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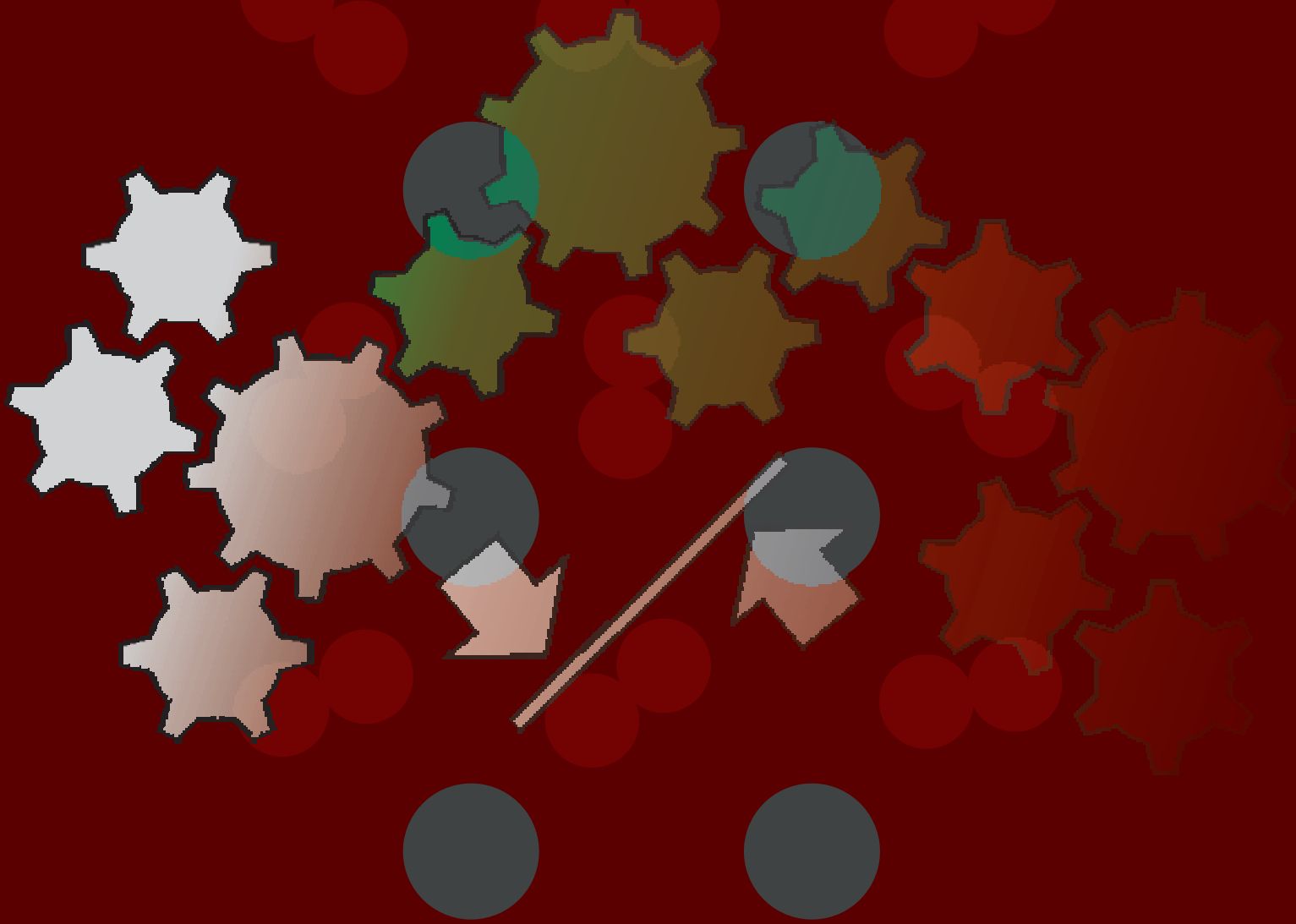

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BUILDING SUSTAINABILITY AND BUILDING INFORMATION MODELLING

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Keywords: sustainability, green building, sustainable building, building information modelling, libraries
Abstract: The environmental protection is one of the most important socio-cultural topics. Protecting and supporting the healthy environment is an important basis for preserving human existence. The quality of the environment is influenced by the construction markedly. There is also required a considerable consumption of redundant sources and energy. In this regard, it is necessary to look for alternative ways and methods for promoting energy efficiency, production reduction, waste and emissions. During the preparation, realization and occupation of buildings, automatized processes are pushed forward. One of the new, innovative processes that increase productivity and production growth is Building Information Modelling (BIM). The paper deals with several options, how the sustainability in construction can be secured in the concepts of building information modelling. The terms as sustainability, green buildings, green components, BIM Libraries are described and the availability of selected "green components" in BIM Libraries is observed.

1 Introduction

A care about the environment is an important activity about socio-economic significance. A healthy environment is the basis for the preservation of human existence, healthy development and influences the factors of the living standard of the population significantly [1,2]. Construction activity influences the quality of the environment greatly and requires enormous consumption of natural resources and energy. A huge amount of waste and pollution is generated. The negative consequences of construction work leaded to redundant pumping of natural sources, pollution, ecosystem disruptions, but also to negative socio-cultural impacts and changes in the environment [3]. At present's society, more emphasis is being placed on the creation of methods and procedures to objectively assess the impact of used building materials for the environment. A lot among of studies deal with green building solutions and emphasize on energy efficiency, reducing waste production, CO_2 emissions, etc. A suitable tool for promoting environmental behaviour is Building Information Modelling. It is considered as a system solution that allows a comprehensive analysis of the building and reviews the overall design in terms of possible environmental impacts with the aim to ensure optimal and sustainable design, construction and operation of the building [4].

2 Building information modelling and building sustainability

Change of lifestyle in modern society is reflected by increased rate of flexibility, productivity and technological development. Civil engineering sector supports the process automatization. Building information modelling is important tool for raising the effectivity and productivity in civil engineering industry. There exist a lot of definitions for Building Information Modelling.

BIM is a digital representation of the physical and functional properties of the building. The process of building and building management includes many stakeholders, and it is therefore important to properly share information throughout the building's life cycle [5].

Model BIM provides graphical and non-graphical information. According to BIM principles, there exist seven established dimensions, which are:

- 3D – Geometry,
- 4D – Time,
- 5D – Cost,
- 6D – Sustainability,
- 7D – Facility management [6].

The third dimension is a more recognizable dimension because it is related to the "visible" part of the BIM model. The fourth dimension is the time schedule of the project. The dimension allows to visualize and control processes across projects. Fifth dimension is cost-related. Dimension allows for budget monitoring and cost analysis. Sixth

dimension is used for reviewing the energetic effectiveness during project and operating stage. The sixth dimension allows to measure and verify building phase data on the actual energy performance of a building. 7th dimension is a tool for collecting relevant information connected to maintenance and management of a building and its facilities during the life-cycle. Dimension offers important information about the management and maintenance of buildings [6].

Figure 1 Dimension of BIM (Source: Author's own processing)

The definition of "sustainability" is the study of how natural systems function, remain diverse and produce everything it needs for the ecology to remain in balance. Human civilization takes resources to sustain our modern way of life [7-9].

Sustainability consists of three basic pillars economic development, social development and environmental protection.

- to mitigate the effect of climate change, pollution and other environmental factors that can harm and do harm people's health, livelihoods and lives,
- increase health of the land, air and sea,
- sustainable economic growth while promoting jobs and stronger economies and other [10].

Impact of environmental aspects of civil engineering is significant in the construction industry. One of them is why and how to build buildings which should be named green buildings. Kibert defined green buildings as "healthy facilities designed and built in a resource-efficient manner, using ecologically based principles". Green buildings, sustainable materials, green roofs and walls represent the results of green environment policy [11,12].

Green buildings get different certificates. Green building certifications can enhance reputation on the market and can bring other opportunities for example owners, developers and civil engineering (one of the most popular is LEED). To participant's construction support of green buildings brings great environmental benefits. In the practise there are more and more requirements of developers and planners on using of green attributes, which directly promote sustainability and don't burden the environment (eco-friendly). LEED was launched in 2000 and it is a voluntary, consensus-based, market-driven building rating system that evaluates environmental performance from a whole building perspective over a building's life cycle, providing a definitive standard for what constitutes a 'green building' [11].

3 BIM Libraries

BIM offers the users all the information about constructions used in the project. User has these data available from blueprint until building usage. This information is included in each elements database. Features' database, so-called BIM Library [13].

BIM Library represents central database of BIM Objects. All the library's components are created in accordance to relevant regulations and standards. User can choose and use BIM components, which contains the essential information and are compatible with all working platforms. All the information about component are saved in model file and are connected with specifications and geometrical data [14].

Libraries are exactly the critical spot of every 3D program. Each of the programs dispose of their own features' libraries, but there exist also central online portals. Most known providers of BIM libraries are [4]:

- BIM Object Cloud,
- Revit City,
- Arcat,
- BIM store,
- BIM components [13].

One of the most used libraries is the portal **BIM Object Cloud,** which spread well known accessory from Autodesk, SEEK tool. BIM Object Cloud is world-wide central internet database, which contains all object's information and BIM files and also represents searching tool, that optimize every product, that is publicized on the portal, because of using "permalinks", what means every product gets unique URL address. Database cooperates closely with manufacturers and contains only products of real producers [15].

The company Autodesk has created popular community portal **RevitCity** for sharing BIM objects, which offers well-arranged tree structure of libraries. The main disadvantage is; that portal offers only objects intended for use only in tools made by Revit [16,17].

Portal **Arcat** offers free online database, which contain BIM objects. Database is filled and updated by the manufacturers themselves. Database are divided into 28 sections [16,18].

Database **BIM Store** offers to the users all the information about constructions used in the project. BIM Store is a collection of products that are designed for civil engineering. These models are perfect for 4D time-lining, Sequencing and planning [19].

BIMcomponents.com acts as a community portal, in which architects and designers can share their objects, they can discuss and rate the uploaded content. Users can also

search, download and upload objects with a single click from ArchiCAD [20].

4 Green components and BIM

BIM provides multidisciplinary information that helps to share information and take action on sustainability Many applications have been developed to address sustainability issues in the design process. During designing buildings, more emphasis is given on creating green buildings that are the main supportive tool for sustainability. Applications work with so-called green attributes - energy, emissions, solar and lighting, ventilation, material, and waste across individual project phases. Elements supporting the so-green homes are, for example heat pumps, green roofs, mineral insulations, photovoltaics components and the others. Components that were mentioned are available in BIM Library, but only in 3D format. Single objects contain graphical characteristics and basic parameters, but don´t provide information about time, cost, sustainability and facility management. Table 1 provides an overview of the availability of selected "green components" in the BIM Libraries.

Availability of heat pumps, green roofs, green walls, mineral insulation and photovoltaics components in Libraries are shown in Table 1. Heat pumps, mineral insulations and photovoltaic components are available in all BIM libraries, which is a good signal for the development of green buildings. Revit City and BIM Store After reviewing selected BIM Libraries, Revit City and BIM Store showed deficiencies in the availability of some "green components" [21,22].

Table 1 Availability of selected green components in the BIM Library

BIM Library	Component				
	Heat pumps	Green Roofs	Green Walls	Mineral insulation	Photovoltaics components
BIM Object Cloud	✓	✓	✓	✓	✓
Revit City	✓	✗	✗	✓	✓
ARCAT	✓	✓	✓	✓	✓
BIM Store	✓	✓	✗	✓	✓
BIM Components	✓	✓	✓	✓	✓

5 Conclusion

Automatization is more and more used in production, management and other processes. An important part of building automatization is BIM- Building information modelling. BIM technology presents helpful tool in designing. BIM technology works with graphical information and non-graphical information. Sustainable and green buildings are object of more conferences and scientific papers. BIM's potential is notable and level of implementation of this technology is increasing more and more through the whole world. One of the important supporting tools implementing BIM are the BIM Libraries. The trend of sustainability is increasingly reflected in BIM libraries. At present, these databases are continually filled and contain more and more green elements. This article brought definitions definition of terms- building information modelling, sustainability, green building, green components and overview of the availability of selected "green components" in the BIM Libraries.

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NEW TECHNOLOGIES OF TISSUE EXPANSION - REVIEW ARTICLE

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Keywords: expansion of skin, muscles and bones, tissue expander
Abstract: Currently, plastic surgeons are often challenged to reconstruct extensive and complex tissue defects in various areas of the body. Despite the availability of a variety of operative approaches in practice that are applicable in the long term for the reconstruction of tissue defects, donor and autologous transplants, skin grafts, implants, etc., the result is often not satisfactory. Restrictions of these techniques in restoring and repairing tissue serve as a driving force for the development of new techniques, the development of adipose tissue in tissue engineering. From a didactic point of view, the expansion could be divided into 3rd groups. The first group consists of physiological expansion, e.g. growth of an individual. The second group includes pathological expansion, i. skin growth over areas of tumours. The third group includes artificial expansion, which was an important part of cosmetic or ethnic adaptations for some tribes. This review article is addresses the application of tissue expansion in various types of tissues, skin, muscles and bones, as well as its localization and its side effects.

1 Introduction

Tissue expansion as a surgical method is relatively new. The clinic has been in use since 1980 and its founders are prof. Radovan, Austad and Rose. In most cases the donor tissue is expanded from the area adjacent to the defect site. The principle of tissue expansion technique is to create a hemispheric dome lobe, which does not leave any after moving respectively minimal scar on the donor side [1,2,16].

The basis of tissue expansion technique is the adaptability of tissues to changing indoor conditions. Expanding tissues has found application in many areas of reconstructive medicine due to many benefits. They can be applied in different parts of the body, even in multiple combinations with transplantation techniques. They provide tissues with a specialized sensory function, skin with almost perfect colour and texture, and minimal morbidity and scarring of the donor site are observed [3,4]. Expansion of tissues is applicable to almost all types of tissues (soft and solid tissues). It is the expansion of the skin - mechanotransduction, muscle expansion - myofibrillogenesis and bone expansion - distractional osteogenesis.

1.1 Expansion of the skin

Tissue expansion of the skin was first described in 1957 by Neumann [3,5], who used a subcutaneous rubber balloon, gradually filled with air, to spread the skin immediately adjacent to the wound. He noted that using this technique can create new, undamaged skin that could be used to cover large areas of skin injuries. In addition, the *de novo* expanded tissue-like colour and structure had identical sensory and hair bearing the missing tissue characteristics, with minimal scarring and morbidity of the donor site [3,5-7]. There is, in theory, no limit to the amount of tissue that can be generated by the expansion of the tissue, provided that the process is carried out sequentially.

1.1 Expansion of the bone

Distraction osteogenesis - this is a rapid expansion, elongation using either external devices such as bone distractor or internal devices such as ISKD (Intramedullary Skeletal Kinetic Distractor). The application of external devices stimulating distraction osteogenesis was introduced in 1951 by Russian physician Ilizarov. The

Ilizar apparatus (Figure 1) is capable of elongating the limbs in cases of congenital diseases, pathological bone loss, limb asymmetry, dwarf growth, nanism, and the like. In reconstructive and aesthetic surgery, the extension of the mandible, e.g. in cases of congenital malformations, traumas, tumours, used with a high degree of success of articulated expanders [8].

The lingering method of limb extension is expansion through intramedullary and skeletal kinetic distractors (ISKD). With this technique it is possible to obtain an extension of 12 cm, but this method of expansion is expensive, painful and time consuming (each procedure takes about 8-12 months [9].

Currently the ISKD system consists of a telescopic extension of the inner limbs, locking screws, instrumentation and an external hand-held monitor. When the patient performs small rotation oscillations of the limb, the ISKD inner limb extension gradually pulls the bone. The stretch rate depends on the level of active activity of the patient or on the manual handling of the limb. It added manually monitor, which includes a magnetic sensor. It activates a small magnet sealed inside the extender. When the stretcher stretches the tissue, the internal magnet rotates. When properly positioned over the magnet, display monitors and records the position of the magnet. With this system ISKD doctor and patient can be monitored regularly achieved by stretching the length, which can be monitored data and print. In use, the present ISKD need its full insertion into the tissue (Figure 2). The potential risk of infection is diminished as compared to extension procedures that require external pins or wires. The ISKD is designed to extend to a predetermined distance and then to stop [10].

The highest efficacy of expansion of solid tissues has been demonstrated in cases such as congenital diseases, pathological growth (nannism), asymmetry, bone loss, prolongation of bones, mandible, trauma.

Figure 1: Ilisarov apparatus [11]

Figure 2: ISKD [10]

1.2 Expansion of muscles

Growth and increase in muscle mass under physiological conditions is proportional to muscle load and a full-fledged diet enriched with sufficient resp. excessive amounts of basic amino acid building blocks. The process of growth of muscle tissue expansion is known as myofibrillogenesis [12,13]. Targeted expansion of muscle tissue is also observed during mechanical transduction by specific techniques applied in repair and regeneration techniques through endermotherapy [14].

Tissue expanders used for muscle expansion are balloons made of silicon and filler ingredients that are molded into the preformed prosthesis. It can be filled with physiological saline through the valve system. It is either incorporated on the surface of the expander (early expanders have this structure that is not visible today) or is remote and connected by a flexible silastic filling tube to the expander (almost all expanders now have a remote valve). The greatest advantage of the remote valve and filling tube is to maintain the injection point well away from the balloon to prevent any risk of penetration of the balloon when the expander is inflated. Remote placement allows placement under the skin where it can be easily palpated [15].

Standard tissue expanders, which are available from the production companies are usually circular, rectangular or crescentic (croissant) in shape and is usually manufactured in commonly required volumes / capacities from 50 to 1000 cubic centimetres in increments of 50 to 100 cubic centimetres (Figure 3). Most of the errors can be quite satisfactorily reconstructed using standard expanders available from the manufacturer.

The expansion technique is based on regular expansion of the expander solution until the skin tissue above the expander reaches the desired size in advance. The average expiration time is 3 months. Tissue expansion is an innovative method that provides ideal tissue for reconstruction with minimal effect on the donor area. It is one of the few techniques that are satisfying both functionally and aesthetically. Attractive in its simplicity in clinical application, tissue expansion may be considered a reasonable method of manipulating the normal physiological process - i.e., for the so-called "biological dividend" [16,17].

Figure 3: Different types of tissue expanders [15]

1.3 Indication of tissue expansion

The most frequent indications of tissue expansion are: mastectomy (breast reconstruction, implant), scars, keloids, burns, trauma, postoperative condition, previous surgery, congenital melanocytic nerve, scalp reconstruction, genital and urethral reconstruction, eye microsurgery, etc. [3,4,18,19].

1.4 Localisation of tissue expanders

The use of tissue expanders has limitations that are particularly related to the location of the expander. Optimal expansion is achieved when the process is performed on a hard surface (e.g. bone), while expansion is more complicated when done against other soft tissues (e.g. neck, abdomen).

In the latter case, it is necessary to closely monitor the process of tissue expansion. Expansion itself can also create new edges of tissue, sometimes hard, that need to be addressed during the final surgery. Due to the high annual increase in tumour diseases, especially breasts, tissue expansion is most commonly used in breast tissue reconstructive surgery [20].

Other sites for expander placement are individual regions of the body where the tissues are expanded mono or bilaterally (Figure 4).

1.5 Expansion of other tissues

1.5.1 Expansion of the scalp, hairline

The tissue expansion induced by the mechanical effect of increasing the volume of tissue expander has been the subject of research by scientists and surgeons since 1957 [6]. The ability of almost unlimited expansion, with all its original features and properties, has long been used in cases of fibrotic scarring of the head and face due to previous surgery, trauma, etc., after the removal of the tumours, where as a result of the occurrence in the hair part of the alopecia, after the excision of the tumours, in the correction of the defects of the cranial cover (Figure 7) [21-23].

The tissue expanders are located near the defect in the cranial area. Percutaneously replenishing once or twice a week increases the volume until the expanded scalp is 20% larger than the size of the wound to be covered by the expanded tissue. The duration of the expansion varies depending on the clinical application, usually in the range of 4 and 8 weeks [23].

1.5.2 Expansion of the iris

In 2008 Dr. David F. Chang, MD used the 5-0 polypropylene Malyugin pupil expansion device by patients with intraoperative floppy-iris syndrome (IRIS) having cataract surgery. He was evaluated it in 30 eyes from 21 patients. This Malyugin ring maintained a constant 6.0 mm pupil diameter throughout surgery (Figure 8). Result was that all eyes achieved a best corrected visual acuity of at least 20/25 [24]. This expander device is increasingly used in such and similar visual operations, sometime with small modification [25-27].

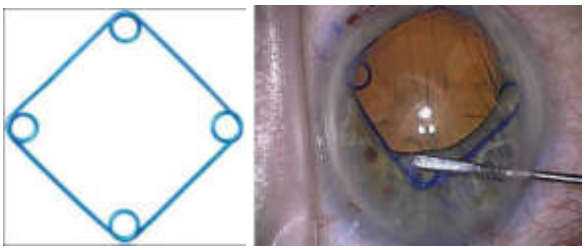

Figure 8: Malyugin ring and its use [24,28]

1.5.3 Genital and urethral expansion

Expansion techniques have almost unlimited possibilities of application in the reconstruction of soft tissues. Barbagli et al. [29-31] belong to pioneers of genital and urethral reconstruction. They work with a high success rate, perform the surgical reconstruction of male genitalia via the tissue expansion method, even in the case of a foreskin recovery technique that is usually inoperable, applying external tension using specialized devices to replace the cut tissue with new cells [32].

1.6 Complications of tissue expansion

Despite the many benefits of expansion reconstruction in the treatment of extensive tissue defects, significant problems have been noted limiting the clinical applicability of tissue expansion. The incidence of post-expansion complications was in the range of 11 to 39% [6,33-39].

Pisarski et al. [38] and Antonyshyn et al. [40] reported as the most common complications following the application of expanders: inflammation, infection, extrusion, wound dehiscence, serum, hematoma, necrosis, capsular contract, and implant rupture. Each of these complications may lead to the expulsion of the expander, the premature elimination, the hospitalization, the newly induced trauma of the patient, the increase of undesirable

economic parameters and the separation of the tissue reconstruction itself.

One of the most common complications of surgical wound healing is dehiscence, premature wound margins that are caused by a wound healing disorder due to wound infection, wound haemorrhage and hematoma, or aseptic necrosis of the wound environment caused by insufficient blood flow. Serum, accumulation of fluid in the confined space that gives rise to a tumour-like feature belongs to the concomitant complications of infection, inflammation and dehiscence. Chang et al. [41] in their studies of the incidence of risk factors following immediate tissue expansions confirmed the incidence of wound dehiscence at 4.1% and necrosis in 4.9% of the 246 cases of breast reconstruction. The most significant risk parameter, up to 95% of all cases were BMI (body mass index). Due to the necessity of applying tissue expansion and increasing its rate of success without causing undesirable factors, preventive solutions have been sought. Egeland and Cederna [42] proposed a way of preventing endoscopic tissue expansion by mini-invasive approaches.

Despite the many advantages of reconstructing large and complex soft tissue defects with tissue expanders, there are several significant problems that limit their clinical usability.

Extra cut: If open access is used to place the tissue expander, the rupture must be close to the tissue expanding bag to allow visualization of the bag during subsequent manipulation. Dehiscence of the wound: Unfortunately, this approach creates a wound near the tissue expansion pocket, which increases the risk of wound dehiscence when the tissue spreads during expansion.

Expansion Delay: To reduce the risk of wound dehiscence, physicians usually wait a few weeks after the surgical site of the tissue expander to allow wound healing before tissue expansion begins. However, the wound reaches only 70% of its original strength after 6 weeks of treatment, so the onset of tissue expansion 6 weeks after surgery does not exclude the risk of wound dehiscence. Techniques have also been proposed that try to make minor incisions and thus reduce the risk of wound dehiscence, but this has occurred at the cost of poor visibility and increasing difficulty in achieving haemostasis [43]. Although a number of surgical approaches have been suggested to reduce as much as possible this risk, surgical wound dehiscence remains a significant problem in using open techniques.

Overall, the extent of complications in the reconstruction of the tissue expander is disproportionately high; the authors report complications ranging from 11 to 39% in individual studies [36-38,40].

In the case of the use of tissue expansion in the reconstruction of the limbs, an even higher degree of complication was observed, more than 50% of the cases. The most frequently cited complications are infection, hematoma, serum, extrusion, wound dehiscence, and tissue expander exposure, each of which may require removal of the expander, hospitalization of the patient and / or delay in the completion of the reconstruction [38,40], the expander may fail at any stage of reconstruction, including at the time of the tissue expander placement or during the expansion process.

In the case of some injuries, the soft tissue loss is so extensive that skin margins cannot be approximated; in such cases, application of skin grafts or FLAP clamps is necessary for closure. (Flap surgery is a technique in plastic and reconstructive surgery where any type of tissue is lifted from a donor site and moved to a recipient site with an intact blood supply [34]. Full grain skin grafts contain the epidermis and the total dermis thickness from the recipient region. The split-thickness grafts contain the epidermis and the variable thickness of the dermis. Grafts with a higher dermis thickness change on the wound bed and provide more durable coverage. Thin grafts have the advantage of faster revascularization, so they are more likely to be successful. Thin grafts, however, tend to provide less durable coverage [35]. This high rate of complications associated with decreasing reimbursement for the operation alone has reduced the usability of the tissue expanders themselves in the current medical environment even despite the large amount of procedures. Therefore, it has become a necessity to design a technique that would reduce this complication while maintaining the effectiveness of the reconstruction technique, significantly improving the clinical utility of tissue extension [37,44-48]. These objectives have been achieved in many surgical areas using endoscopic approaches to performing routine procedures. Based on this assumption, surgeons have begun to use endoscopic approaches to the performance of tissue expander placement in the hope that the complication can be reduced without minimizing the effectiveness of the reconstruction technique.

Conclusion

The main objectives of Plastic, Reconstructive and Aesthetic Surgery is especially perfect replacement of damaged tissue, in terms of functional and aesthetic. The technique of tissue expansion is based on the observation that living tissues respond to mechanical stimulus dynamic manner. Tissue expansion has become a preferred technique in many reconstruction techniques, but its preferences are currently under discussion due to dissatisfaction with the post-operative state and the need for subsequent reoperation to achieve aesthetic and functional satisfaction. Nowadays tissue expanders are used only for expansion of the skin and some muscle. Methods expansion of other tissues are currently in the experimental stage.

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CONSUMPTION PROFILE AS A BASE FOR DESIGNING RES USING SIMULATION TOOLS

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Keywords: consumption profile, energy management, simulation of energy production, prediction
Abstract: Nowadays, projecting of the renewable energy sources (RES) through simulation program is the very popular. In case usage RES in systems with stable consumption the simulations are sufficiently the exact. The problem arises, when it is necessary to simulate the supply from an unpredictable energy source to a system with unstable or unknown consumption. In particular, in residential buildings, it is very important to know the detailed consumption profile of heat and hot water consumers in the proper design of the RES. Underestimating its importance may lead to significant financial losses of the investor, user of RES technology.

1 Introduction

In discussions about the energy intensity of housing, it said more and more about the notion "consumer profile", recently. Its importance is growing with the increasing share of renewable energy use due to its unpredictability. In fact, it is very important taken into account their instability with potential energy instability. The same proportion of its importance can be attributed to the size and type of the customer. If we move only at the level of the communal sphere, the most problematic is the consumer profile of the apartment houses [16]. It is almost impossible to find two type identical apartment buildings with an identical profile of consumption of heat, hot water and electricity. The reason is simple - people.

The energy performance in buildings is influenced by many factors, such as ambient weather conditions, building structure and characteristics, the operation of sub-level components like lighting and HVAC systems, occupancy and their behaviour [3]. It is important to identify the cluster of households when analyse the load profile, because the load profile depends very much on the occupancy pattern [4]. Parker [5] noticed occupant number as the key determinants of DHW consumption and importance of occupancy pattern for modelling of domestic energy consumption [6]. The consumption of energy in case of using appliances, lighting, DHW was depended on the activity of the apartment residents [7].

2 Need for energy versus consumption in apartment buildings

When assessing apartment buildings in terms of their energy intensity are usage two main processes – standardized vs. operational evaluation. Common practice is combination both processes. The basic difference in determining the energy intensity is that while in a standardized assessment, technical factors are taken into account, such as:

- thermal technical properties of the building envelope,
- technical parameter of thermal source,
- floor and utility area of the building,
- estimated number of users,
- location and so on,

In operation assessment is considered in addition to the above, in addition to these data:

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- real measured consumption of the house for as long as possible,
- operating time of appliances,
- operating parameters of heating systems and system for DHW,
- behaviour of consumers and other.

In general, a standardized calculation is used to design the energy system of the new house, and the experienced designer will also take into account experience with the operation of similar buildings. If a "standard" source, such as district heating, boiler, electric heating, etc. is proposed as a source of energy, the potential difference between planned demand and real consumption is not problematic [9]. These heat sources have a sufficiently large range to cover the resulting supply differences, such as the AH in Spišská Nová Ves. The figure below shows the difference in actual heat consumption compared to the need for standardized calculations. The differences range from about 1,500 kWh per month in winter to about 300 kWh / month during the summer season.

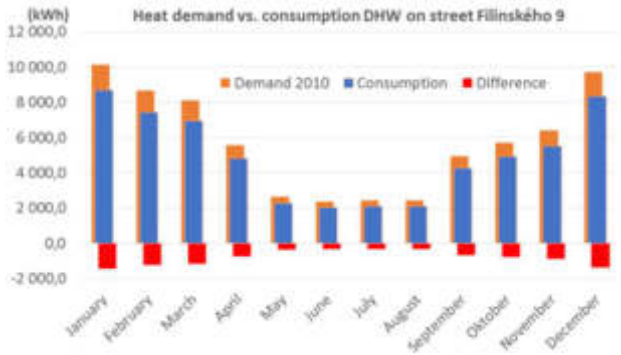

Figure 1 Heat demand vs. heat consumption in the apartment house in 2010

For larger differences caused by, for example, thermal insulation of the house or behaviour of the inhabitants, it is necessary to consider change, respectively. adjustment of the heat source. In this case, the heat consumption in three months is lower by almost 3,000 kWh / month and the year-round difference is almost 40 MWh.

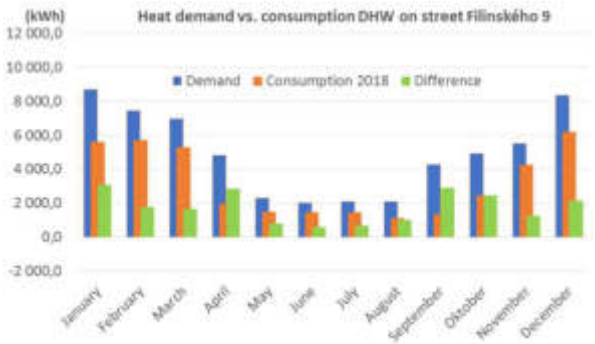

Figure 2 Heat demand vs. heat consumption in the apartment house in 2010

It is therefore obvious that knowing the heat consumption is important. However, when providing heat for heating, the minimum difference between calculation and measurement is more likely than to determine the need for heat for the preparation DHW. Although, of course, exceptions confirm the rule. Consumption of heat water is very affected consumer behaviour regardless of the thermal performance of the building envelope (if not considered in extreme cases) [13]. Establishing a relatively accurate DHW consumption in a residential building by calculation is virtually impossible, and only a very complex modelling process can be used to produce a serious consumption profile. However, even these cannot be developed without the values obtained by detailed and long-term measurements.

As is evident from the graphical representation of the hot water consumption trends in the house under consideration, the differences with the standard values are more pronounced every year, which may be due to more responsible behaviour of the population, a certain weight can be attributed to the modernization of the distribution system in the house.

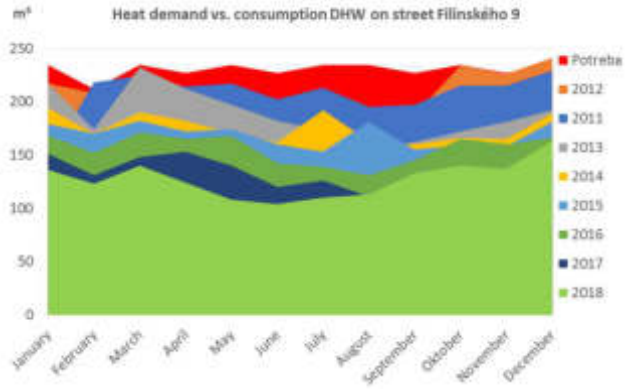

Figure 3 Heat demand vs. heat consumption in the apartment house in 2011 - 2018

The difference in DHW consumption by more than 55% compared to the standardized value of the need is already considerable and not only technological but also economic difference represents a significant difference in the use of renewable resources. While in the case of a traditional energy source, excess heat is neither produced nor taken away, in the case of a RES-based improperly sized energy source, excess energy is produced regardless of consumption, so it is very easy to get into the situation when the owners' money goes in unused energy. Precise design of a renewable resource is necessary but impossible without knowing the behaviour of the population - i.e. without a detailed consumption profile. In the case of investing in the renovation of a house and a renewable energy source such as EPC, this is doubly true. In the case of a stable alternative source of energy, for example, based

on the production and use of hydrogen, this problem is not so striking [9-17].

3 Consumption profile and financing RES in apartment buildings

Because RES technologies still represent a significant higher financial burden than "standard" energy sources, their projecting and planning use must be solved precisely and always in more variations.

This is the only way for the future user to choose the one that best suits his needs and the behaviour of the residents of the house. As an example, the AB in Spišská Nová Ves with the average monthly energy consumption for DHW preparation in the last years at the level of 7,000 kWh and the consumption profile according to the graph in fig. 4.

By appropriately dimensioning the solar system, it is possible to provide coverage of the total heat demand for DHW preparation at 58%, while overproduction of heat is not present in summer despite the lowest monthly consumption. 50 pcs of selected solar collectors will suffice for this consumption. For the sake of simplicity, only the numbers and prices of solar collectors are given, the relevant technologies are not quantified. However, the solar system designed in this way already has a solar heat deficit in March, April and September and October.

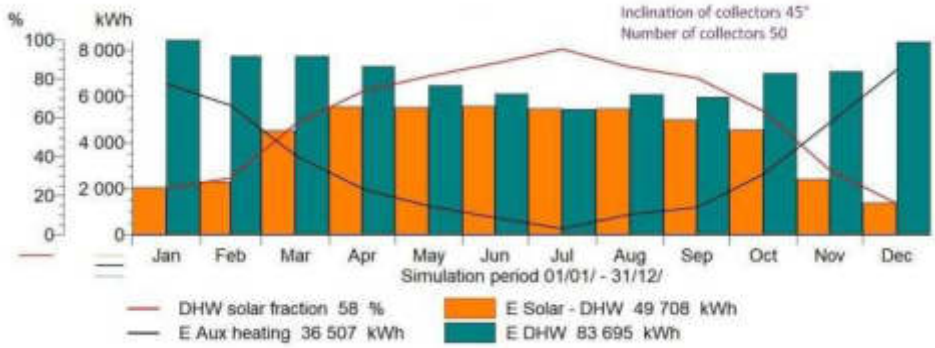

Figure 4 Solar energy contribution to DHW from solar system with 50 collectors, inclination 45°

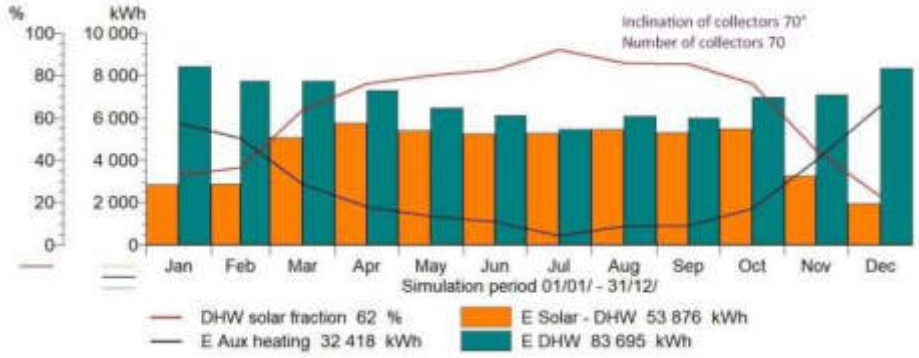

Figure 5 Solar energy contribution to DHW from solar system with 70 collectors, inclination 70°

If the user is interested in increasing the solar share even in the aforementioned problematic months, the solar system can be adjusted by increasing the inclination of the collectors and increasing their number. At a inclination of 70 ° and a number of collectors 70, the solar share has increased significantly in the required months and the total solar energy benefit has risen to 62%.

However, it is questionable whether a 4% increase in the solar share represents the same financial benefit for users. For the price of natural gas in a given dwelling house € 0.054 / kWh (for the sake of simplicity it is not considered again with other costs for the natural gas), such a solar benefit for an apartment building amounts to € 180.00 per year.

So the price of one solar collector at the level of 700, - €, the investment is increased by 14 000, - €, which in terms of a return is 78 years!

Thus, if the designer does not have a detailed and stable consumption profile and is based only on standard values, it is possible to oversize the solar system by tens of percent! The heat produced in summer will not be utilized and the return on investment may exceed the life of the system.

A similar situation may arise if apartment owners decide to finance the renewal of the house and new RES-based energy equipment in the form of EPC (Energy Performance Contracting), thus one of the forms of energy guaranteed service. The essence of the EPC is that the EPC provider itself will provide financing for home renovation

and energy technology. The owner of the house repays the investment only from the savings achieved, while the contract is set so that part of them remain to him.

However, the service of guaranteed energy service requires a great responsibility of the customer. A precondition for maintaining guaranteed savings is the strict adherence to the operation of the building as set out in the EPC project. This point is a critical point for residential buildings, because it is very difficult, if not impossible, to guarantee the operation of energy systems according to the rules, among others:

- fixed and maintained temperature of individual spaces, including apartments,
- default hot water consumption.

In an apartment building with dozens of dwelling units and hundreds of users, such operations are very difficult to maintain, and this is the reason why EPC service providers are cautious. However, as there is some tolerance in determining energy behaviour rules, in the case of a sufficiently detailed long-term and stable consumption profile, EPC service providers are willing to discuss with the administrators and owners the conditions of mutual cooperation.

4 Conclusion

The conclusion can be summed up in a single sentence - No measurement no steering! This is especially true for the relationship between apartment buildings and renewable energy sources. Two non-predictable systems are very difficult to align into an optimal system from an energy, economic and user-friendly perspective.

It is necessary to get used to the fact that high-quality measuring systems in a residential building are not a burden, but to help reduce energy costs. Whether energy management or the use of energy that is renewable and clean.

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THE 3D PRINTING IMPLEMENTATION IN MANUFACTURING OF AUTOMOBILE COMPONENTS

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Abstract: The paper is focused on the issue of 3D printing and its possible use in automotive production. It introduces the principle of 3D printing and its main advantages. An automobile disk production is demonstrated using 3D printing. The process of the disc production is realized in steps disc design, CAD model creation, wall thickness analysis, STL format creation and loading, 3D print parameters definition, printing process visualization in software environment, and 3D printing process itself.

1 Introduction

3D printing has already existed for several decades, but since 2009 there has been a massive expansion among end users. It was the year when the patent protection of FDM (FFF) technology expired. Recently, there are up to eleven technologies for 3D printing, seven of which are standardized in accordance with ISO/ASTM 52900. Individual technologies use specific materials. The most widespread are plastic string melting, stereolithography and, polymer and metal powder sintering. The 3D printing belongs to additive manufacturing, which creates a physical model of progressively layered material.

2 The 3D printing

3D printing represents a modern concept of creating three-dimensional objects from digital data. The 3D printing initialization starts with the 3D input model from CAD systems. Another way to obtain input data for 3D printing is by means of 3D scanners. The following step is a division of the 3D model into thin horizontal layers, which the printer gradually applies the melted material layer over layer. After hardening and amalgamation of the spread layers, the product gets the final form. The 3D printing process takes several hours. It is true that the print time increases directly proportional to the size of the product [1-4].

At present, the 3D printing is mainly used in the production of plastic products up to 200x200x200mm dimensions. It is a single piece production, in some cases a small batch production. The 3D printing has been used in the manufacture of tools to schools, functional devices, functional metal parts, medicine, art, fashion, etc.

The main benefits of the 3D printing include [5-7]:

- minimal technological and shape constraints over other technologies,
- production efficiency (reduction of cost of tools and devices that are replaced by the 3D printing, up to 98% utilization of material to produce the product, ...),
- production flexibility, that means, it can be manufactured quickly, in required quality and custom made.

3 The 3D printing in manufacturing of an automobile disc

In this part of the paper, an automobile disk production utilizing the 3D printing is demonstrated. The production process of a disc is performed in the following steps [2,5]:

- disk design,
- CAD model creation,
- wall thickness analysis,
- STL format creation and loading,
- 3D printing parameters definition,
- printing process visualiz*ation* in software environment,
- 3D printing process itself.

The first step is to design a disk shape using a pencil and paper. The proposal is processed in several variants. For the selected disk variant, a 3D model is created in the CAD software. In this case, input for the 3D printing is a three-dimensional CAD model created in SolidWorks 2014 software. Since the designed disk is only used to demonstrate the 3D printing, the relevant STN standards are not considered in parameters and properties of the disc.

The CAD model creation procedure is shown in Figures 1 through 6. First, a disk profile is projected. The Revolved Boss/Base command is used to create a three-dimensional object. The input for the command is a closed disk profile and rotation axis (Centreline) (Figure 1). Following is creation of the internal shape of the disk - using a circle with a selected radius and an Extruded Boss/Base command. Subsequently, the profile from which the material must be removed is drawn and quoted. To remove material, the Extruded Cut command is used (Figure 2). To use the Circular Pattern command, parameters such as the cut-out part profile, the front of the object (blue circle - Figure 2) are required, span extent, number of needed shapes, etc. In this case, it is a flat span of 360 degrees and five beams.

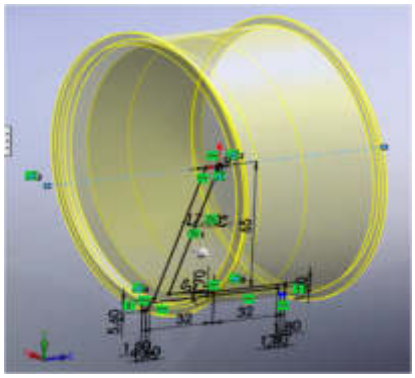

Figure 1 Quoted disk profile

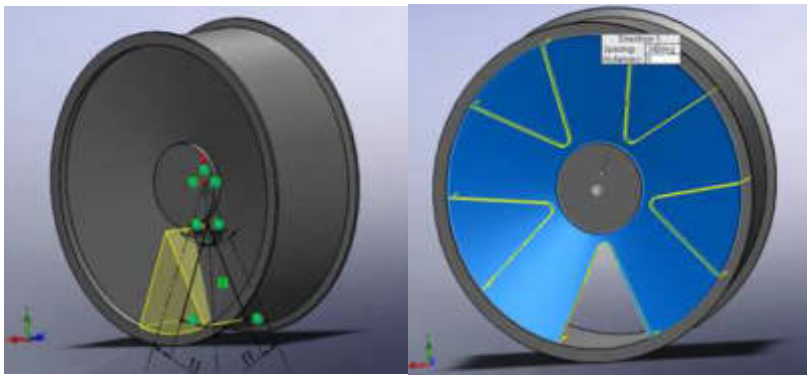

Figure 2 Creation of internal disc shape

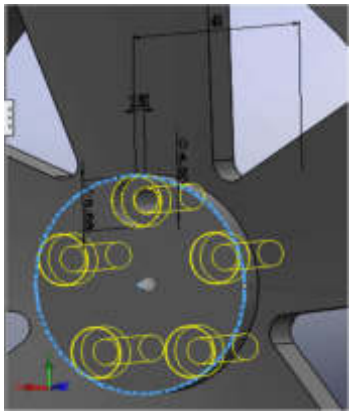

Figure 3 Holes positioning

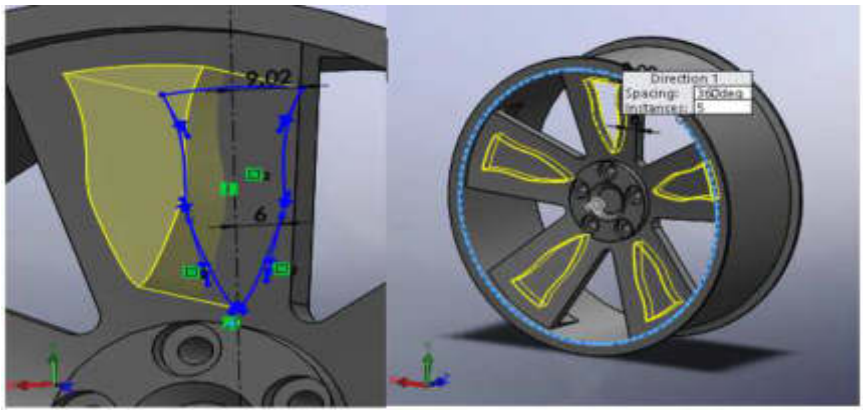

Figure 4 Creating a design using the Extruded Cut and Circular Pattern commands

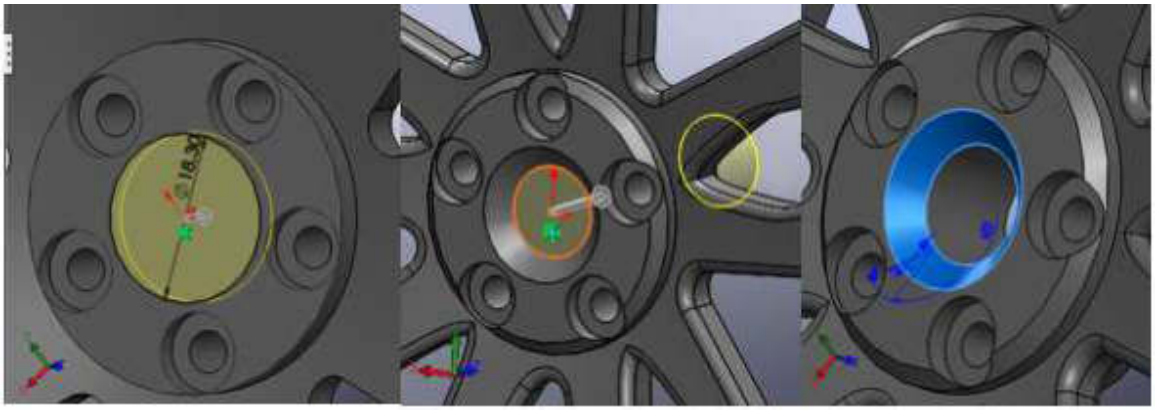

Figure 5 Creation of a driven shaft hole

Once the wheel beams have been created, it is necessary to draw another circle to the centre of the wheel, in which, after selecting the size and type of the hole, the position of the first hole is applied by means of the Hole Wizard command. The required number of holes is created using the Circular Pattern command, with the procedure used to create disk beams (Figure 3) [6-8].

The next step is to create a new sketch at the centre of the selected beam (Figure 4). The Spline command is used to draw a profile and uses the curve shaping option. After the position is quoted and the curve shape is completed, the Mirror Entities command is used (mirroring). When the profile is finished, the Extruded Cut option is used, after removing the material of the selected shape, the Circular Pattern command is again used, the spacing and number of shapes are set, etc. [6-8].

Figure 5 shows the procedure to create a hole for a driven shaft. The hole is created in the middle of the disc and counter-sinked by the Chamfer command.

The next steps are focused to remove the sharp edges of the disc. To do so, the Fillet and Chamfer commands are used. Removing of sharp edges on the disc increases its aesthetic appearance and security. The final shape and colour of the disc are shown in Figure 6.

The correct wall thickness of the disk is verified by analysis. The results of the analysis provide information on parts of the model in which there is a risk of cracking, spreading flaws, etc. The analysis can be used for the whole model, or only to the selected part of the model. The analysis results are evaluated using the Thickness scale (Figure 7).

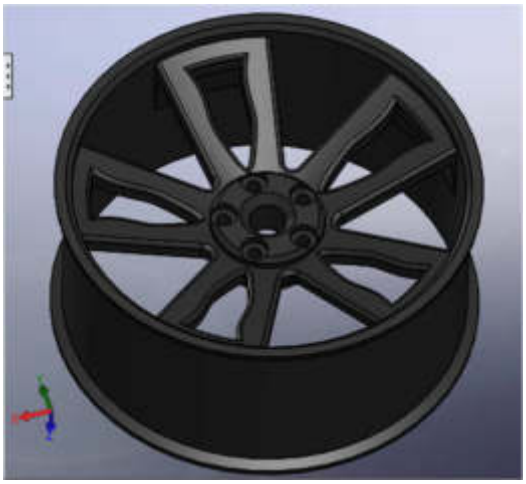

Figure 6 Final shape and colour of the disc

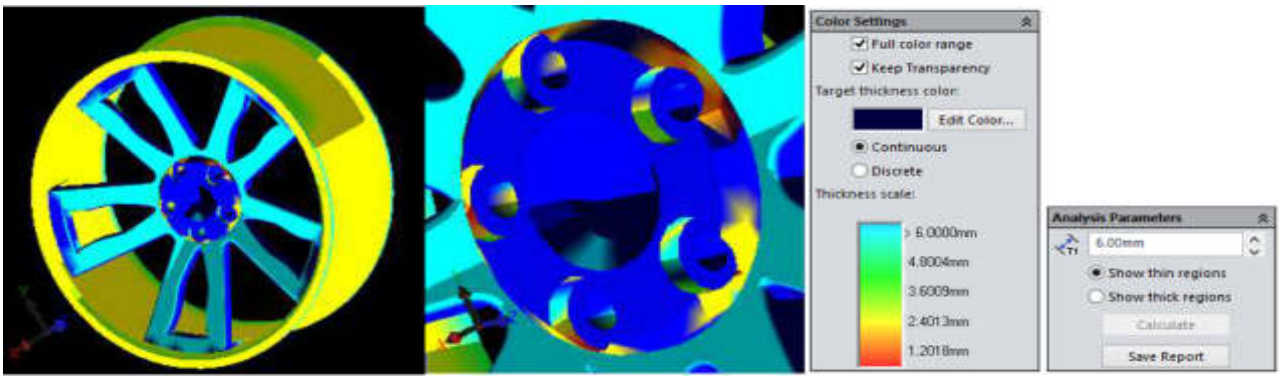

Figure 7 Analysis of wall thickness and analysis parameters

When the shape of the disk is modelled, the STL file is generated, which is the input file for the 3D printer. The STL format retains the shape and dimensions of the disc in the form of small angular pieces (Figure 8).

Subsequently, it is necessary to define the 3D printing parameters such as layer thickness, print quality, fill, fan speed, application layer axis, etc. For the 3D printing of objects such as car disks, it is necessary to use a supporting structure, as without it, focus and beams of the disc would not remain in the desired position. This fact does not need to be considered in the CAD modelling itself, because this problem can be solved by the 3D printer. Before starting the 3D printing, it is necessary to check the input material (quality and quantity). The procedure of printing the disc is demonstrated in Figure 9, [9,10].

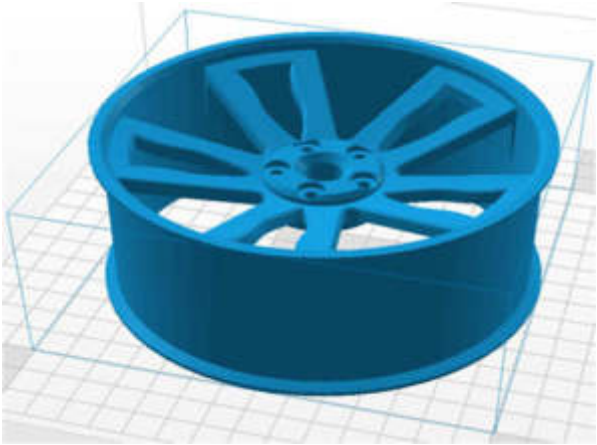

Figure 8 The STL format in the Z-Suite environment

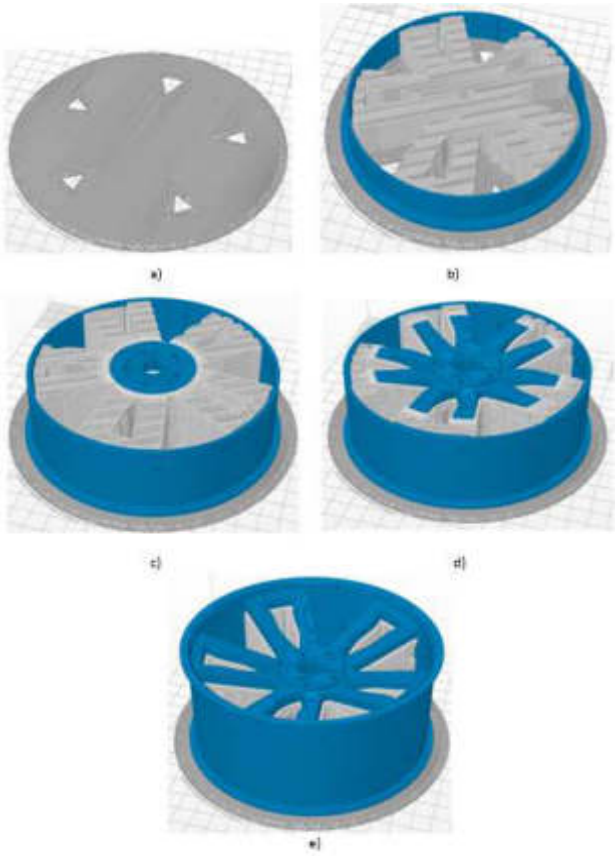

Figure 9 The 3D printing phases of a disc
a) The printing phase of the pad, b) The printing phase of the support structure and hoop,
c) The printing phase of the wheel centre, d) The printing phase of the wheel centre and beams,
e) Visualization of 3D printing with a supporting structure

Figure 10 Physical model made by 3D printing

The finished physical model of a disc produced by the 3D printing is shown in Figure 10. On the surface of the disk are visible layers of gradually laid material. The shape of the disc is not a perfect circle, but a polygon. The surface of the disc can be machined (grind, polish, etc.) as required.

4 Conclusion

Besides to the 3D printing, nowadays also the 4D printing is known. The four-dimensional printing uses a similar technology to the 3D printing - the computer programmes to lay out the material into individual layers that eventually create the entire object. The fourth dimension means that the object changes over time under the influence of heat, humidity or other factors. This is a very difficult and lengthy process, also because of the additional necessity to mechanically programming each printed material so that it changes under the influence of external circumstances. In addition, many of the commercially available printers are able to create an object from just one material. The utilization of the four-dimensional printing can be, for example, in aerocosmonautics or medicine.

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