable unless treated with a flame retardant, it is not windproof, it holds static electricity, and hence accumulates lint, dirt and hair. It may also be prone to pilling”.

Polar fleece cannot be defined an innovative material, because was originally introduced by Malden Mills in 1979 (the company has since been renamed Polartec LLC). More in deep, fleece is a non-woven fabric that is a textile structure “produced by bonding and/or interlocking of fibres and other polymeric materials such as films using mechanical, chemical, thermal adhesion or solvents or a combination of these methods” (Scott, 2005). Polar fleece was originally made from Polyethylene terephthalate (PET) but it can be made from other synthetic fibres, including recycled plastic bottles or recycled fleece. Moreover, the fleece is characterized by high technical properties; for example, it is warm, soft to the touch and has great insulating properties, it dries very fast and it is wrinkle resistant. Another benefit is that its raw edges do not fray; therefore, seam finishes are not necessary. Traditionally it is used for athletic and outdoor wear, but also in casual jackets and sweaters. “Within a decade, however, fleece had become an inescapable element of daily life. And just as the fabric’s lightness appealed to sportsmen, its colourfulness, lack of fur and relative inexpensiveness made it, in a word, trendy” (Greenbaum & Rubinstein, 2011).

Polar fleece, in spite of its good technical properties, is not much valued: it is used for daily life clothing and for outdoor wear, but it’s not appreciated considering its expressive properties. Interesting possible uses can derive from polar fleece colours (this 100% polyester material can be coloured in mass), its high wear resistance (colours and surface wear resistance), its easy care, its anti-pill and softness (good hand feel properties). Moreover, polar fleece garments traditionally come in different thicknesses: micro (lightweight and thin), 100 (lightweight, for underwear), 200 (medium weight, widespread) and 300 (loftier and heavier, for cold or extreme weather conditions).

The presented characteristics can be useful for application fields different from sportive wear: specific aim of the workshop was the polar fleece revaluation and its exploration using innovative presentation formats of this textile.

4. The workshop “Macromé, textiles knots and weaves”

The workshop “Macromé, textiles knots and weaves” was organized at the Circolo dei Lettori in Torino, during the 3th edition of the “Voce del Verbo Moda” exhibition (22-25 October 2015). “Voce del Verbo Moda” depicts the fashion story through the voices, experiences and knowledge of Italian and international guests, to seize the many nuances of fashion and to analyse trends and phenomena that produce continuous innovations. The workshop was organized by MATto, the materials library of the Politecnico di Torino (www.polito.it/MATto.it), with the technical support of Polar® (productive company, based in Torino, leader in polar fleece production).

Voce del Verbo Moda 2015 edition was dedicated to the twine/weave art, considering also the production phases from yarn to product, made not only of materials, but also of knowledge, stories and people. The workshop transferred the weave art into the macramé technique and into the most innovative knitting trends, which tend to be bigger and giant. From this consideration was defined the name of the workshop: “Macromé”, in which Italian “macro” adjective means big, giant in order to anticipate the results of the workshop, that were pillows created knotting giant polar fleece yarns (tubulars). The traditional macramé knots will be transformed into giant knots.

4.1 Inspirations and suggestions

The workshop “Macromé” is inspired from one side to the art of macramé, weaving technique in which the vertical wires are wrapped and knotted with the fingers, without the aid of bobbins or other tools, to compose a lace with a geometric design. On the other side, the workshop takes inspiration to knitted Army, designed by Andrea Brena, young Italian designer living in Berlin: this technique allows people to weave strips of recycled fabrics, using their arms as knitting tool to make and create furniture products.

Macramé, the art of tying knots in patterns, is also called “Knot Lace”: thanks to this ancient technique, wires are variously twisted and knotted by hand, to create a lace characterized by geometric pattern. Macramé was a popular technique used to create ornamental fringes and clothe trimmings and home decorations. The origins of Macramé can be found in Arab countries and spread to the whole of the Mediterranean area, and spread in Italy, in particular in Liguria Region. Macramé in the last years (from 2000) has been revaluated and subject of different researches and projects, in home furniture and interior fields, among which it’s possible to mention “Shine a Light Shade Kit” by Plumen and Wool and the Gang (Figure 1) and “Macramé Installation” and “Vertical Garden Installation” at Hotel Aguas de Ibiza by RANRAN DESIGN (Figure 2). The collaboration between lighting designers “Plumen” and the DIY fashion brand “Wool and the Gang” define a new interesting vision of macramé: Plumen designed a macramé lampshade kit you can make at home.

RANRAN DESIGN develops, inspired by the tropical nature and travels around the world, its Contemporary Macramé and Textile work, to create wall art and accessories, supporting small and local businesses.



Figure 1. Modern Family Collection by Plumen - Berry Bright Factory. Photography: ©Dean Dorat



Figure 2. Macramé Installation and Vertical Garden Installation at Hotel Aguas de Ibiza. Credits: Ranran Design by @belensenra

Knitted Army by Andrea Brena is defined by himself as “a collection of furnishing that re-interprets traditional techniques like knitting and crochet through the use of the body as a production tool. By knitting with the arms and crocheting with the hands it is possible to create unlimited shapes whom pattern strictly relates to its maker therefore his hand-signature determines the density and regularity of the knots. The project, although still in a very early stage, has been showed in many fairs in Europe has had an incredible impact due to its performative character. At each exhibition, new products were made on the spot. Knitted Army was the first spark that has generated a worldwide movement of arm knitters” (Figure 3).



Figure 3. Knitted Army by Andrea Brena. © 2015 Andrea Brena.

4.2 Case studies

Beyond macramé (the revaluated traditional technique) and knitted army, different knotting techniques are now used to create home accessories and clothes, by exaggerating yarn knot and weave dimensions. During the workshop and thesis experience, different case studies have been analysed and arranged into the following categories: giant macramé, giant knitting, knots in fashion macro-weave and knots in sculpture. The table below gathers a synthesis of the analysed case studies.

Table 1. Case-studies.

Categories	Product description
Giant macramé	Mega Doily Rug, Jean Lee (Ladies & Gentlemen Studio). Macramé knots become giants: doilies giants, handmade, made with cotton strings of various colours, and transformed into original carpets (Figure 4).
Giant knitting	Blankets and Needles, Knitting Noodles. Products made of merino wool: the brand allows the customer to buy balls of wool and wooden needles in order to realize himself his own product. Ohio company of Anna Marinenko. The company creates super-chunky knit blankets and Merino Wool for Arm knitting in handmade 100% merino wool blankets (Figure 5).
	Knot collection, by Emilie Lecouturier and Céline Poncelet of Atelier Blink. Collection of wool seats and cushions made in polymer foam inspired to sailors' nodes.
	Notknot, Umemi studio by Ragnheiður Ösp Sigurðardóttir. Collection of cushions and pillows, crocheting long tubular legs (Figure 6).
Knots in fashion	Jackets, by Oihana Garaluce, 2010-2011. jackets made weaving and knotting big fabric bands (Figure 7).
	Sculptural clothing, by Emily Hiller. Clothing line – big knots and big macramé created with textile surplus.
Macro-weave	CANASTA Collection, Patricia Urquiola, B&B Italia, 2013. The traditional caning pattern Vienna Straw is blown up in the scale dramatically.
	Tangled and Fused, Dana Barnes. Rugs made by combining different fabric braids (in natural fibers, not spun but felted).
Knot sculpture	Needle, Thread and Knot, by Claes Oldenburg and Coosje van Bruggen, 2000 Milano. Sculpture realized in two parts, made of stainless steel and reinforced plastic; a tribute to Milan's influence in the fashion industry.
	The Giant Knitting Nancy, 2010, Canary Wharf. Collaboration between Dan Preston (Sculptor), Holly Packer (Jewellery designer) and the Superblue Team. The Giant Knitting Nancy it's a large-scale knitted structure with inflatable balls enveloped by knitted yarns and used as seats (Figure 8).



Figure 4. Mega Doily Rug. Credits: Mega Doily Rug by Ladies&Gentlemen Studio.



Figure 5. Different examples of blankets and balls by Ohhio. Credits: Ohhio



Figure 6. Notknot, Umemi studio. On the left the new collection for the Icelandic market using the Icelandic wool. On the left cushions produced by Design House Stockholm. For this last picture, credits: Jonas Lindström.

“Macro” and “giant” seem to be the new trend in the complementary furniture and, even if, in a niche, in fashion design. In particular, this trend is related to the wool world, to felts, and to macramé and knitting techniques. The workshop “MACROMÉ, textiles knots and weaves” wanted to transfer this trend to polar fleece world, introducing a new way to consider this material, both from expressive point of view and from its presentation formats. Polar fleece was turned into big yarns, into tubulars that can be modified by people to obtain, as illustrated above, complementary furniture. Moreover, another trend merging from case studies’ analysis is the DIY: in fact, many companies and studios, newly created, offer a DIY kit (DIY Knitting Kit, DIY arm knitting). Riding that wave, the workshop MACROMÉ presented a DIY kit to participants who were able to create their own cushion, following the instructions prepared for them.



Figure 7. Jackets - Sculptural 3D fashion with voluminous form & experimental structure. Credits: Oihana Garaluce.



Figure 8. The Giant Knitting Nancy, 2010, Canary Wharf. © Superblue Design.

4.3 Workshop results

The workshop challenge was to produce a textile item to take home, using hands as a single processing tool: so take life artefacts that reinterpret nodes and contemporary twists. By knotting and unrolling the polar fleece tubulars supplied during the workshop, thanks to the support of workshop technical partner, the workshop organizers defined three types of pillows that can be created during the workshop by participants: Ball, Flower and Knot (Figure 9), inspired from the case studies presented before. Tubulars we produced sewing fleece bands (5 meter long and 45 cm width).



Figure 9. Ball, Flower and Knot: the pillows - Ball, Knot and Flower - designed for the workshop "MACROMÉ, textiles knots and weaves".

Twelve participants took part to the workshop: each participant was able to take home at least one pillow at the end of the workshop day. The kit for the creation of each pillow consisted just in one tubular and an instruction sheet with data to be followed to create the different pillows. Hands and arms were the tools to knot and roll polar fleece tube (Figure 10).

The Handmade Knowledge was compared with the expressiveness of technical textiles, revisiting in a contemporary way the traditional processes: nodes become giants and "macro"; hands are the only tool used for creating artefacts. Moreover, old and used fabrics, production scraps can be transformed into furniture components and products for the person: damaged fabrics and scraps become updated in shape, size and, more important, in function, from waste to new material.



Figure 10. Some examples of the pillows creation during the workshop (credits: photo by author and Il Circolo dei Lettori, Torino).

5. Improving polar fleece properties

The results coming from the workshop were analysed in the thesis (Desandrè & Quarato, 2015) to define new possible applications of the polar fleece. Moreover, workshop participants were asked to answer to a questionnaire about the new possible application fields of this material: the answers were matched with the analysis results of researchers involved into the polar fleece studies. This material merged as a new textile that needs a revaluation starting from its characteristics of softness, its insulating properties and its different possible colours. New possible application fields were identified, such as public spaces and interior furniture.

To answer to these new application fields, the polar fleece need a revaluation of some specific properties, such as its fire resistance. In fact, in public spaces and interior furniture textiles need to be fire retardant, non-flammable and non-combustible. In order to be able to answer to these

requests, in the thesis the polar fleece fire resistance was investigated, considering in the finishing phase, the addition of substances directly on the fabric surface. Specific tests were carried out on scraps of the polar fleece used during the workshop. The research was coordinated by MATto Materials library of the Politecnico di Torino.

Considering innovative materials and technologies coming from different application fields (design, architecture, engineering) and following the technology transfer methods (development of new products envisioning unconventional interpretations for materials, semi-finished products, components and finishing), the technique defined to be used to improve fire resistance in finishing phase is the Layer by Layer (LbL) assembly. It is a versatile, gentle and simple method for immobilization of functional molecules in an easily controllable thin film morphology. As reviewed by Richardson et al. (2015) “the deposition of thin films from multiple materials is essential to a range of materials fabrication processes. Layer-by-layer processes involve the sequential deposition of two or more materials that physically bond together”.

Moreover, Layer by Layer (LbL) is an interesting finishing technique that can be used on different surfaces (from cotton fabric to biopolymer film) to improve their oxygen barrier properties or their fire protection (Alongi, Carosio, Frache, & Malucelli, 2013). The thesis tested this last property improvement.

5.1 Testing new properties of the polar fleece for new applications

Thanks to the support of the DISAT Department of Applied Science And Technology of the Politecnico di Torino, polar fleece were tested to analyse its improved fire resistance properties after the Layer by Layer finishing. Different are the assembly technologies that can be condensed into five broad categories to which automation or robotics can also be applied (Richardson, Björnmalm, & Caruso, 2015): immersive, spin, spray, electromagnetic and fluidic assembly.

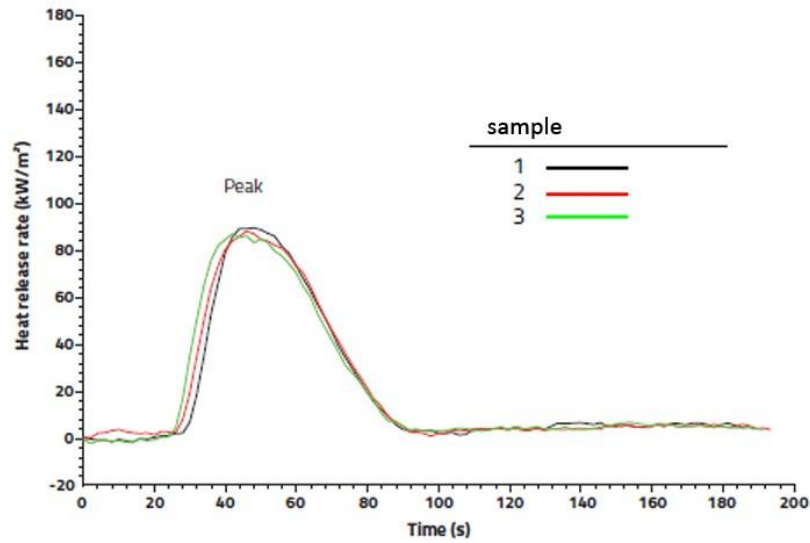
For this test, samples were finished using the immersive technique: the chosen substances were polyelectrolytes and, more in details, the chitosan. We defined to test two samples of polar fleece (30 x 23 cm dimensions, medium weight), one by depositing two bi-layer and the other one by depositing four bilayer, in order to find the best solution. The flame-retardant properties of the polar fleece were tested: the three types of polar fleece (the fleece without finishing, the polar fleece with two bi-layer and the last one with four bi-layer) were inflamed. The first one showed being a dripping material, incandescent for a few seconds. The samples treated with two and four bi-layer, on the contrary, have extinguished the flame immediately (Figure 11).

Analysing the results obtained from tests, the appearance and the touch perception of the polar fleece samples, the one with two bi-layer was the selected for future application. In fact, its tactile perception was the closest to the untreated fleece and its softness seemed not modified as in the case of the four bi-layer sample. To conclude, the layer-by-layer finishing can be used to improve the fire resistance properties of polar fleece, in order to use it in public spaces.

The LbL technique could also be employed to improve properties of water repellence and anti-static and to give new proprieties, such as antimicrobial; in fact, the key advantage of this technique is the possibility of adding particles (varying coating thickness) in order to achieve custom-made properties, for a custom designed material.

In particular, antimicrobial property can point new possible application fields of the polar fleece, such as complementary furniture for public spaces (pillows, cushions, etc.) and for specific location, such as hospital.

POLAR FLEECE with 2 LbL: Graphic of the heat output average



t(ig): Time to ignition
 t(fo): Time to flame out
 HRR(peak): Peak Heat Release Rate
 tpeak: Peak time
 THR: Total heat release
 TSR(whole): Total smoke release

Test	t(ig) [s]	t(fo) [s]	HRR(peak) [kW/m ²]	tpeak [s]	THR [MJ/m ²]	TSR(whole) [m ² /m ²]
Mean	35	87.7	88.95	45.3	3.6	161

Total Oxygen Consumed: 2.9 g
 Residual Mass [%]: 8%

POLAR FLEECE with 4 LbL

Test	t(ig) [s]	t(fo) [s]	HRR(peak) [kW/m ²]	tpeak [s]	THR [MJ/m ²]	TSR(whole) [m ² /m ²]
Mean	41	96.8	88.64	54	3.96	156

Total Oxygen Consumed: 3.12 g
 Residual Mass [%]: 11%

POLAR FLEECE without LbL

Test	t(ig) [s]	t(fo) [s]	HRR(peak) [kW/m ²]	tpeak [s]	THR [MJ/m ²]	TSR(whole) [m ² /m ²]
Mean	32.8	72	169.19	45.5	4.28	140

Total Oxygen Consumed: 3.42 g
 Residual Mass[%]: 4%

Figure 11. Graphic of the heat output average of different polar fleece samples: polar fleece with 2 LbL, with 4 LbL and without LbL.

To sum up, considering the new possible properties of polar fleece, the thesis define how this renewed material could be used in public and private sphere. In the first case, the “new” polar fleece can be used for hospital upholstery, blankets and uniforms of hospital attendants (taking advantage of different possible colours, softness, wear resistance and insulating properties of polar fleece); moreover the renewed material can be used for new upholstery in means of transport (colours, softness, wear and fire resistance). In private sphere, fleece can be used as a macro yarn for home furnishings (e.g. rug and pillow, doghouse) and for personal accessories (e.g. macro scarf and other clothing complements).

6. Conclusions

The specific aim of the cultural and didactic experiences was the expressive and functional revaluation of the polar fleece, that was explored involving both a SME (that produce the material and which was the workshop technical partner) and citizenry (that learns how to realize a product without the use of specific equipment).

Moreover, SMEs and companies in general, can also define a new productive concept, in order to identify improvements for materials or semi-finished products already in production phases and define ideas for an alternative use of materials already used in production. The “new” materials or semi-finished products produced by the companies can be part of a sort of toolkit that consumers can use to produce their own product.

To conclude, designer are able not only to define guidelines useful for people to create their own new product, but also to investigate new technical properties of the fabric and, therefore, to define new possible markets for manufacturing SMEs. As indicated in the introduction, the cultural and didactic experiences underlined how working on the two directions, expressive and technical ones, it is possible to outline opportunities to exchange knowledges between SMEs, research centres and Universities and therefore to define new possible markets for manufacturing SMEs.

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