Abstract
The paper explores the issue of surface features, which has a special role within body conscious spatial design. We have set surface features such as particular quality, skin and interface that create limits or open an honest communication between the human and the built-environment. Roughness as a measurable parameter is very important for an overall feeling of comfort, especially contact comfort, and has a direct relation to all other parameters such as thermal comfort, sorption activity, possibilities of maintenance, antibacterial behaviour, control over body position or acoustic well-being, while in the most of these relations there is a direct proportionality. The paper presents the results of different tests related to the roughness of solid wood with chemical surface finishing with the aim of showing the consequences for well-being, based on recent research studies of the interaction of wood and human.

1. Introduction
Real well-being, in a long term sense, starts with the quality of the inner space. There is a reciprocal relation between environmental perception/spatial recognition in a momentary given environmental setting, social background/context, and a direct physical interaction with objects. For every environmental designer it is important to know the basic facts about visual, tactile, behavioural, somatic, acoustic and socio-cultural comfort, which is particularly important for spatial design. To master this knowledge, it is necessary to adopt a multidisciplinary approach and to deal with knowledge from social and medical sciences. It is time to think and act in a multidisciplinary and transversal way. Applied sciences like neuroergonomy, environmental ergonomics and environmental psychology are good examples of this approach. We need to think in a similar way also in the design process.

In creating any kind of artificial environment, we have to consider the fact that the human is a cultural creature and at the same time an animal with a nervous system millions of years old.

Designing with respect for nature, humanity and material contributes to the lowering of environmental stresses. Conscious choices of materials, their forming and surface finishing for built-in elements and furnishings, play a crucial role in the well-being of users. In a time of extreme haste, progress in material engineering is bringing many new materials, moreover it is particularly important to understand and respect the pure nature and character of materials; this is also related to neuroergonomy and body conscious design with neuroergonomy as the application of neurosciences into ergonomics, based on the biological explanations. This approach brings new challenges and perspectives into the designing process.

To be in a state of visual comfort on first entering any room, it is necessary to trust, to feel safe, and to consider the space as affordable and understandable. In this scale we perceive the space as a whole picture.
Here, according to the Gestalt theory approach, the sum of the single items is less than the whole complex picture. But if we go closer, the appearance of single objects already matters more. At this level, these properties of visual comfort come into play:

- Respecting the own-form principle for each material – shape authenticity;
- Inspiration through well-known and functional shapes and principles from nature;
- Sensitive dimensioning the materiality – proportion of material vs transparency;
- Respecting socio-cultural contexts and semiotics
- Quality and authenticity of surface.

From this summary we have chosen one special character that has a strong impact on all the other parameters of well-being or complex comfort. It is the surface quality and authenticity concerning spatial elements. Surface properties, in narrow sense, are part of visual comfort, but they also have a significant effect on all the other parameters of complex comfort – tactile, performance, somatic, acoustic, olfactory, gustatory and finally socio-cultural comfort. This is the reason why we pay this phenomenon special attention. The authors have to submit carefully written and proofread manuscript. Spelling and grammatical errors, as well as language usage problems, are not acceptable. The authors should limit their papers to 10 pages, presenting their work as concisely as possible.

2. Surface features

Among surface properties we can include colour of surface, texture/structure and topography. Some other authors also include translucence and transparency among surface features [1].

After nine years exploring the interaction of built microenvironment, going into the interaction of human and material and overall analysis of complex comfort in microenvironment there special attention was paid to surface features? It is like a skin that either sets limits or communicates. Roughness, as a measurable parameter, is very important for an overall feeling of comfort, especially contact comfort and has a direct relation to all the other parameters of well-being such as thermal comfort, sorption activity, possibilities of maintenance, antibacterial behaviour, control over body position, acoustic well-being, olfactory and gustatory comfort, and also socio-cultural comfort. Most of these relations have direct proportionality.

Particular importance was given to the presence or absence of a surface finishing or modification that influence the authenticity of a surface, which is extremely important from a neuroergonomic point of view.

2.1. Authenticity of surface

Every material surface has its own authenticity. First of all, through our visual interaction with materials of natural colour and texture/structure, there arise responses supportive of well-being. This is caused by the fact that they are already very well known to our nervous system from evolution as well as from cultural archetypes.

But in the contemporary main stream housing culture there prevail materials like laminated particleboard, metals, glass and plastics; they are durable and it is easy to maintain them. But are they the right choice if we want to create really healthy microclimates? When we leave aside the impact on indoor air quality, there remain many other factors, such as tactile comfort.

There is a trend toward using vivid or intensive colours and especially colour accents, but the most important factor here is not the colour. The responses to textures and structures are more appealing, especially for our reptilian brain, which is the evolutionary oldest part and is responsible for life function and for emotions.

Nowadays, when a digital print can create any kind of imitation of a natural material, it is possible to create any kind of “fake nature”. But is our nervous system so blind? No, it isn’t. Imitating materials and surfaces creates completely different tactile, olfactory and acoustic microclimates. It is significant that visual interaction is more connected and interactive with culture and it is easy to trust visual contact with some illusions. But the other human senses are more connected with our inner instincts, and they are smarter in distinguishing between authenticity and pretence.

To allow materials to express their authenticity, it is necessary to tolerate or respect their aging process. Plastics are already coloured during their production design, but natural materials have a native colour which is very often irregularly distributed across the surface. There is a strong need to modify and homogenize this in light of trends and cultural stereotypes. Colour modification and colour homogenisation with intention are thus among the main interests of material engineering. Another movement is also the finding of “New authenticity,” which is mostly understood as finding appealing decors from nature or industry, scanning them and copying them like a décor cover onto any other kind of material (Figure 1). These inventions then suffer due to rapid moral obsolesce.

In the aging process, the texture and structure of any surface is more stable than the colour. We have to count
on physical and chemical deterioration, which creates a patina. It is irregular and there are efforts to homogenize it too.

One example of colour homogenisation or aging homogenisation is the Swiss BIOOD technology, which offers regular silvering of wood surfaces thanks to enzymatic processes carried out before the external application.

Another fact that is necessary to accept is the irregularities of texture and structure of surfaces of natural materials. Swedish wood researcher Olof Broman (2000) found in his study, whose objective was to understand and describe how people see and evaluate visible wood “defects” (such as knots) in a given wood surface. And what did he find? The respondents assessed the wood surfaces based on a general impression rather than evaluating single surface features such as knots. The respondents favoured wood surfaces with a “balance” between the degree of harmony and activity in order to avoid a state of disharmony. The result of the study suggested that consumers do not reject wood surfaces with “defects” out of hand. Instead, wood surfaces may contain a rather large amount of activity-creating features (such as knots), if these activity-creating features are well balanced across the surface [2].

To feel visual comfort on seeing some textured material, continuity is very important, especially when it concerns a “big-flowered texture”.

2.2. Roughness and its impact on complex comfort or well being

Western culture is a visual culture wherein tactile interaction is often underestimated in spatial design. Structure and roughness are extremely important for tactile comfort, especially contact comfort consisting of several measurable parameters (thermal contact comfort, hardness, sorption activity etc. Especially thermal comfort is directly related to thermal conductivity and thermal effusiveness, which are the parameters expressing the behaviour of some surface and the human body.

Usually, the rougher the surface is the higher contact comfort is possible to achieve.

This statement can be stated after testing a chair with 12 exchangeable sets of different materials used in seating furniture (seat, arm rests and backrests) with the spruce wood set with no finishing considered to be the most comfortable, and the aluminium sheet the least comfortable. Tactile interaction and contact comfort are the main indicators of surface authenticity [3].

A strong “luxury look” component is good for vision and conceptual understanding, but less suitable for usage, especially for long-term interaction. Objects that scream at us: “Don’t touch me!” are not very good room-mates.

There is also a significant relation of roughness and performance comfort. We will mention here one feature within performance comfort: it is the maintenance issue. Easy and effective cleaning of surfaces plays significant role in our culture, especially in humid areas such as kitchens, toilets and bathrooms, as well as wellness areas and health care facilities. The chemical and cosmetic industries support the illusion of a perfectly clean and disinfected environment and a fight against microorganisms. But is it a war that it is possible to win?

To prevent the problems caused by leaving a material in its authentic form, high roughness of the surface, a
highly resistant chemical/artificial finishing is needed. But with chemical finishing are lost many of the positive effects of wood on a healthy microclimate, not to mention authenticity. Thus the conflict arises between man as a cultural creature and man as an animal with the same instincts as millions of years ago. So usually it comes down to a hard decision, whether to have the surface perfectly cleanable or authentic and truthful (Figure 2).

Concerning *somatic comfort*, roughness brings better control over body position, by grasping/holding objects in the hand, by sitting it prevents sliding down and getting C-shape spine, by laying down, standing up etc. Another aspect of somatic comfort is a supporting the possibility to occupy a space in all kinds of body position and thus creating and offering tangible surfaces with high contact comfort, which is connected to roughness - naturally up to a certain limit, where the rough elements start to be a real danger and may cause some injury. Here using the structure of the surface has high potential for leaving a message or making a massage for the body.

In *acoustic comfort* there is a direct relation between the more rough or perforated surface is and the better acoustic wellbeing it is possible to achieve. Here the acoustic balance can be set by a sensitive combination of rough and smooth and hard and soft surfaces.

Within *olfactory and gustatory comfort*, the rougher a surface is, the stronger is its ability to manage air humidity and VOC. Its smell is stronger, because the interface between the material surface and air has bigger dimensions. When it is left with open pores, without additional chemical finishing blocking the natural pores of a material, this effect is even stronger. At least in natural wood surfaces the correlation is valid, while this effect has to be further explored by the other materials. In clay plaster there is a correlation between the ability to manage air humidity and the thickness of the plaster and the content of loam in it. Surface features have strong impacts on regulation of air humidity and overall thermal comfort, particularly with naturally rough, porous and hydroscopic materials like clay, wood or straw. In addition, cooking and serving food on natural rough surfaces, brings more joy and potential taste for cooking in a healthier way.

There is also set a hypothesis, based upon psychosomatic and psychoanalytic studies [4], [5] that this function of surface, like a material skin, is also connected to the communication between the material world and human. Matt/rough/porous surfaces can be associated with belonging, welcoming, penetration, permeability, while high glance surfaces can be related to reflexion, refusing, rejecting, setting borders/limits. These associations are being further explored. Being surrounded by such a setting for a long term (in the work place or at home), can create a stressful setting that can lead to health problems, usually some of the civilisation diseases related to suffering stress.
2.3. New trends and challenges

Is the contemporary strong trend towards rough surfaces and “big flowered” textures just a fashion or a hunger for materiality caused by the virtual, digital and abstract environments we live in?

Thus the roughness is so important. Here the “new authenticity” comes in. Material engineering brings new solutions in the structuring of surfaces, printing or pressing of different reliefs, 3D effects for decors (Figure 2), where only parameters of comfort and wellbeing show a difference with the original. Here the “new authenticity” begins to be very often transformed into superficiality.

One can see this development particularly at furniture and materials fairs, such as INTERZOOM 2015 in Cologne in Germany. The question is what will come next? What will be the new trend for surfaces? We can predict that interactivity and advanced technologies, particularly nanotechnologies or technologies related to 3D-printing, will permanently bring some progress and will be more available also for low-end products and thus will have a stable position in material engineering and spatial design. There will be more and more solutions inspired by nature, bionics/biomimetic and using biological solutions for progressive technologies. At the same time, the strong need for coming back to roots and to naturalism and “normality” will remain as a sustainable value. Only new styles in artificialities and superficialities will bring every year some innovations as nutrition for the media business (Figures 3 and 4).

Within the research project “Interaction of Human and Wood” are explored all sorts of this interaction, along with its potential to be an idea for the development of new materials and their finishing. A number of tests of visual and tactile interaction have been executed; a recent tactile test was introduced at a furniture fair in Nitra, Slovakia, in March 2015, where 80 respondents tested 5 solid oak surfaces with different levels of roughness achieved by different techniques, all without and with oil finishing. The respondents had to rate them according to subjective feeling and, right after, according to suitability for kitchen working counters and tables. The preliminary results show that even when respondents intuitively liked the rougher brushed surfaces, when they were asked to make a rational decision concerning indirect maintenance, they chose the more practical – the maintainable solution - the grounded finish. Here one can feel a lot the strong impact of western cultural concerns for hygiene.

We are developing a method for comparison of the subjective and objective rating of contact comfort with wooden surfaces to bypass time-demanding subjective testing. It would lead to a clearer categorisation of roughness, on the technical level but also on the hedonistic or well-being level.

The ideal surface for humans in high performance environments is antimicrobial/antibacterial and hydrophobic at the same time and, despite this, still authentic [6].

Just now we are testing the hypothesis that it is possible to secure a surface modification such as adjustments by plasma or by finishing based on nanotechnologies and biomimetic, with the aim to reach the state that wood can be rated hydrophobic or even superhydrophobic, and thus easy to maintain. These are the topics of our contemporary and future research.

Ideal surfaces for public spaces are antimicrobial/antibacterial and hydrophobic at the same time, and despite all this, still authentic.

The goal is to develop natural and authentic surfaces, using natural antibacterial and hydrophobic effects thanks to plasmatic and enzymatic adjustments.

3. Conclusion — Summary

Surface features of built-in materials play a crucial role in the overall feeling of complex comfort. Particularly roughness has a significant impact on many other well-being parameters. But there is one more important fact: Environments leave a MESSAGE in us, educate indirectly, and influence future preferences and attitudes to values and sustainability. Materials in built environments have to offer real support for humans and be a complementary harmonising element to the virtuality and digitalisation of contemporary culture.

When we give materials the chance to find their own authenticity, we can benefit from it in the form of a complex feeling of well-being which contributes to public health and to a positive social atmosphere, while also increasing productivity and efficiency in workplaces. Let’s introduce quality instead of quantity into environmental design.

Let’s give materials the chance to find their own authenticity, also thanks in part to the truthfulness of their surface. At the end, we would refer once more to Wolfgang Haipl and his statement that “The truth is the best material”.

V. Kotradyová: “Material Surface Features in Body Conscious Spatial Design”, pp. 38–44
Figure 3. New “rough” surfaces: HTS Exklusive oberflächen, Organoid panels, Franz Kolar, Stepwood, Truffle grey, Laminate decor of Pfleiderer
Acknowledgements

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