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VIRTUAL REALITY IN LOGISTICS

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Abstract: *With evolving technology and increasing power of computer technology there seems to come a three-dimensional (3D) image display and virtual reality (VR) to the forefront. The technologies are used in various fields of human activity and with increasing popularity. So the question is: Why not use new technologies in logistics and what benefits can it bring? Virtual reality system is to create a model copied from the real world, thus there can be a 3D technical documentation created. It is also possible to use mixed virtual reality, where virtual components are intertwined in the real world. And creating an imaginary world of monitored or measured variables can assist in management or decision making. In this article the application of virtual reality devices is aimed at logistics of transport thermal energy in parametric networks*
Key words: *Virtual reality, logistics, parametric networks*

1 INTRODUCTIO TO THE VIRTUAL REALITY

Virtual reality is a three dimensional environment generated by the computer, in which the user can react with the virtual world in real time. From the information point of view, the VR is the way how to show the complex information by the computer interaction and manipulation by the user. The very important thing is to show the feeling that you are a part of the virtual world generated by the computer.
Here are three possible integrations: [4]
1. Passive - The user can move and see what happens in VR. The scene around the user can change so the user has a feeling that VR environment is moving however, the user cannot react.
2. Active - The main difference compared to passive VR is the full movement possibility. (For example the walking, flying, swimming etc.)
3. Full interaction - The highest level brings the full interaction. (For example; the full reaction and manipulation with the things.)
The level of VR integration is given by human senses, which are fully interacting with computer environment.

The largest part of human perception (about 80%) is formed by sight. Therefore, virtual systems produce three-dimensional space while maintaining the basic laws of view, perspective, and lighting.

Fig.1 *Generation and perception of three-dimensional image*

Stereo and quadraphonic sound system creates surround sound influencing others human sense of hearing.

Fig.2 *Generation and perception of three-dimensional sound*

Tactile feelings are transmitted to a user of VR by the using of special clothing with body position sensors, pneumatic sensors. These sensors are causing a collision resistance, reaction, overload, etc.

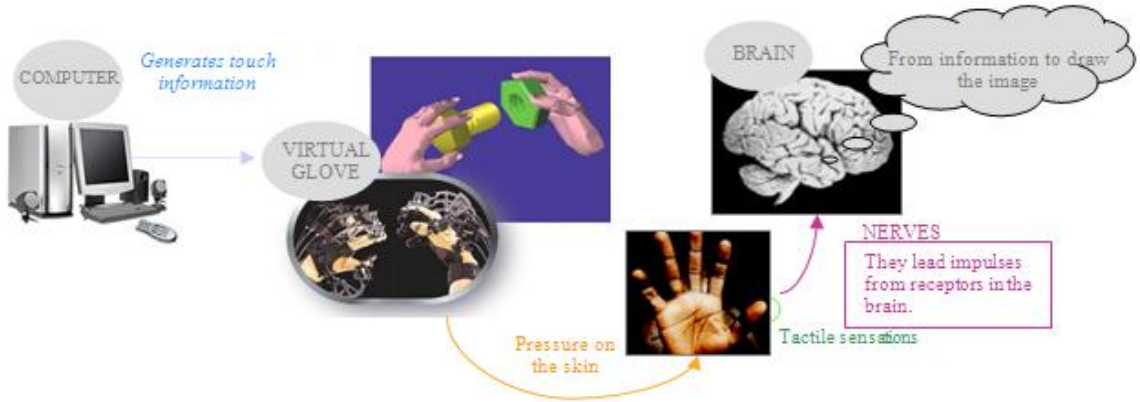

Fig.3 *Generation and perception of tactile sense*

The use of these resources and generated VR scenes in real time induce a nearly perfect illusion of the real world. VR can be done without special equipment, however in emotionally less intense form by using the monitor and mouse. [1]

2 THE VR APPLICATION IN THE LOGISTICS PROCESSES

Logistics is seen as a service that deals with the coordination, synchronization, management and optimization of all processes associated with the production, transportation

and sale of various commodities. Logically even here, we can find a space for the application of virtual reality.

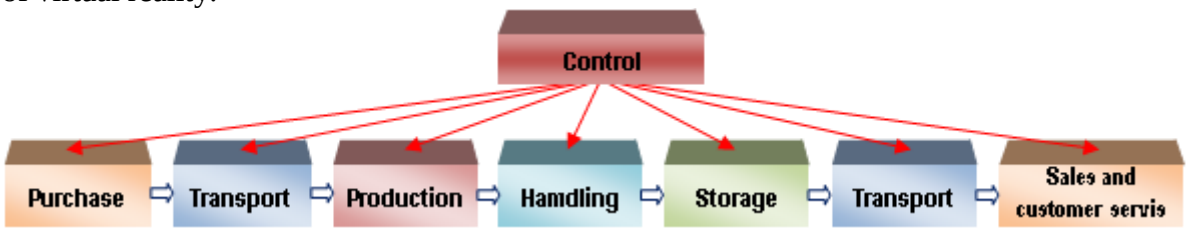

Fig.4 *Processes in the logistics chain*

Ideological proposals apply virtual reality in the logistics chain processes:

In purchase - buyers can see a virtual model of the semi-finished product before confirming the order, or do the tests (e.g. mechanical stress using Matlab toolbox and virtual reality toolbox).

In transport - on a map background, you can create a dimensional model of traffic flow and manage it according to the direction of movement of the carrier so that the necessary parts were delivered on time to the production warehouse.

In production - you can explore the whole manufacturing technology by using virtual reality. Top management does not be personally in operation; at a meeting management can inspect a progress of work on a specific product. In manufacturing a mixed reality can also be applied, the employee sets up real parts and product base on the actual scheme in virtual reality.

During transport and handling - there is offered the use of trainers and simulators for various vehicles and manipulators. Training of the common tasks, as well as hazardous and non-standard. (Emergency Landing Pilot, driving with the load of large dimensions, etc.) We can classify "the training" of the crane, during handling with extremely large cargo. After mastering operations on the virtual model, the process saves the data of the movement of the crane and will use them for the real automatic handling.

In storage and identification - there is the possibility to use virtual reality as convertor of the bar code or RFID code to a specific virtual object, which we will have a sufficient information to keep track of it. (E.g. status of a particular car in production - the subject is painted in red and has four wheels mounted).

In sales and customer service - the final customer can inspect the product before fabrication, design changes, and modifications. It is also possible to create a virtual guide that teaches the owner to handle the product correctly.

In control – We can convert into a virtual three-dimensional world dozens to hundreds of measured quantities and in this world we can have more control and orientation for decision on further management. [1]

3 APPLICATION OF VR IN SUPPLY NETWORKS

Transportation of goods in supply networks creates flows in the transport system, which also can be referred to as the transport network. While networks may be divided differently from different perspectives, but suitable for logistics network is divided them into:

- **parametric**, where the flow rate in the subdivision is determined by the properties of the subdivision and by the difference of the potential and
- **non-parametric,** where the flow rate in the subdivision is dependent on how much load can be put on the transport element.

Another view of the distribution network is based on the features, distribution according to their structure, purpose or meaning, and it is divided into following networks:

- **distribution,** where matter, energy or information is distribute from one location to several places

- **collection,** where the energy or information is collected from several locations and transported to one place
- **combination,** the association of distribution network and the collection network.

As the representative of the parametric grid model and virtual reality applications, the heat supply management has been chosen.

3.1 Supply chain of heat distribution

The user's view is that the heat is obvious expectation. It is absolutely regular that when he needs a cold or the hot water he goes and turns on the radiator or battery for water supply. User (end user) does not perceive the way of production, road transport or heat, but he manages only his own needs or feelings.

An interesting situation occurs in cities where there is central heat and its distribution to end customers. The main task of the companies engaged in production and distribution of heat to the widest possible customer satisfaction. That means to deliver the heat at the right moment, in the right amount at a specific location at a reasonable cost. [3]

This generates heat supply chain that begins with heat in the heating plant, as well as its distribution through the steam pipes, hot water or hot water pipes network directly to the end customers.

This concept corresponds to the schema; **source → network → consumption.**

Fig.5 *Processes in the logistics chain*

On the resulting logistics, chain can be seen as an ordinary string of transporting goods. We need to take into account some specifics of heat transport. The heat cannot be easily transported in pipelines, it is necessary to have a heat carrier (carrier fluid). Basically the heat "will load" on the cooling medium and deliver to a destination/transportation place, this place can be a heat exchange station, where the heat is "translated" or a place of consumption where the heat is "unloaded". However, even after this operation the heating medium must return for further use in the production site.

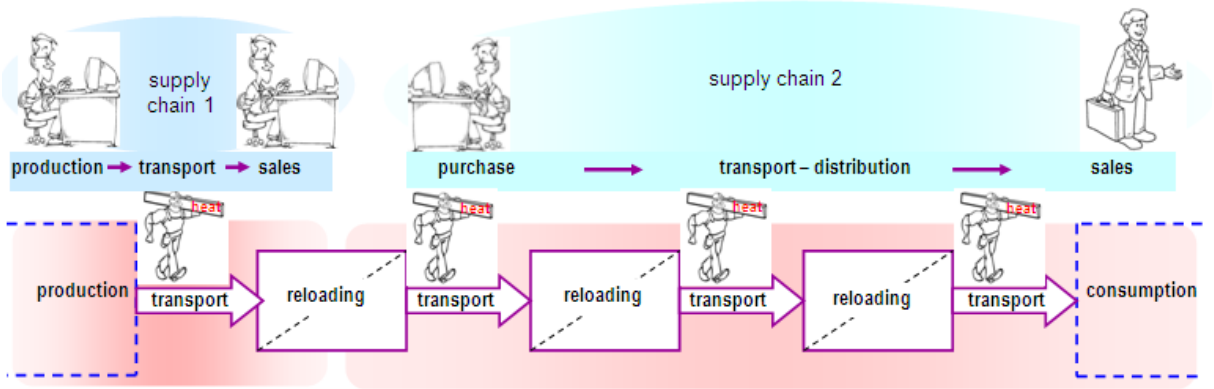

Fig.6 *Supply chain of heat distribution*

Another integral part is a securing of the economic and financial requirements. The related parts are planning, metering, billing, payment, etc.

3.2 Modelling of the heat networks

Modelling and simulation can significantly simplify the decision of the management, because the results of simulations involve the expected solution.

Modelling of the heat networks can be divided into two categories:

1) Models representing the actual dimensions and geometric shapes. These models use planners, architects, geometers, etc. It is a CAD, GIS model. These models are then

used as a part of design documentation, part of digital maps with the coordinates. You can also apply a model created in VR. In this model, you can browse sites or network and engineers have an opportunity to see the places and can choose the method of valve repair before actual go on site, etc.

2) Models representing different properties than geometric (e.g. technical). These models are based on a different content. They describe the behaviour of the object and examine the dependences of the required system based on measuring or calculations.

For modelling of the features different from just geometric, it is important to ensure that each change of the variables (either measured or calculated) has an immediate impact to the model and provides a calculated change in the virtual model.

Example, the first measured value can affect the height of the body, the second measured value can affect the body understaffed, and the third variable can represent the colour of the body.

Bodies can be distributed in the virtual space according to the actual distances by maps, but can also be efficiently distributed for easier and clearer view for the operator. To view this type of VR we have available basic geometric objects (cube, cylinder, cone and sphere). We can create a representation of the different variables and states by their mutual combinations. In our case, it is possible to use a cone, where the average size of the base will be equal to the heat transfer fluid flow. The height of the cone will show a temperature difference between input and output media. The colour will show if the size of the heat supplied is expected compared to original planned expectation. The various geometric shapes are put in the base map according to the location of heat exchangers, in the place where they are showed measured values. Of course, we can use different geometric shapes, we can arbitrarily determine when the measured or calculated value will be displayed in the scene, according to the interest and needs of staff.

Another possibility to display measured values is the virtualization of the landscape, where the surface corresponds to the measured ripple. [2]

3.3 Modelling by using of application T-sit and VR

The application T-Sit can be use for modelling of a simplified heat distribution by heat network. Only modelled part of the network is a steam network, this network collecting condensate is considered as a separate collection network with its own resources. Basic network nodes (important places of sampling) and subdivision of the pipes perform simplification. To solve such a network we need to know the pressure and temperature for each node, for each subdivision the hydraulic resistance or the flow or heat in case of heat loss. In the view of all these values, the model can be quite confusing because of a large number of variables displayed. [2]

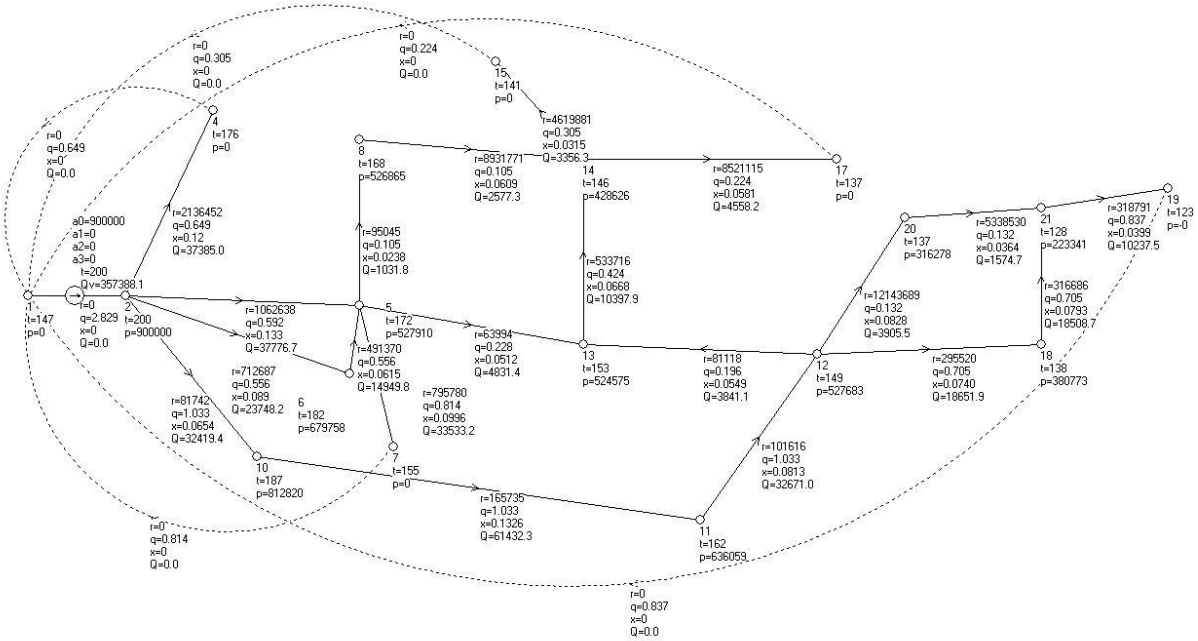

Fig.7 *Modeling in the application T-Sit*

This is why we can use the virtual reality models for viewing these environments. For example, we can display the map with heat network, where the diameter of each subdivision will represent the flow in this subdivision. So even less consecrated users will immediately see how large flows between the nodes are. [5]

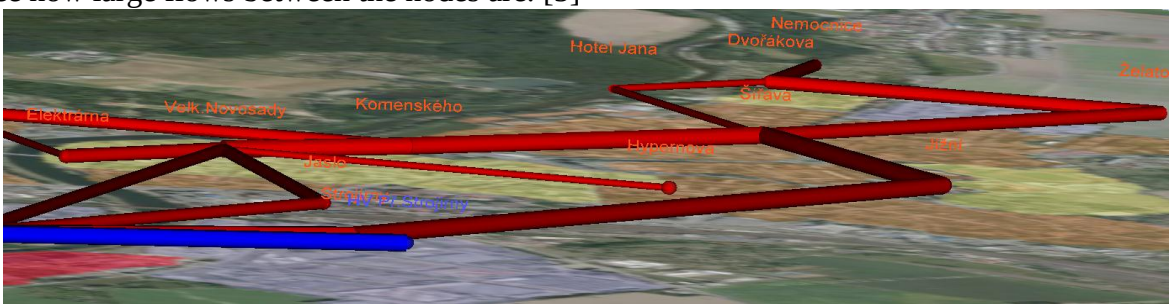

Fig.8 *Visualization using virtual reality*

Furthermore, each node can be represented as a "hill," where the volume of the hill can represent the heat output and the high of the hill represents the thermal gradient. Another possibility is to define the colours according to the temperature at the site. [5]

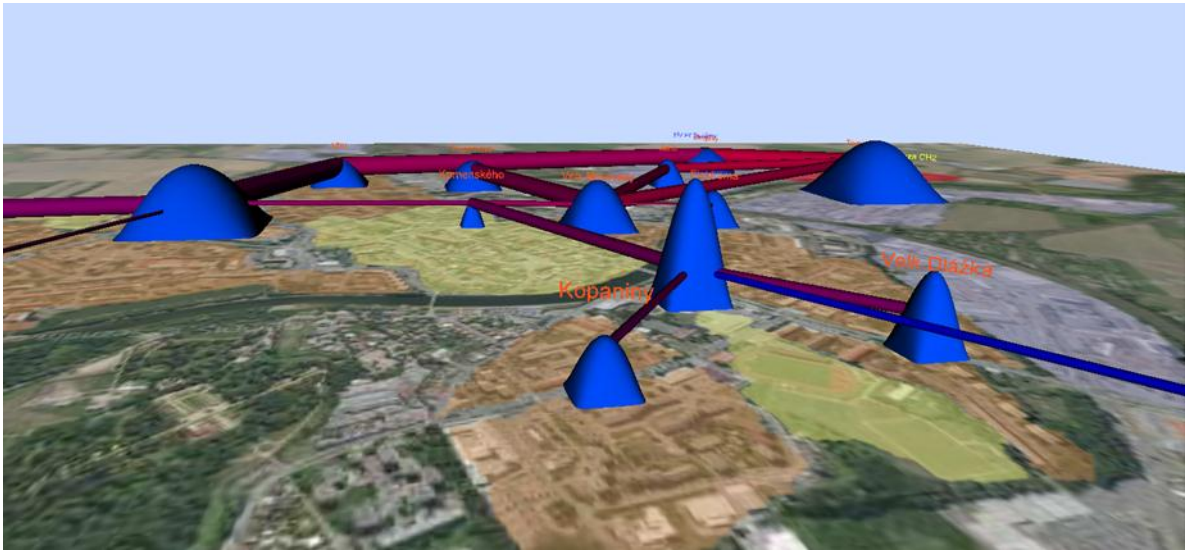

Fig.9 *Visualization of heat consumption using virtual reality*

The model offers the possibility of parameter changes in a time "such as heat power displays", in this situation the scene changes dynamically according to the recorded values.

6 CONCLUSIONS

Logistics and its processes, technologies and logistics methods are independent of the production technology and they are applicable to many others disciplines. These are many activities related to transportation, storage, distribution, and integration and streamlining. For effective managing with the large number of input variables, the possibility of many failures and a large set of criteria influencing the outcome, it is very difficult to find the exact solutions. One of the possibilities is to use the simulation and the visualization resources. In this area, we cannot resolve the problems without analysing them by the computer systems.

The large computing power can offer several solutions for different variants based on the calculation of input values. User - the operator must decide which option he will choose or his key decision. Decision-making can be in the use of virtual reality, in which some parts can be "viewed and perceived" better than when we use the standard computer technology, more easier and more efficient.

References

[1] Boyko, M.: Aplikace prostředků virtuální reality v logistice. (2007) Přerov, Bachelor Thessis, VŠLG Přerov, 52 p.
[2] Kavka, L.: Logistický proces ve virtuální realitě. (2009) Ostrava, Doctoral Thesis Sumary, VŠB-TU Ostrava, 38 p.
[3] Kolomazník, I.: Program T-Sit. [Online] [Cit. 2011-062-0] <http://homen.vsb.cz/~kol70/graf_sit/stranka_6%5Cstranka_6.htm>
[4] Malindžák, D. and kolektív: Modelovanie a simulácia v logistike /teória modelovania a simulácia/.(2009) Košice, TU Košice, 182 p. 978-80-553-0265-2.
[5] Strakoš, V.: Inženýrské sítě. (2007) Přerov,Teaching Text, VŠLG Přerov. 106 p.