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OPTIONS FOR THE INTEGRATION OF TRANSPORT IN THE SLOVAK REPUBLIC

MOŽNOSTI INTEGRÁCIE DOPRAVY V SLOVENSKEJ REPUBLIKE

Ing. Edina Jenčová, PhD.[1]

Faculty of Aeronautics, Department of Air Transport Management
Technical University of Košice
e-mail: edina.jencova@tuke.sk

Ing. Juraj Vagner, PhD.[2]

Faculty of Aeronautics, Department of Flight Training
Technical University of Košice
e-mail: juraj.vagner@tuke.sk

Ing. Peter Koščák, PhD.[3]

Faculty of Aeronautics, Department of Air Transport Management
Technical University of Košice
e-mail: peter.koscak@tuke.sk

Ing. Žaneta Miženková[4]

Faculty of Aeronautics, Department of Flight Training
Technical University of Košice
e-mail: zaneta.mizenkova@tuke.sk

Abstract

The aim of the contribution is to discuss options for the integration of transport in the Slovak republic. Experiences from abroad suggest a potential for improving the quality of transport services in regions of Slovakia and thereby improving the attractiveness of public transportation through the creation of integrated systems of transportation. The paper deal with the integrated transport systems in general, explains their historical development and conditions for their establishment. It defines the basic pillars of integration and highlights the problem of funding of integrated transport systems and the absence of the Public Transport Act in the Slovak Republic, which would establish rules for public transport and the service of the territory. The conclusion consists of an analysis of regional transport in the Košice Region.

Abstrakt

Cieľom príspevku je pojednať o možnostiach integrácie dopravy v Slovenskej republike. Skúsenosti zo zahraničia poukazujú na možnosť skvalitnenia dopravnej obsluhy regiónov na Slovensku, a tým aj zatraktívnenia verejnej hromadnej dopravy prostredníctvom vytvárania integrovaných dopravných systémov. Príspevok pojednáva o integrovaných dopravných

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[1] Assistant Professor
[2] Assistant Professor
[3] Assistant Professor
[4] Internal PhD. student

systémoch všeobecne, objasňuje ich historický vývoj a predpoklady vzniku. Definuje základné piliere integrácie a poukazuje na problém financovania integrovaných dopravných systémov a na absenciu zákona o verejnej doprave v Slovenskej republike, ktorý by stanovil pravidlá pre verejnú dopravu a obslužnosť územia. V závere je uvedená analýza regionálnej dopravy v Košickom samosprávnom kraji.

Key words

transport, integrated transport system, pillars of integration, options for integration

Klíčová slova

doprava, integrovaný dopravný systém, piliere integrácie, možnosti integrácie

INTRODUCTION

Steadily increasing share of individual motorized transport at the expense of public transport (PT) has a negative impact on the environment, which is accompanied by an increase in number of congestions, increased number of accidents, environmental problems (emissions, noise, vibrations), as well as the constantly increasing demands on infrastructure quality.

Experiences from abroad suggest a potential for improving the quality of transport services in regions of Slovakia and thereby improving the attractiveness of PT through the creation of integrated systems of transportation. The advantage of this method of transport services is that the population of the region and the state has access to better PT.

1 INTEGRATED TRANSPORT SYSTEMS

Integrated Transport System (ITS) is a way of ensuring transport services of the area by integrating all modes of transportation, including individual forms, all public carriers operating in the region, which are characterized by optimizing the transportation supply, interconnection of lines of transport modes, coordinating timetables of individual carriers and minimizing time losses related with changing the transport modes.

For the passenger, traveling within the ITS becomes simple, with the possibility of season pass cheaper and above all more comfortable compared to the current form. ITS features a single information system for all modes and carriers, unified tariff system and unified transport conditions throughout the system. [1]

1.1 Historical background, objectives and organization of integrated transport systems

Opportunity to address transport service based on the integrated transport system (in Slovakia too) emerged in the early nineties of the last century. For first integrated transport system of similar type is considered one that was established in 1965 in Hamburg, Germany.

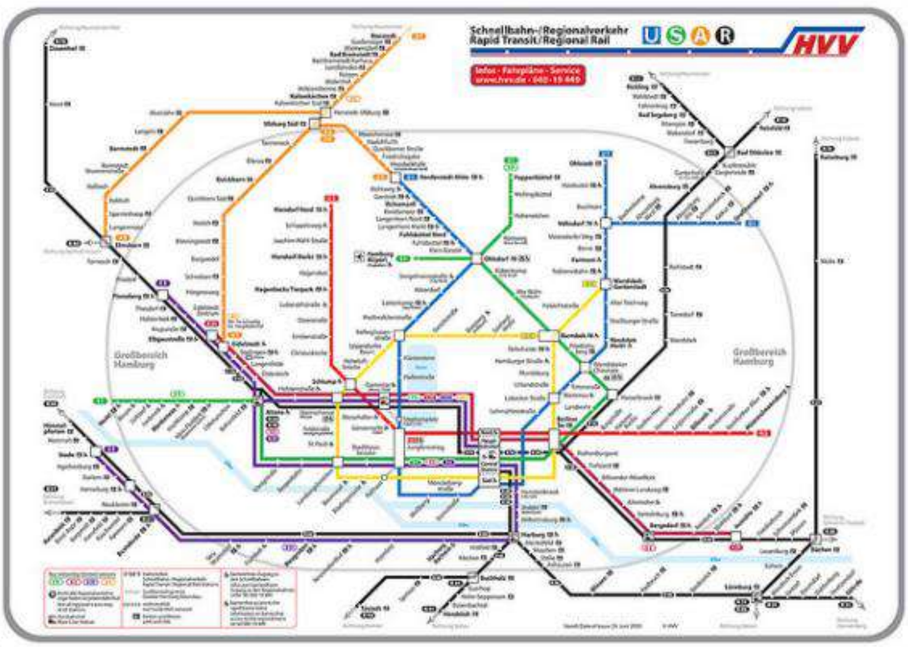

Fig. 1 Map of the integrated transport system in Hamburg, Germany
Source: (https://www.flickr.com/photos/rllayman/18162935352)

Another was established in 1972 in Munich on the occasion of launching the backbone line of S-Bahn. Initially, the organizing companies were the community of carriers. Around 1996 there was a reorganization of public transport and the organizing companies have moved from the ownership by the carriers to a joint ownership by contracting authorities, i.e. cities, federal states and districts. [1]

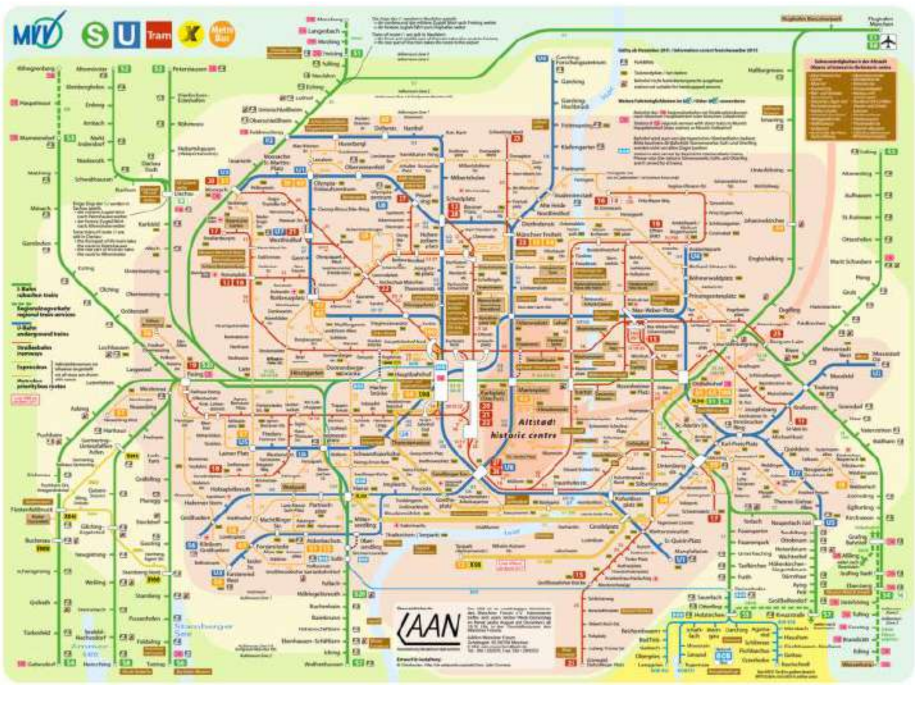

Fig. 2 Map of the integrated transport system in München, Germany
Source: (http://www.mvv-muenchen.de/)

Aim of the ITS is to optimize the transport process, which in practice means the use of a single pass or ticket during the journey, regardless of the operator and mutual spatial and temporal coordination of transport means of transport modes involved in ITS. Generally, this means ensuring the availability of destinations as efficiently as possible.

The organizational structure of integrated transport systems should meet the requirements and needs of passengers. To optimize operational costs, it is important to coordinate all modes and carriers in ITS. It means to map the spatial needs of the conurbation, optimize the network of ITS and ensure that it is operated by reliable carriers.

At the same time there is need for coordination of schedules so individual lines follow each other and meet needs of as many customers (passengers) as possible. Of particular importance is cooperation between carriers. They can collaborate together on the basis of tariff community transport community or the transport association. [1]

1.2 Basic pillars of integration

The basic pillars of traffic integration are:

a) *Territorial integration*.

Initially it was the unification of urban and suburban transport, later, the involvement of the local transport occurred. Finally, there was a unification of the entire territory, regardless of the nature of the settlement or state-legal organization.

b) *Tariff integration.*

It creates a single tariff between carriers, which must be accepted by all carriers. They must accept these tariffs, but in addition the carrier may also use its own tariff. Both tariffs must be valid on the territory of ITS.

c) *Operational integration.*

The basic principle is to coordinate transport offer since there are multiple carriers involved in ITS. It is set up by a responsible entity, which may be either one of the carriers or the coordinator, in order to set clear rules for serviceability. A unified planning system must operate in the entire ITS, so the carriers do not compete, but rather work together.

It is necessary to create a transparent system of codes for lines by means of transport, area or the type of line. Coding of lines is fundamentally not made by carriers. The coding will use different numerical sequences, letters and the like. [3]

1.3 Financing of integrated transport systems

In public transport, as with the organizational structure, financial flows are simple and clear, unlike ITS, where everything is more complicated.

In the integrated transport system there are three financial flows that need to be redistributed:

- The division of revenues – with single tariff, revenues from sales and revenues of selected carriers are uneven.
- Liquidation of loss by contracting authorities.
- Liquidation of loss for the carriers.

For the redistribution itself, several methods are used.

In general, various methods are suitable for various flows. These methods can be combined, but it is not appropriate to combine several methods in a single redistribution of package.

For example, the subsidies can be redistributed according to the population, according to offered transport performance, according to the results of research and other transport. [3]

2 OPTIONS FOR THE INTEGRATION OF TRANSPORT IN THE SLOVAK REPUBLIC

In Slovakia, there is no law on public transport, which would set rules for public transport and accessibility of the territory, and thus does not and cannot operate any integrated transport system.

At present, public sources fund more traffic systems simultaneously in many areas. ITS could save the state budget nearly a third of spending on transport and savings could possibly be used for additional subsidies of public transport, as in Slovakia there are still municipalities where no bus or train is available.

The law on public transport would clearly set the parameters of overlapping lines. Rail transport would be the main system. Bus services would provide mainly the transfer of passengers from rail stops to final destinations and vice versa. Such a system is a prerequisite in order to create real integrated transport systems.

The law should also stipulate, however, other key rule that the purchaser of public transportation in Slovakia would be only one entity.Currently, the transportation is ordered by government, autonomous regions and municipalities. The question is whether it would be a single purchaser for the whole of Slovakia, or each of the eight regional units would order transport for its own territory. The Manifesto of the Government in section 2.3 Transport, Regional Development and Tourism, the Government undertook to promote public passenger transport (the "PPT") and create conditions for the expansion of integrated transport systems (hereinafter referred to as "ITS") in the largest cities of Slovak Republic. The purpose of this document is to define the conditions for the deployment of ITS in the largest cities of Slovakia. The document builds on the material "Development of public transport before individual transport" approved by the Government Resolution no. 675 of 1 October 2008, in which the Government of the Slovak Republic for the area of passenger transport undertakes to support the development of public transport to individual automobile transport.Text is divided into paragraphs. [2]

The main objectives in the document approved by the Government Resolution no. 675/2008 are:

• more attractive public transport as a mean of personal mobility in cities and regions, for it to be an alternative to individual automobile transport.

• create external conditions for increasing the competitiveness of public transport to individual automobile transport.

Measures to increase the share of public transport must focus primarily on improving basic parameters affecting passenger in the choosing the means of transport (PT or IAT), which are:

- temporal and spatial availability,
- awareness,

- comfort,
- quality,
- range of additional services,
- the costs of realization of the transportation process (cost to the user).

3 ANALYSIS OF REGIONAL TRANSPORT IN THE KOŠICE REGION

Strengths

- Self-functioning public transport (suburban bus transport, rail transport and urban transport) with all suburban and urban bus operators mutually accepting each other smart cards - make the basic prerequisite for the establishment of an integrated transport system.
- The developed system of public transport in terms of area coverage - particularly dense network of lines of regular bus service adequately covers the entire territory of the region and ensures basic transport services to the extent necessary for travel to school and work.
- A sufficient supply of transport - especially the suburban bus transport is aiming to maintain long-term performance of suburban bus services stable.
- The effort to create an integrated transport system, which is given by the requirement to manage the amount of transport demands, increasing demands on the quality of public transport and efficient use of public resources. [4]

Weaknesses

- Lack of coordination of transport systems - transport systems are only coordinated in the field of coordination of suburban bus transport and rail transport timetables, but without any tariff integration between different transport systems (in urban bus transport, leap traveling with the smart card is possible).
- Less attractive rail transport compared with the suburban bus transport - rail transport is convenient only for some passengers that are provided with direct connections (that fact is most obvious on the line Košice - Prešov).
- The steady decrease in passengers carried by public transport - a significant influence on a higher demands for public resources (Košice Region paid up to 17.1% of its budget to secure the suburban bus transport in 2011 - in 2007 it was 13.1% of budget).
- Fragmentation of the management of various public transport systems - lack of central control room to manage the various transport systems as a whole. [4]

Opportunities

- To increase the efficiency of public transport and financing of services in the public transport.
- To create favorable conditions for increasing the competitiveness of public transport to individual transport.
- To modernize the infrastructure using EU funds.
- Better use of railways in regional transport.
- The possibility to establish ITS for conurbation Košice, Prešov.
- The possibility to raise capacity of railway track in the section Prešov - Kysak. [4]

Threats

- Fragmentation of ordering and financing of public transport.
- The lack of legislation concerning the organizer of an integrated transport system.
- Concerns of the participants according the system changes.
- The current weak preference of public transport. [4]

CONCLUSION

The geographical location of the Slovak Republic predetermines and highlights the importance of transit traffic in the west - east and north – south directions. Intermodal transport in Slovakia has very good conditions in the system of road - rail - water, because SR has developed railway and road networks in its transport infrastructure that can be connected to the waterway.

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3D PRINTING IN LOGISTICS

3D TISK V LOGISTICE

Ing. Lukáš Kubáč[5]

Vysoká škola báňská – Technical University of Ostrava
e-mail: lukas.kubac@vsb.cz

Abstract

In recent years 3D printing technology is developing rapidly. In the near future, when 3D printing will be widely used, the world's industrial structure will be greatly changed. As 3D printing becomes more integrated in manufacturing, it is easy to conclude that logistics should be influenced as well. 3D printing could bring massive changes to manufacturing processes and logistics functions, such as: global logistics, inventory levels, fulfilment process, stock location, transportation routes or consumer relationships. This article will briefly describe the technology of 3D printing, application possibilities in logistics and its impact on the Supply Chain.

Abstrakt

V posledních letech se technologie 3D tisku rychle rozvíjí. V blízké budoucnosti, kdy bude 3D tisk široce využíván, se struktura světového průmyslu výrazně změní. Jak se 3D tisk integruje ve zpracovatelském průmyslu, je snadné dospět k závěru, že logistika by měla být také ovlivněna. 3D tisk může přinést obrovské změny výrobních procesů a logistických funkcí, jako například: globální logistika, úroveň zásob, proces plnění, umístění skladů, dopravní trasy nebo spotřebitelské vztahy. Tento článek stručně popíše technologii 3D tisku, jeho aplikační možnosti v logistice a dopad na dodavatelský řetězec.

Key words

3D printing, additive manufacturing, supply chain

Klíčová slova

3D tisk, aditivní výroba, dodavatelský řetězec

INTRODUCTION

From engineering to automotive to healthcare, companies are recognizing that 3D printing presents an opportunity to "do things differently". It allows us to profoundly rethink the way we create and manufacture products, as well as fundamentally reassess the design of supply chains.

3D printing have potential for revolutionize manufacturing, enabling companies to produce almost anything, layer by layer within the boundaries of a single 3D printer. 3D print technology makes it possible to create nearly any geometric form with the help of design software – incorporating hollow spaces and filigree honeycomb structures, for example, that are much lighter than traditionally manufactured components, but offer the same stability.

Manufacturers from all industry sectors are exploring which items they may be able to produce using 3D print technology, and logistics service providers are launching pilot projects

[5] External PhD. student

to identify the need, potential and options for adjusting their business models to include 3D print services. Increasing number of companies beginning to realize, on the one hand, the possibility for new 3D printing business models and services and, on the other hand, the major economic advantages of 3D printing compared to conventional manufacturing techniques.

1 WHAT IS 3D PRINTING

3D printing, technically known as additive manufacturing (AM). 3D printing is an additive technology used for making three dimensional solid objects up in layers from a digital file without the need for a mould or cutting tool. 3D objects are created by a highly specialized printer, which prints successive layers of a material from the bottom upward in a continuous fashion. In essence, each layer is a cross section of the finished product.

Three basic ingredients are essential for creation of an 3D object [1]:

1. **A digital model** – this is the digital design information needed to print an object. Digital models can be created from scratch using design programs such as CAD (Computer Aided Design) or by using a scanner to capture a 3D virtual image of an existing object. Slicing software automatically transforms virtual model into hundreds or thousands of horizontal layers, depending on the size and structure of the object (fig. 1).
2. **Feed material** – this is the material that is used to ultimately manufacture the final object. Materials are joined in successive layers one on top of the other through additive processes under automated computer control.
3. **A 3D printer** – this is the hardware used to create the solid object out of the digital model and feed material. 3D printers come in various forms utilizing different additive techniques to produce the object. Selection depends on whether the application is for consumer or enterprise purposes.

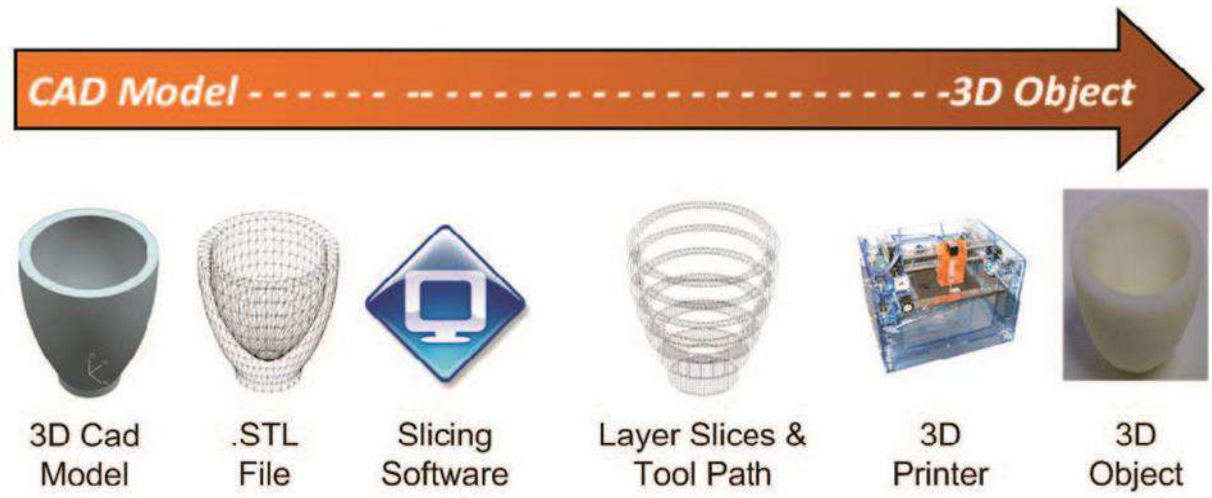

Fig. 1 Generalized additive manufacturing proces
Source: Campbell T, Williams C [2]

The 3D object is printed, not with ink, but with a wide variety of materials. Material is added layer by layer instead of molding or cutting or bending materials. In recent years 3D printing technology continued developing, especially the breakthroughs in the material application.

More than one hundred of raw materials can be used for 3D printing. Some of the most common materials used include plastics, glass, metal, polymers, wax, sand and glue mixes, nylon, ceramic, edible material, and even human tissue. The expansion of the material type will promote the application of this technology in more productive areas. Nowadays this technology could be used to produce spare parts, singular parts, bioconstructs, micromachines, electronics, and even jewelry. [3, 4]

Additve technologies

The term "3D printing" covers a range of additive technologies that apply different approaches. Today there are to choose over ten different 3D printing technologies. But mainly three technologies are used. These are selective laser sintering, fused deposition modeling, and stereolithography (fig. 2).

- **Stereolithography (SLA)** uses a moving laser beam to build up the object, layer by layer, from a liquid polymer that hardens on contact with the laser's light. SLA is well established for rapid prototyping applications.
- **Selective laser sintering (SLS)** uses lasers to melt powdered feed material into the desired object. It is most established in professional and industrial contexts as it also allows the printing of metal-based materials.
- **Fused deposition modeling (FDM)** is the most widely adopted and user-friendly 3D printing technology and the one that's most familiar to consumers. FDM printers use hardened feed material (usually plastic on a coil) which is then fed into the printer and melted layer by layer to produce the final object.

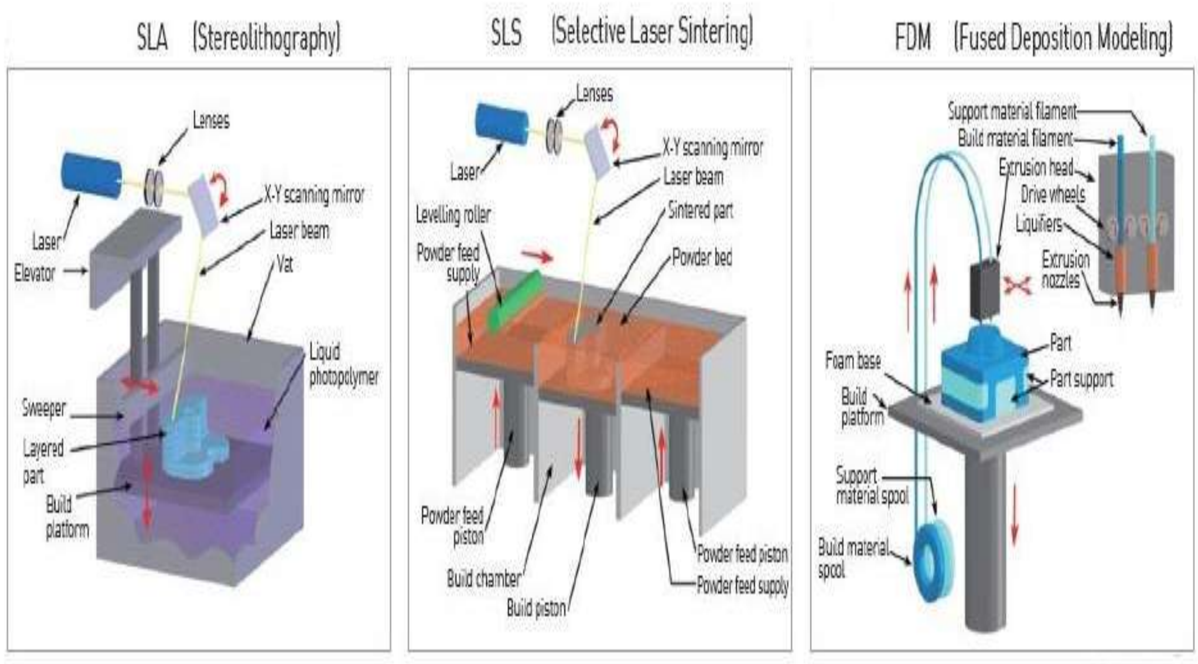

Fig. 2 Additive technologies SLA, SLS, FDM
Source: Web MOLD [5]

2 IMPLICATIONS FOR SUPPLY CHAINS

With traditional manufacturing, materials are usually sourced and shipped from several locations to centralized factories that develop and assemble the final product. The finished goods then pass through several steps in the supply chain, usually being stored in warehouses before delivery to stores or directly to the end-customer once an order has been placed.

3D printing, in contrast, can greatly reduce complexity in manufacturing and holds a number of additional advantages over conventional production techniques.

Key advantages of 3D printing:

- Lower number of production steps to design, prototype and manufacture highly complex and/or customized products
- Faster delivery time through on-demand and decentralized production strategies
- Lower logistics and production costs (e.g., reduced shipping and storage costs, potential elimination of import/export costs through localized production, elimination of new production tools and molds and costly modifications to factories)
- Higher sustainability and efficiency in production through using the least amount of material and energy in production

A major benefit of 3D printing is the ability to produce a variety of products from a single 3D printer. This reduces the number of steps in the production chain, essentially enabling companies to leverage on-demand and decentralized production concepts. As a result, potentially significant economic savings can be made on logistics and production costs. It is relatively clear that 3D printing will not be used to mass produce anything and everything. The greatest potential of 3D printing technology’s lies in its capability to simplify the production of highly complex and customizable products and parts.

Spare parts on demand

At present, hundreds of millions of spare parts are kept in storage all across the world to service products. Although most spare parts warehouses have a high proportion of fast-moving items, many items will rarely be used and some may never actually be needed. Not only is it costly for companies to store this unused stock but it also builds inefficiency into the supply chain, as excess inventory is being produced with no guarantee that all parts will ever come into use.

Thanks to 3D printing, companies may no longer need to store spare parts physically in a warehouse. Instead, they can print these parts on demand, where required, and rapidly deliver these items to the customer. In order to achieve coverage and efficiency in lead-time reduction, logistics providers could support companies in creating a dense network of 3D printers to instantly print and deliver spare parts on demand.

The virtual print files of spare parts would be securely stored in software databases that essentially act as a “virtual warehouse”. One organization that has already developed and implemented this type of virtual warehouse concept is Kazzata. The company aims to provide an online marketplace for spare parts, effectively establishing a CAD repository for obsolete and rare parts. [6] When a part is required, users can simply search for the right part and send the file to the nearest 3D printer.

Each logistics provider can achieve economies of scale by building up an owned network of shared 3D printers located in warehouses and distribution centres around the world. In the same way as many companies today provision spare parts to a third-party logistics provider, in future companies will be able to entrust their logistics provider to efficiently process, print, and deliver spare parts orders in a fast, low-cost manner.

3D print shops for businesses and consumers

Businesses and consumers can also use future networks of 3D print shops for a variety of applications. In the consumer context, one application could be for companies to retrofit their many service points or retail points with a 3D printing infrastructure. In essence, this would allow them to offer local communities access to state-of-the-art 3D printing services. The root of this concept is not new; it would work in a similar way to how consumers currently print paper documents by taking a file on a USB drive to their local copy shop or print photos at a photo kiosk in stores. Looking into the future, these 3D print shops could eventually integrate not just 3D printers but also design tools and scanners, as well as a wide selection of materials.

3D print shops like this could also be used by companies to rapidly prototype new products without having to invest in and maintain the latest 3D-printing infrastructure. These facilities could also serve local businesses such as architects and small design studios that need to produce 3D models, as well as craftspeople creating tailor-made items for their customers. Personnel working inside 3D print shops will be trained to offer varying levels of support to match each customer's 3D printing skillset. And because the printing process itself can take some time, the 3D print shop could also offer a delivery service to its customers. To enable a 3D print shop, key success factors will be the ability to provide a range of printing materials and low operating costs. Generalized processes in traditional and 3D printing supply chain see Fig. 3.

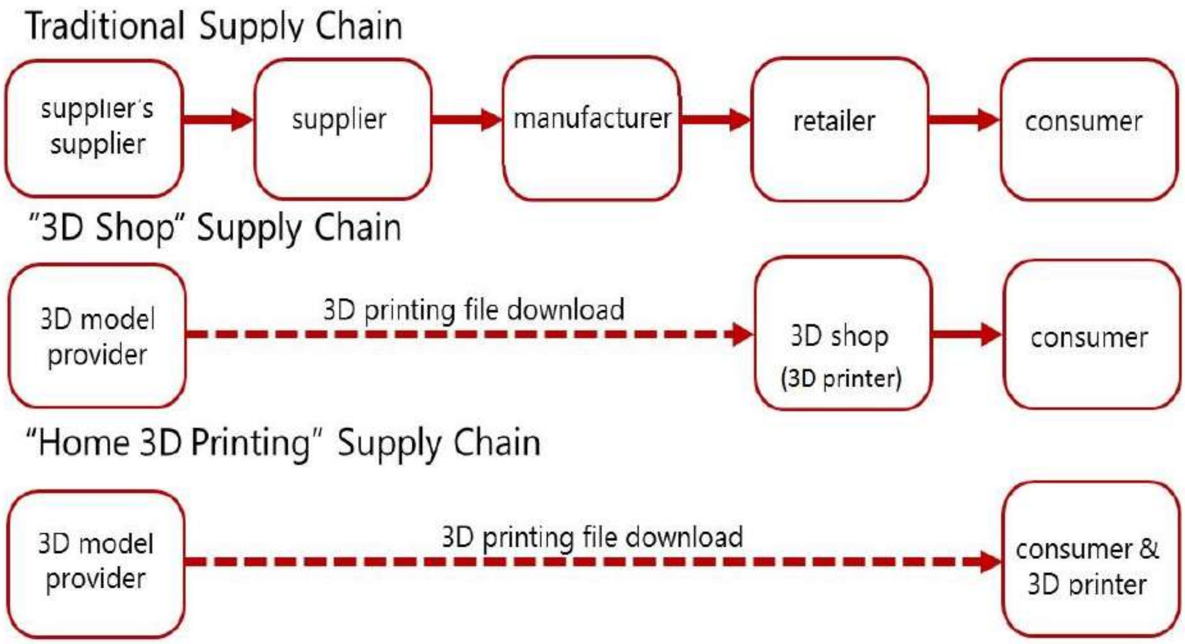

Fig. 3 Supply chain winth 3D print shop
Source: A. Wieland, [7]

Individualized direct parts manufacturing

There are many exciting examples of companies in aviation, automotive, healthcare, and other industries using 3D printing to produce individualized parts.

When customers require high levels of customization, 3D printing can represent a source of competitive advantage for the organization; companies are incentivized to create tailored parts that can be delivered quickly to the point of use.

One of the future vision is the idea of manufacturing individualized parts not in a stationary location such as a warehouse but in a moving vehicle. This can additionally reduce delivery lead times. Amazon, for example, has filed a patent for a truck fitted with 3D printers, with the intention of manufacturing products on the way to a customer destination. At scale, this could enable companies to produce parts very close to demand and thereby drastically reduce the lead time of individualized parts delivery to customers. [8]

3 POTENCIAL IMPLICATIONS AND CHALLENGES

The following summary highlights some of the key potential implications of 3D printing for logistics and transportation (in no particular order of priority or significance). [9]

- A shift to more localized production, resulting in more on-demand manufacturing and smaller inventories.
- Supply chains and distribution networks for certain types of goods will disrupt both national and international trade.
- Transportation providers will need to become more flexible and agile to adapt to changes in logistics and the supply chain.
- Capital projects and investments in transportation facilities may need to be re-prioritized to reflect shifting changes in logistics and the supply chain (i.e. less emphasis on ports).
- Centralized manufacturing in Asia and Latin America will shift toward smaller hubs near end users.
- More products will be manufactured in customers country, reducing long-distance distribution and a likely decline in the cargo industry.
- Truck traffic patterns may shift toward smaller vehicles, with an emphasis on regional or local deliveries, and lesser long-hauls.
- Lower costs and less difficulty of procuring hard-to-find parts and supplies for transportation providers and fleets.
- Deliveries of finished goods may decline, while shipments of raw materials might rise. This could mean reduced infrastructure requirements, as some products currently manufactured overseas shift to domestic production.
- Wear and tear impacts on transportation infrastructure could be reduced, but may be partially offset by more local deliveries with smaller vehicles.
- The service part industry will be replaced in part by portable 3D machines and operators.
- Third party logistics providers will be impacted by growing numbers of businesses printing on demand.
- Portions of the retail sector will become only store fronts with no inventory, or will cease to operate.
- Continued growth in companies specializing in 3D printing service providers.
- New safety standards and industry regulation likely to be instituted.

Following are the key areas in supply chain and logistics likely to be impacted by 3D printing technology:

- **Rationalization of inventory and logistics:** Logistics will adjust to print on demand, eliminating the need to carry inventory
- **Resource efficiency:** Material saving during production and ability to utilize recycled materials
- **Customer demand will be met more quickly:** Reduction in manufacturing lead time and strategic near-shore manufacturing facility
- **Customization:** Tailoring individualized offers to each customer, involvement of client in design, and providing ability to test prototypes
- **Global Logistics:** Reduction in cost of international logistics by reducing overseas manufacturing thus decreasing quantity of air and ocean freight and brokerage cost

The supply chain traditional model is founded on traditional constraints of the industry, efficiencies of mass production, the need for low cost, high-volume assembly workers, and so on. But 3D printing bypasses those constraints. From that point of view, the traditional model stops making sense. It is no longer financially efficient to send products zipping across the globe when manufacturing can be done almost anywhere at the same cost or lower.

However, disruptive technologies come with challenges. Following are challenges for 3D printing:

- **IP Issues –** Authors of digital design templates could be targeted by hackers and incur copyright infringement.
- **Security Concerns –** For example, when printing harmful objects such as a knife, gun etc., which party would be held responsible?
- **Liability –** For example, who is to blame if a 3D product fails: the company printing and selling it, the material supplier, the printing machine manufacturer, or the designer?
- **Mass Production –** It cannot compete with the speed of traditional manufacturing process.

CONCLUSION

Of course, not all products and parts can and will be 3D printed. Therefore it will be essential to understand early on where 3D printing will be advantageous to manufacturing and supply chain strategies.

3D printing is likely to complement rather than entirely substitute traditional manufacturing techniques. Simply put, not all products can and should be 3D printed. However, 3D printing is likely to substitute traditional manufacturing in industry segments that produce highly complex and customized goods. This is, in fact, already happening in aviation, automotive, and medical and healthcare applications. To achieve wider application and adoption, companies must collaborate and innovate in order to overcome 3D printing's remaining challenges – such as speed of production, cost, and limited materiál inputs.

In logistics, 3D printing will play a much more prominent role in the areas of spare parts logistics and individualized parts manufacturing. As manufacturers adapt their production processes and supply chains, this will open new opportunities and will also challenge logistics providers to find new customer solutions.

To understand the full implications of 3D printing in a company's supply chain, it is necessary to consider each company's operating environment, manufacturing capability, customer needs, and product portfolio.

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AUGMENTED REALITY APPLICATION POTENTIAL IN LOGISTICS

APLIKAČNÍ POTENCIÁL ROZŠÍŘENÉ REALITY V LOGISTICE

Bc. Filip Snížek[6]

Master student of Logistics
College of Logistics
e-mail: SnizFi@vslg.cz

doc. Dr. Ing. Oldřich Kodym

Department of Master Studies
College of Logistics
e-mail: oldrich.kodym@vslg.cz

Abstract

The aim of this article is to introduce augmented reality and outline its potential use in logistics processes. Utilizing available modern technology, the authors try to find a suitable solution for communication and data display in the environment of Industry4.0. They also investigate the influence of modern technology on people as its users. The article is based on a bachelor thesis successfully defended at the College of Logistics in Přerov in 2016 [1].

Abstrakt

Cílem tohoto článku je seznámit čtenáře s rozšířenou realitou, a následně poukázat na možnosti jejího využití v logistických procesech. Na základě dostupných moderních technologií se pokusíme nalézt vhodné řešení pro komunikaci a zobrazování dat v podmínkách Průmyslu4.0. Posléze se budeme věnovat člověku, jako uživateli, který je pod vlivem moderních technologii. Téma bylo zpracováno jako bakalářská práce na VŠLG v roce 2016 [1].

Key words

Logistics, augmented reality, picking, smart glasses, wearable electronics

Klíčová slova

Logistika, rozšířená realita, vychystávání, chytré brýle, nositelná elektronika

INTRODUCTION

The term reality comes from the Latin realitas which is derived from the term designating a thing. It is related to other concepts like world, factuality, and existence. In everyday life, reality refers to everything that exists, without distinction whether it is a human creation or not. Reality can also be understood as a real situation contrasting with our expectations. Philosophy distinguishes independent, objective reality which exists outside an individual person, and subjective reality which is created by the consciousness of an individual person [2].

Many people do not realize the difference between the concepts of virtual reality (VR) and augmented reality (AR). In fact, each of them offers a completely different perception of the environment. Reality as such is perceived through our senses which play the key role in

[6] Promoted Bachelor in the branch of Information management

providing the perceptual experience to us. Virtual reality creates an environment completely different from the environment in which we are physically present. When a person uses a tool for virtual reality, the senses stop perceiving the current physical environment and start to concentrate on the perception of virtual reality. An integral part of VR is interactivity, i.e. VR must provide communication in both directions. The environment in which the person is located must respond to the stimuli.

Augmented reality is in between reality and virtual reality. The aim of AR is not to transfer a person to another place or world, but to modify the environment in which the person is currently located. The first experiments with AR worked with a video camera capturing an environment which included an element used as a starting point for generating additional elements of AR. The image can be viewed on a computer, and with the advancement of mobile computing devices, it can be implemented e.g. in smartphones. The starting point is often a marker which is an area with a black square on a white background. The camera image of the marker is used to determine at what angle the marker is located and to display a virtual object at its place. This allows integrating virtual elements, both static and dynamic, into our environment. For the purposes described in this article it is sufficient to detect and track edges in the current environment. The most convenient tools for perceiving both AR and VR are glasses or goggles with lenses and screens or transparent displays.

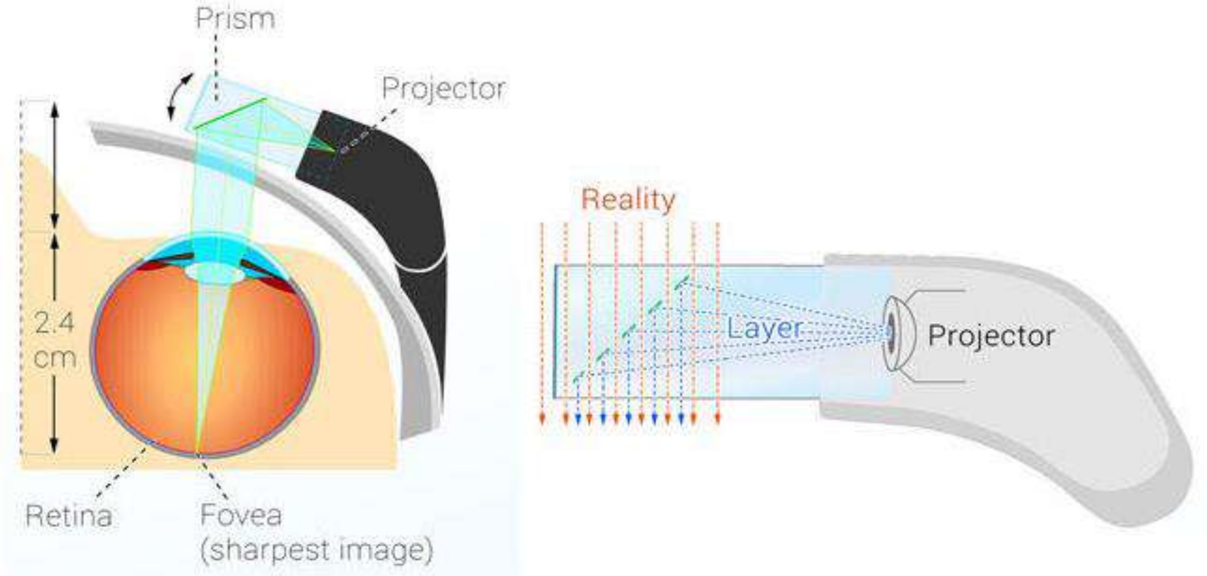

Fig. 1 The principle of glasses for augmented reality

Source: http://cdn04.androidauthority.net/wp-content/uploads/
2013/04/Google-Glass-Projector-Display.jpg

Glasses for AR are usually equipped with a small projector which creates an image on a semitransparent mirror or other suitable material. This image combines with the real-world image coming simultaneously through the glasses from the other side as shown in Figure 1. The combination of VR reflection in the mirror and the real-world image creates AR. The resulting image is projected in the eye fovea which provides the sharpest vision.

Figure 2 shows a design of glasses for AR systems which should be suitable for the use in logistics processes associated with picking.

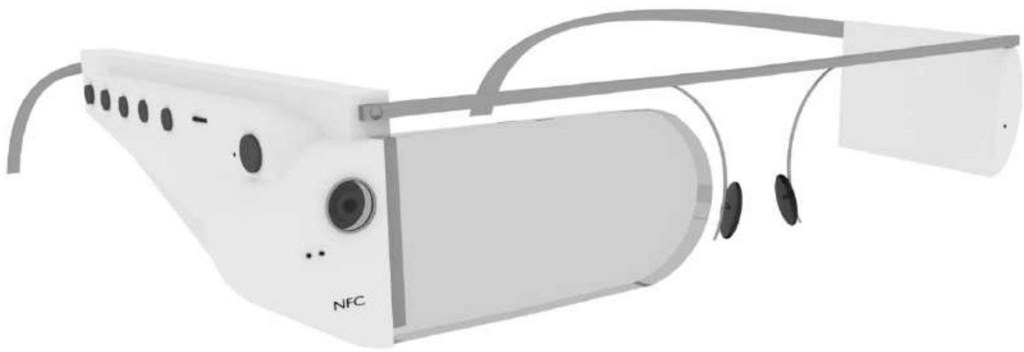

Fig. 2 Smartglasses design
Source: [1]

1 SMARTGLASSES IN LOGISTICS CHAINS

The creation of logistics chains, particularly the coordination and optimization of material flows, is connected with a number of activities related to transporting, packaging, material handling, warehousing, customer service, inventory management, and information systems. All these logistics activities are part of a logistics system [3]. Each of the individual subsystems of the logistics system represents an independent economic activity, which has an impact on other activities. Moreover, in order to get a product to the right place under optimum conditions, additional aspects affecting the logistics system must be considered [3].

There are three basic types of storage: production, circulation, and consumption storage. Processes associated with these types of storage are almost identical, but their functions differ. The main processes include the receipt, identification, put-away, and dispatch of material [3].

Logistics processes must be supported by information systems which enable communication and decision-making throughout the whole chain. Today, a suitable information system is an essential foundation which makes a company competitive [3]. The main benefits include reducing errors, improving logistics services as a whole, and centralizing data in the information system. By centralizing data and inventory in real time, the company can ensure the optimal use of its inventory and quick processing of urgent orders. In addition, a simple user environment reduces the time needed for training new employees [3].

Order picking is one of the most labor-intensive operations in logistics. It takes place in distribution centers, warehouses, wholesale organizations, but also in industry to provide the delivery of products, parts, and semi-finished products into production [4].

Picking systems can be used in palletized warehouses; in manufacturing or distribution centers with free racks, shelf systems, rack sections, or in deep freezing storage rooms; for the put-away and retrieval of goods and materials; processing of returned goods; inventory check; quality control; in special warehouse areas for handling; or in assembly stations [5].

Order picking consists of the usual sequence of sub-processes: order receipt; supplying the order picking lines with the required product ranges; handling the picked items; selecting the required quantity of items and putting them in picking containers (crates, cardboard boxes) [4].

Since these operations take a lot of time (10–30% of the order processing time) and require high degree of precision, new technologies are developed and subsequently implemented. After receiving customer orders, the system identifies places where the required items are stored in the warehouse. It is advisable to batch smaller orders together and sort them down before shipment. The items should be put directly in the packaging for shipment [4]. Order picking systems can be static in which employees move to the locations where the items are stored, or dynamic in which the items move to the picking area [4].

To increase productivity, it is necessary to accelerate transport operations, shorten transport distances, eliminate manual data recording, batch smaller orders together, and use dynamic systems, e.g. gravity flow racks in which the items move towards the employee [4].

2 THE USE OF AUGMENTED REALITY TO PICK-BY-FRAME

The basic idea is to replace all displays with glasses for AR. This will allow removing the display from the central module attached to the frame. Instead, the module can be fitted with an NFC antenna to easily pair with the glasses. After putting the glasses close to the antenna, connection will be established automatically. The glasses will also replace a barcode scanner. The design of a basic central module is depicted in Figure 3. The programmable buttons are preserved, because some activities are not always easily controlled through AR.

Fig. 3 Central panel with NFC
Source: [1]

Currently, EAN barcodes with 13 digits are used. Nevertheless, barcodes are not suitable for item identification in AR. Even a minor damage to the code results in an identification failure. It can be seen in retail shops where even a small deformation of the code leads to repeated scanning, or eventually to entering the code manually.

Newer QR codes can include redundant data which increase their tolerance to errors caused by a partial damage. Conversely, the more data the QR code contains, the more complex and more susceptible to damage its scanning is. QR codes generated with error correction level H can be read even if 30% of its area is damaged which also decreases the requirements on the camera and other hardware [6].

The employee needs to be sure about the correct location and item for picking. Therefore, it is suitable to create a control sequence with QR codes.

The sequence consists of three parts (see Figure 4), each of which makes the identification gradually more specific. Each part must be confirmed in the information system; otherwise the employee will not be able to scan the next part of the code.

The first part is the designation of the warehouse in the form WXXX where W identifies the part of the sequence for the warehouse and X is a numeral 0–9, e.g. W003 designates warehouse 3.

The second part of the sequence represents the location in the form LYXYX where L identifies the part of the sequence for the location, Y is a letter A–Z, and X is a numeral 0–9, e.g. LA1A2 designates location A1A2.

The third part of the sequence uses the EAN code of the item barcode which reduces the scope of necessary system modifications. For example, if the EAN code of the item is 901234123457, the new code will be S003LA1A2901234123457.

Once the sequence is completed, the picking of the item is finished. If there is an additional item to be picked in the same location, it will not be necessary to rescan the entire sequence. If the system identifies that one of the initial parts of the sequence has been skipped during scanning, its previous value will be applied. Thus, the speed of scanning will increase.

This solution is simple and easy to implement. Nevertheless, certain problems may arise when multiple labels with codes are beside or behind each other. This may be partially solved by setting the upper limit of the camera focus distance to approximately 5–7 meters. Labels farther than 7 meters will be blurred and therefore illegible for the QR scanner. However, the problem with side-by-side locations of the labels with QR codes remains. If the employee spends too much time on the correct head positioning, the efficiency of the system will decrease. One solution may be to limit the field of view of the camera. In Figure 4, three QR codes are placed beside each other. When all of them are in the field of view, the limitation is difficult. In this case it is better to scan all three and subsequently highlight the desired one.

Fig. 4 Sequence of QR codes

Source: [1]

The picking process will be smoother and there will be no need for external handheld devices. The employee's hands will be free for handling the items themselves.

3 AUGMENTED REALITY ENVIRONMENT

For the whole workday, employees will wear glasses which combine the environment in which they are physically present with virtual reality. This environment should therefore be user friendly and easy to control.

The displayed information includes communication status, battery status, job status, job location, job destination, time, and picking notifications.

For controlling, majority of the latest technologies use hand movement in space. Nevertheless, this solution requires the implementation of an additional device into the glasses which would also increase energy consumption. The design of the glasses presented in this article utilize audio input and output for controlling, because voice interaction is the most natural way of communication.

The login screen requires no command. The employee simply logs in with his or her ID card with a built-in NFC tag. After successful login, the menu shown in Figure 5 opens. Here, the following commands are available: open job, employee profile, logout, settings, hide, show.

Fig. 5 Example menu of smartglasses
Source: [1]

The following commands are available for picking: synchronize, hide, show, check the settings, back, confirm, reject (see Figure 6). These are the basic commands required for interaction with any system which needs to be controlled. Additional functions can be programmed for the central panel buttons, or directly for the glasses. Nevertheless, voice control should be used as much as possible in order to maximize picking efficiency.

Fig. 6 Graphics for picking
Source: [1]

The screen graphics uses slightly darker background color which outlines the space for displaying information. The used nanoparticle film itself is clear; the only visible element serves to mark the boundaries of the display. For safety reasons, the Intelligent Hiding System (IHS) should be implemented and always enabled. It uses data from an accelerometer to hide the graphical interface. This function can be activated manually with a voice command "hide". It is an active safety feature which prevents the display of information when the employee loses balance and there is a risk of injury.

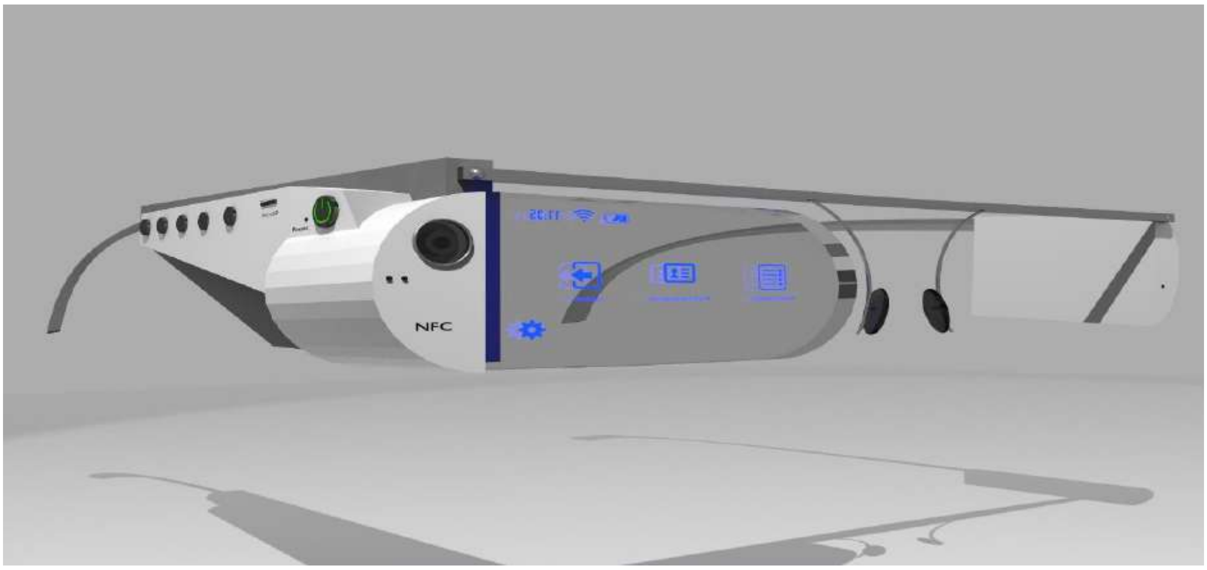

Fig. 7 Smartglasses with the displayed information
Source: [1]

4 CENTRAL PANEL

Since the solution with AR requires no additional displays, an NFC antenna for quick pairing is placed in the saved space. The central panel communicates with the glasses for AR through Bluetooth Smart, which ensures low energy consumption. The process of pairing non-NFC devices would require the employee to select the desired device manually from a list of available devices. The warehouse environment may contain dozens of such devices and the selection of the right one would be difficult. Using NFC technology reduces this process to bringing two devices close together at which point pairing information is exchanged.

Figure 8 shows communication between the devices. WiFi communication between the control module and a Pick-by-Light module is preserved. The glasses for AR communicate via Bluetooth Smart with the control panel which provides a communication interface with the Luca system.

Systems which use Pick-by-Light and Pick-by-Voice fully rely on the AR solution for rechecking. Nevertheless, the proposed design preserves the frame with its functions. When employees put items in the frame, they push a button confirming that the item has been placed in position. But when using AR for rechecking, the employees may not put their hands close to the frame, but the picking can be still considered successful. This demonstrates a limitation of AR. Well-defined interaction is required to confirm clearly that the right item has been placed in position. Picking fully based on AR without tactile response can result in an increased error rate.

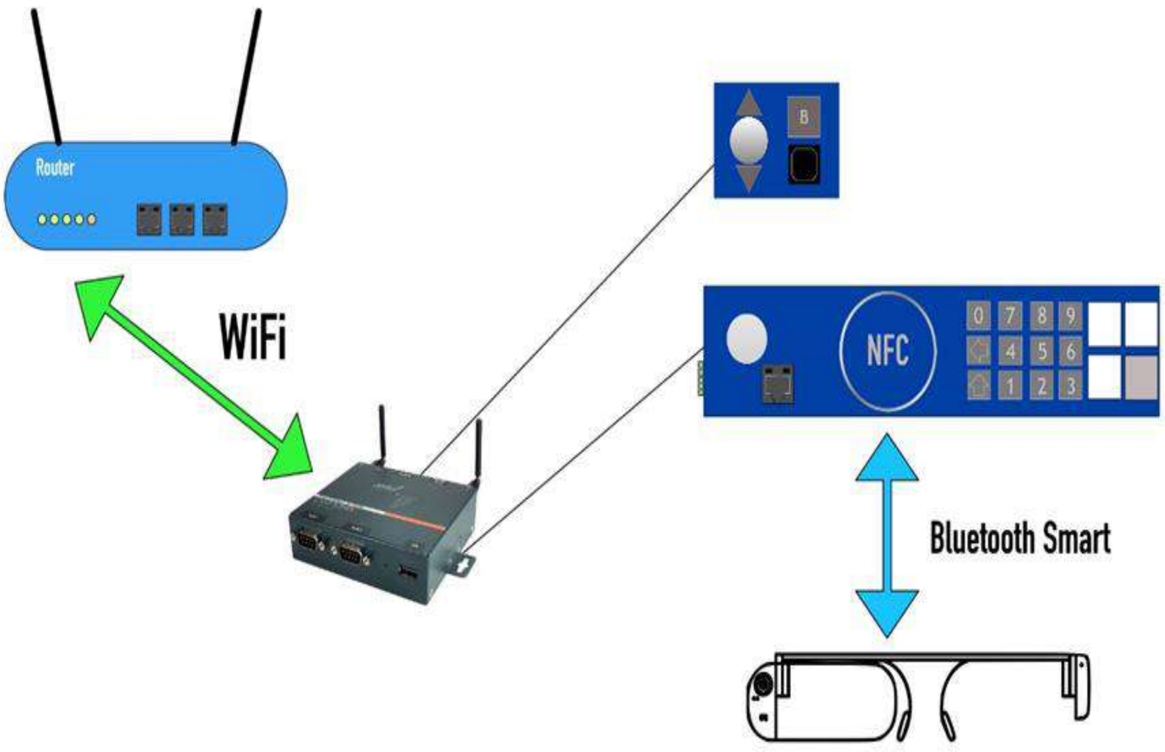

Fig. 8 Pick-by-Frame AR
Source: [1]

As a pilot project, Ubimax [7] has integrated Google Glass smartglasses into its Pick-by-Vision system. These glasses are not primarily intended for use in logistics processes. Nevertheless, Ubimax claims that this solution has brought some benefits, because it has replaced barcode scanners which were not sufficiently reliable for the reasons mentioned above. Barcodes themselves have been preserved in this AR solution.

Overall, AR is becoming a trend in logistics, with systems suppliers presenting their own solutions. A noteworthy solution has been implemented by DHL [8]. It is similar with the solution proposed in this article, but it still uses barcodes to transfer information. KNAPP [9] has extended its Vision system for picking which is based on the already introduced solution for image recognition in a warehouse. The drawback is that the glasses for AR are impractically large and connected by wire.

5 IMPACT OF WEARABLE ELECTRONICS ON EMPLOYEES

People are surrounded by modern technology and rely on it more and more. When asked whether modern technology has an impact on their profession, the answer "Yes, it is a benefit for me" chose 80 respondents, which is almost 82%. This proportion is likely to increase in younger generations. The reason is that people are naturally lazy and constantly look for ways to make their work easier. Moreover, only 9 out of the 89 respondents who see an impact of technology consider it as a source of difficulties [1].

The fourth industrial revolution is based on a synthesis of technologies which are already used in some fields. It can be perceived as the breakpoint for a massive trend that will lead to decentralization [10] affecting not only industry, as the term suggests, but all other aspects of our lives. The remaining 20 respondents whose answer on the opening question was "No" may be affected by modern technology in the next 5 years [1]. At the same time, however, an increase in people's dissatisfaction may be expected, with technology bringing noticeable difficulties in certain fields.

To summarize, the impact of and reliance on modern technology will increase and the future development in technology will make the replacement of human work with robots increasingly easier.

As for the current trends, they are often presented in various magazines ranging from fashion to technology. But is a trend set by the editors of the magazines, or perhaps by ordinary people? A trend can be understood as the direction in which an industry is heading. People tend to look for trends in leaders, in what they see, what is part of their image. These trend leaders may be for example actors, singers, or political figures. Public visibility is crucial here. Nevertheless, these leaders only pass the trend to other people without being affected themselves [11].

Currently, one such trend is wearable electronics, i.e. any piece of electronics which can be worn on the body or clothing. The main representatives of this category include smart watches and sport trackers. In both cases the device is in fact attached to the body with a strap as in case of an ordinary watch. The difference is in functionality. Basic smart watches are intended to provide the users with notifications on events from their smartphones, e.g. messages, calls, reminders, or any other application which needs to notify the user. Sport trackers measure sport activity and performance of the human body.

The survey showed that 75% of the respondents do not use any wearable electronics. Since 73% of the respondents fell into the age group 15–26 years, this proportion was expected slightly lower (about one half) [1]. The trend was expected to have bigger impact in this segment.

Still, more than half of the respondents who do not use any wearable electronics at present would like to gain some experience with this technology which proves that wearable electronics constitute a current trend.

With respect to the topic of this article, the respondents were asked whether they had any experience with AR or VR. The proportion of positive answers was expected low with only a few individuals having some experience. The general knowledge of these concepts was also investigated with similarly low expectations. Nevertheless, only 16 respondents did not know the meaning of the AR and VR concepts. It was not more than a few days before the survey took place when Oculus Rift, a device for VR, had been launched for sale at a price close to 1,000 USD. Still, 31 respondents already had some experience with these technologies, supposedly through the use of smartphones which offer certain AR capabilities without any external devices.

Modern technologies have already enabled employers to track virtually every step of their employees, but camera-equipped glasses for AR have pushed monitoring to the level of looking directly over the employee's shoulder. Only four respondents expressed no concern about such monitoring. In general, monitoring is taken very negatively and may have a detrimental effect on human performance. When people perform or demonstrate some activity while being watched, there usually comes a failure.

The constant awareness of the employees that they are monitored and the data from smartglasses may be used for the termination of their work contracts could affect work performance in a positive, but also negative way. The use of this technology is therefore an important stress element.

As already mentioned above, monitoring is now the norm. The use of modern technology will always require certain modifications of our approaches. At the moment, people see modern technology as a threat to their social life. On the other hand, there is a certain percentage of people who can identify the potential of technology in various fields. For instance, athletes use technology to measure their activity and performance. Analogically, when such potential is identified, it should be brought into focus in order to modify the working environment so that employees find the implementation of a new technology acceptable.

CONCLUSION

Any job continuously facilitated more and more by modern technology will ultimately be simplified to a level at which machines will be able to replace human employees. Natural laziness will always lead people to ease their work tasks, so that AR may be expected not only to facilitate the picking process in logistics, but to serve as the fundamental technology for the identification of objects in space.

Current modern technology can be used to accelerate the process of picking and simultaneously improve safety when handling bulky items. This article has presented a design of glasses for AR with advanced display technology which allows positioning all the necessary information in the field of view of an employee. This solution is intended to largely eliminate error rate resulting from continually repeated tasks in the picking process.

The fourth industrial revolution starts the era of total connectivity, which will lead to the creation of virtual copies of physical, production, and ultimately also social processes. Thus, the total connectivity will incorporate also people who will be continuously monitored by their own IT devices. People are aware of the impact of technology on their environment, but they are always under the influence of current trends. As part of these trends, modern technology influences and will continue to influence our social life. Therefore, it is a matter of the extent of such impact which people allow AR and VR to have on them.

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INDUSTRY 4.0 IS INVOKED BY THE NATURAL EVOLUTION OF TECHNOLOGY (HOLON AND MULTI-AGENT SYSTEMS)

INDUSTRY 4.0 JE VYVOLÁN PŘIROZENÝM VÝVOJEM TECHNIKY (HOLONY A MULTIAGENTNÍ SYSTÉMY)

prof. Ing. Vladimír Strakoš, DrSc.

Department of Master Studies
College of Logistics in Přerov
e-mail: vladimir.strakos@vslg.cz

Abstract

The development of machines, vehicles, robots and to that the development of all areas of information technology, including super miniaturization hardware resources is almost unbelievably fast. Therefore, there had to be a fundamental change in the design processes and the management of production processes and the related thinking of technical resource managers. All these aspects related to the automation of manufacturing processes as well as their service processes have provoked the need in Germany to mark this revolutionary change taking place in a relatively short period the Fourth Industrial Revolution. The article describes individual steps which provide the rationale and lead to the culmination of the development in the field of automation and cybernation of manufacturing processes. Interesting, even though often neglected steps of this developmental terminus are Holons and multi-agent systems. These two elements have contributed to the onset of the Industry 4.0 process.

Abstrakt

Vývoj strojů, dopravních prostředků, robotů a k tomu vývoj všech oblasti informační techniky včetně super miniaturizace hardwarových prostředků probíhá téměř neuvěřitelně rychle. Proto se musely zásadně změnit procesy navrhování a řízení výrobních procesů a s tím související myšlení pracovníků v řízení technických prostředků. Všechno co souvisí s automatizaci výrobních procesů a také s jejími obslužnými procesy vyvolalo v Německu potřebu označit tuto převratnou změnu probíhající v relativně krátkém období, čtvrtá průmyslová revoluce. Velká většina techniků toto označené přijala a tak žijeme v období 4 průmyslové revoluce. Dílčí kroky, které k tomuto pojmu vedly, jsou obsahem tohoto článku a také zdůvodněním a vyvrcholením vývoje v oblasti automatizace a kybernetizace výrobních procesů. Zajímavými a téměř opomíjenými kroky, které vedly k takovému označení této etapy, jsou holony a multiagentní systémy. V těchto dvou skutečnostech je, podle autora, zakomponován nástup procesu Industry 4.

Keywords

Industry 4.0, Holon, Multi-agent systems, RFID, Case systems

Klíčová slova

Industry 4.0, holony, multiagentní systémy, RFID, Case systémy

INTRODUCTION

When considering the concept of the Fourth Industrial Revolution, several questions arise. First of all, is it a real revolution? It is the fourth, or just the second industrial revolution? Does the current development in technology deserve such title, or is it exaggerated? These are all interesting questions which can be answered in different ways. What really matters is the substance of the issues in question. Over the past few years, such issues have been in the focus of the technological practice which shows that these considerations are not exaggerated at all. They require our attention and provoke us to raise up the young generation in the spirit which is truly revolutionary.

Technical sciences and the implementation of their findings have been developing extremely rapidly. To avoid any unnecessary delay, we have chosen a developmental terminus and named it the Fourth Industrial Revolution. This concept is quite appealing and reasonable. The following paragraphs present the development in Europe, where it has been in fact faster than in other parts of the world.

The first terminus of a real industrial revolution was the steam engine as an energy source. It allowed detaching production from water and wind mills and factories could be built in the middle of human settlements – the sources of labor force. It could be even placed on a vehicle to propel it. This was a truly revolutionary change.

The advent of electricity enabled relatively simple transfer of energy from one place to another. Electric motors allowed the removal of transmissions from factories significantly increasing safety and efficiency in the transmission of mechanical work. It was again a great and important revolutionary change in technology.

The third revolutionary change which was brought by the possibility to transmit and store information was no longer so clear-cut in time. Still, it can be identified with the day when a young enthusiast for logical circuits at IBM pushed through the design of the first digital computer thus starting their development. It can be considered a revolutionary change in the processing of digitized information.

The beginning of the Fourth Industrial Revolution is according to me completely “blurred”. Unlike other authors, I would associate it with the design of integrated circuits. They allowed placing a large number of diodes and transistors on an extremely small piece of semiconductor which could store words and any digitized information. Nevertheless, given the blurriness mentioned above, the fourth developmental terminus can be attributed to many things, including "intelligent systems". Whatever we think, a radical cybernation of technical systems has arrived marking the real and entirely indisputable beginning of an extremely rapid development of control systems. The cybernation of technical systems together with other aspects has a significant (good or bad) impact on human life and society.

1 HOLON

A multi-agent system is a concept which has been brought by the rapid development of information technology, automation and automation means, and advanced algorithms and their implementations as software systems. The extremely fast progress in the development of hardware resources for control technology is also of great importance. This was followed by the yet somewhat neglected concept of a cybernetically controlled process.

Control computers were introduced into the management process relatively recently. At that time, the computer required a dedicated air-conditioned room from which the production was managed. This is one of the reasons leading to the evolution of the centralized management of automated or semi-automated processes. Complex technological means were used to feed signals from the processes to the control center which became the focal point accumulating a large amount of information. In the opposite direction, strings of control commands, or recommendations, were sent based on the computer suggestions.

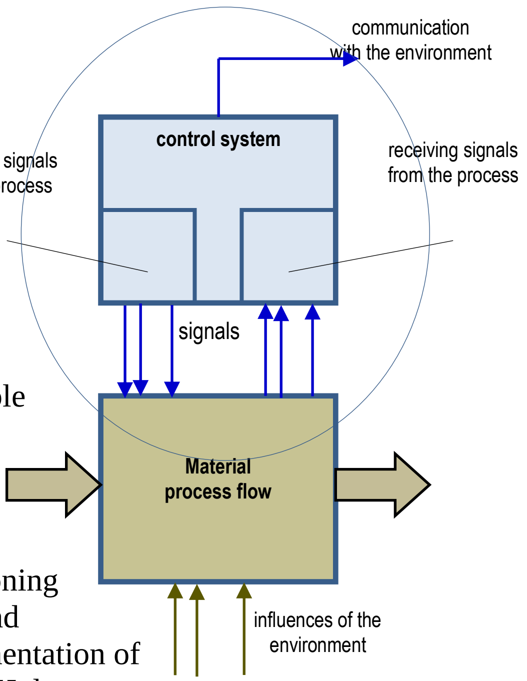
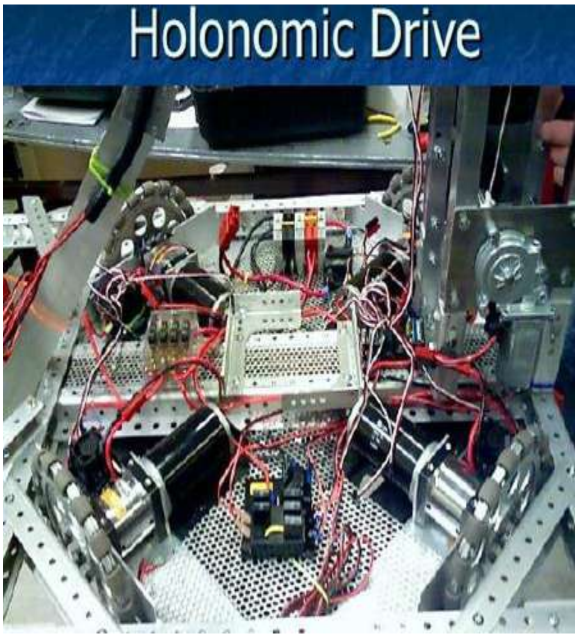


Fig. 1 Example of the functioning and implementation of a Holon



(Source: a photo from Google Images)

The progress in the development of control technology imitates the nature. The size and energy consumption of sensors measuring individual values needed to control the processes are becoming smaller and their parameters are improving. Once our dream that the sensors on the controlled machine had a wireless connection with the computer has practically come true. Today, the control computer unit is small (and the reduction of size still continues) with low energy consumption and it can be integrated with the controlled device. The control system in automated processes has been divided into relatively independent sub-systems. As exemplified by an actuator in Figure 1, such concept is conventionally used in many processes.

A Holon is an automation component used to control a physical element of a production system. It provides full automation of one specific part of the process contributing to the system intelligence. As decentralized control elements of the physical process, Holons ensure that it works automatically. In case of an unexpected situation, such as a failure in one part of the process, Holons usually stop the whole process automatically. If the Holons should avoid a complete stop preferring uninterrupted work of the process, perhaps with some limitations, they must be supplemented with a higher level of control system based on software. In this way, groups of Holons will create relatively small and smart control system elements which might be called **agents**.

Figure 2 shows an example of an articulated mechanism in which every joint is controlled by independent automatics. Based on input data, it ensures an accurate rotation angle of the arm, measures the mechanical load (torque), temperature, or vibration of the arm both in a stable position and during repositioning, monitors energy consumed for the rotation to identify any deviations, and so on. Each joint is controlled by an independent automation unit, i.e. a Holon. With respect to software implementation, a Holon is a universal system which can be adjusted easily to perform required tasks, in this case to serve as a perfect control element of one part (the joint) of the whole moving system.

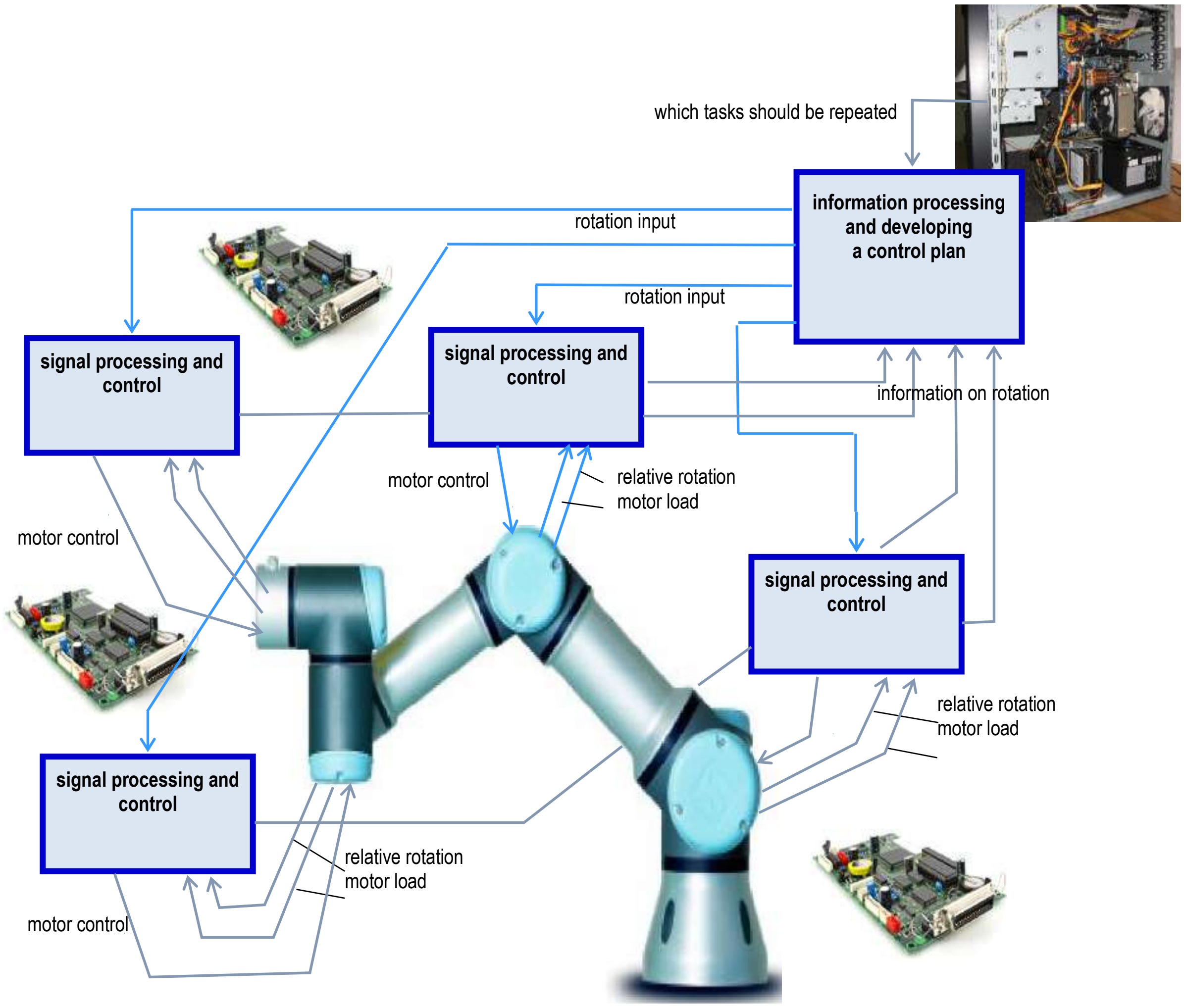


Fig. 2 Example of a decentralized mechanism controlled by Holons which use intelligence to control the movement of the joint

It mostly wirelessly monitors all relevant variables and performs the required task, in this case it rotates the joint. The control task is simple and a manipulator will generally need a number of such Holons. It may well be a manipulator for very heavy loads. Nevertheless, all Holons are designed and manufactured uniformly. They are not made specifically for a given mechanism, but they are equipped with all functions necessary for their universal application.

If the robotic system runs into an obstacle preventing the required rotation of the arm, its control Holon cannot solve such problem itself. An error in the mechanical movement is identified. In such cases, there must be a suitable higher-level software control system to which the Holon reports the error in its environment. The higher-level system evaluates the situation together with other systems managing additional Holons and sets a different rotation of the arm.

Thus, without operator intervention from outside, the gripper reaches the target position regardless of the difficulties with one arm. These groups of Holons subordinated to a higher-level control system are referred to as agents. Through the Holons, agents can intervene in a physical system. Essentially, agents can cooperate to solve a situation without any adjustment at the Holon level. If there is a need to change a production plan based on robotics, all the actions take place at the level of agents. The Holons only ensure correct arm rotation without noticing any functional change in the mechanism. For example, if one joint is blocked, the production runs without interruption because the agents arrange suitable changes in the rotation angles of other joints.

2 MULTI-AGENT SYSTEM

The following section is based on the insights of professor Vladimír Mařík, a leading figure in the field of Industry 4.0 and multi-agent systems who has published a number of interesting articles on these topics. The technology of multi-agent systems draws significantly on the object-oriented technology combined with the functional specialization of modules for distributed decision making and management [3]. The term multi-agent system, as already mentioned, refers to a community of autonomous units capable of functioning together to coordinate their activity, or to cooperate purposefully. Each of these units, i.e. an agent, is able to solve a substantial part of its tasks autonomously, using the knowledge of its own abilities and the abilities of other agents. In conventional multi-agent systems, there is no central decision-making element and the global strategy of the whole community is distributively "owned" by individual agents. Sufficient knowledge about the properties of the community members as well as of the overall strategy enables the agents to communicate with others only if it is appropriate or necessary.

Multi-agent systems are characterized particularly by their purely software form. They are used in planning and decision-making, but they can also be found in the systems of technical diagnostics and operational control of production. Suitable hardware platforms are also being developed for discrete control based on the principle of multi-agent systems. These are mainly small discrete controllers capable of transmitting and receiving messages in a selected Agent Communication Language (ACL). They are able not only to respond to the changing situation, but also to use their own reasoning based on their knowledge and thus contribute towards the rational, i.e. target-oriented behavior of the controller community. The Holonic Manufacturing Systems (HMS) consortium working under the international organization Intelligent Manufacturing Systems (IMS) has created the first internationally recognized standard for communication between agents (IEC 1499).

The benefits of multi-agent systems are illustrated in Figure 3 which shows a large production unit with multiple functionally connected transport networks. A change in any component is reflected in almost every other component. It is due to the deterministic nature of the production system. Each transport section is operated by a suitable actuator which controls the pressure or flow rate in the given component. Each section is thus controlled by a Holon with a relatively simple task to control the pressure, flow rate, or both in the assigned component. It monitors all relevant parameters and usually adjusts a single actuator. If the task is to control the actuator, the Holon not only monitors the output parameter, but also adjusts it based on a suitable algorithm. The stabilization or regulation of the parameter is done by means of e.g. a program, follow-up, or adaptive system. The Holon has all these algorithms stored in its memory and uses the one which is needed. This principle is the basis for a single software design of all Holons which can thus be manufactured as uniform products.

The task of a Holon which, for example, controls the fluid distribution in three directions is more difficult. It needs a rule to decide on the required flow rates for each pipe. The Holon itself is not equipped for such tasks, and therefore it needs a superordinated agent which monitors the situation from a higher-level perspective. If a change is necessary, the whole network of agents is activated. They start to solve the situation. Once a suitable solution is found, they implement it through their own Holons.

The description above makes it clear that Holons are physically bound to their positions in the system and cannot be moved. In contrast, agents are “non-physical”, and even though they too cannot move because they are bound to their Holons, they can be linked to the physical production system remotely. In theory, and in fact preferably, they can be concentrated in one place (a control room), but even there they are still parts of the production unit and their Holons.

The functioning of agents could be likened to a flying flock where every individual is driven by its reasoning, or intelligence, while following the direction of the flock and contributing to its rational movement as a whole.

Fig. 3 A perfect environment for the “life of Holons”. They are grouped together by their agents which control the whole environment through their multi-agent system with respect to the “global goals” specified by human operators.

Greater application of Holonic and multi-agent systems in manufacturing will require a fairly substantial change in the way designers and users think. It will actually constitute a shift from the traditional transaction-driven control model to the event-driven control model. Such model is a way of thinking that has naturally evolved in parallel with (and almost independently from) the field of object oriented programming, strongly distributed control systems, artificial intelligence, as well as the application area of electronic commerce (e-commerce) [2].

3 CYBERNATION OF PHYSICAL SYSTEMS

Cybernetics, the study of control in living organisms and machines, has evolved logically with the development of technological systems. At the beginning of the previous century, it was necessary to improve the regulation of electric power generators in order to stabilize voltage. By doing so, professor Jaroslav Hrdina, known as Grdina in St. Petersburg, the son of Czech parents from Pilsen, worked out the basis of the automatic control theory. Professor Norbert Wiener, the son of Russian parents in the USA, worked on the automatic aiming of anti-aircraft guns during World War II. Since the two men knew about each other's work, professor Wiener came up with the idea of using mathematical tools to describe the processes which take place in nature. More and more engineers became aware that we need to learn from nature and try to imitate her ability to control and regulate. These efforts quickly transformed into the scientific study of control – cybernetics.

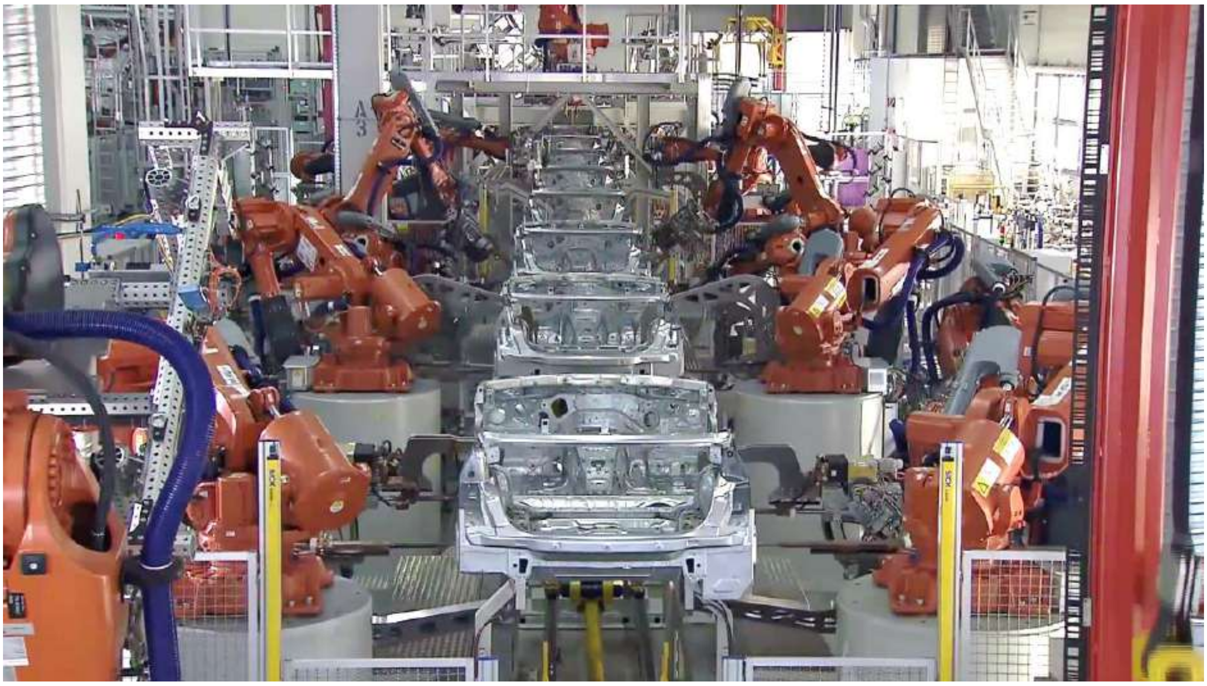


Fig. 4 Fully automated system as a part of automobile production

With the advent of computers, automatic control gradually moved to the large computer rooms. Initially, it was not possible to move the computer hardware close to the machines. Computers were placed in central control stations from which the machines and the production process were controlled. These activities brought many challenging problems which were difficult to solve with the primitive information technology of that time. The principles of cybernetics were therefore virtually forgotten.

Nevertheless, control processes using computers have been evolving continuously and quickly and the hardware of digital technology has been getting smaller rapidly at the enormous growth in the capacity of individual elements. Hardware which previously required two or three rooms has been folded almost into a box of soap. Thus, one very large computer has been replaced by series of small-sized but powerful computers which meet all the requirements to control the processes they are attached to.

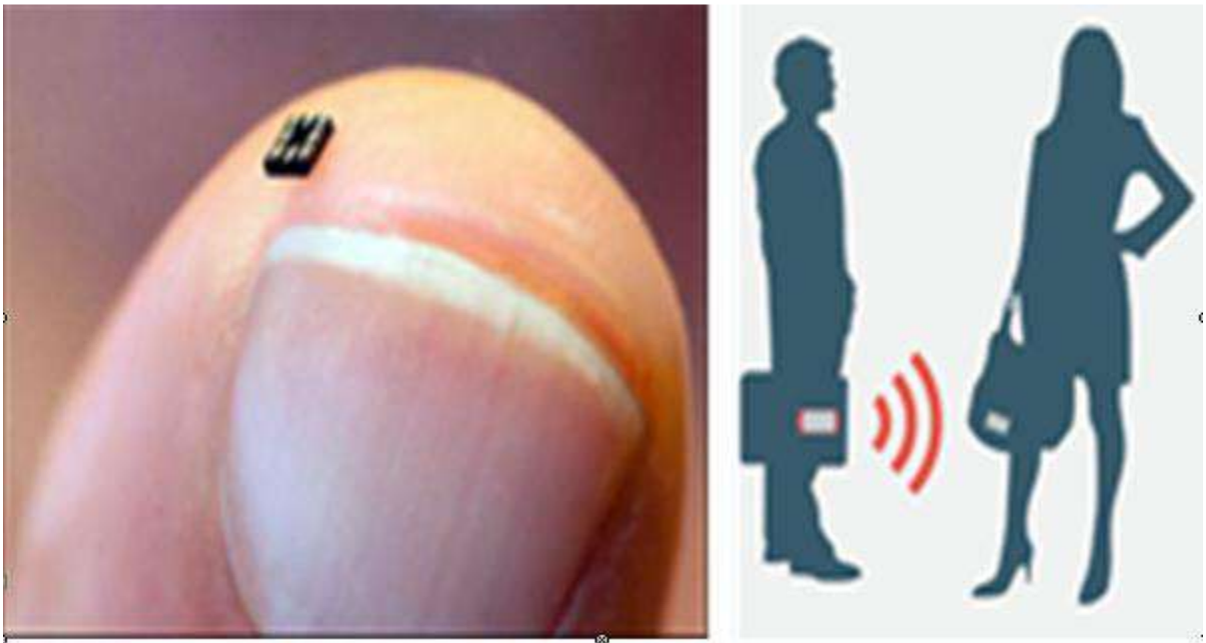


Fig. 5 Tag as an identifier may be very small but also problematic

As the next step, it was necessary to connect these small and powerful systems so that they can together perform manufacturing tasks. The goal was to combine the management of larger units as wholes and many partial self-control elements at the same time. These are then grouped into multi-agent systems creating finally cyber-physical systems (CPS). It does not, however, constitute the revolutionary change leading to the concept of Industry 4.0. The development of wireless transmissions between large and small units and processes has almost inevitably brought extremely small elements, or tags, capable of transmitting and receiving messages wirelessly which has enabled radio frequency identification (RFID). The need to mark objects with which we work is a logical necessity, so barcodes and their scanners appeared very quickly. These barcodes have been soon replaced by wireless transmission from tags attached to the objects which we want to track.

In parallel with this development, wireless transmission networks have evolved quickly creating a system in which every thing as well as living organism can be connected to a home, enterprise, or global network. The result is that every thing can be connected, if applicable, to a suitable control system, including information about its location anywhere in the world, thus creating the Internet of Things.

4 INDUSTRY 4.0

Multi-agent systems, Internet of Things, Internet of Services, continuously improving sensors gradually replacing human senses and logistics in all areas of application – all these have a significant impact on human activities and deserve the title Industry 4.0.

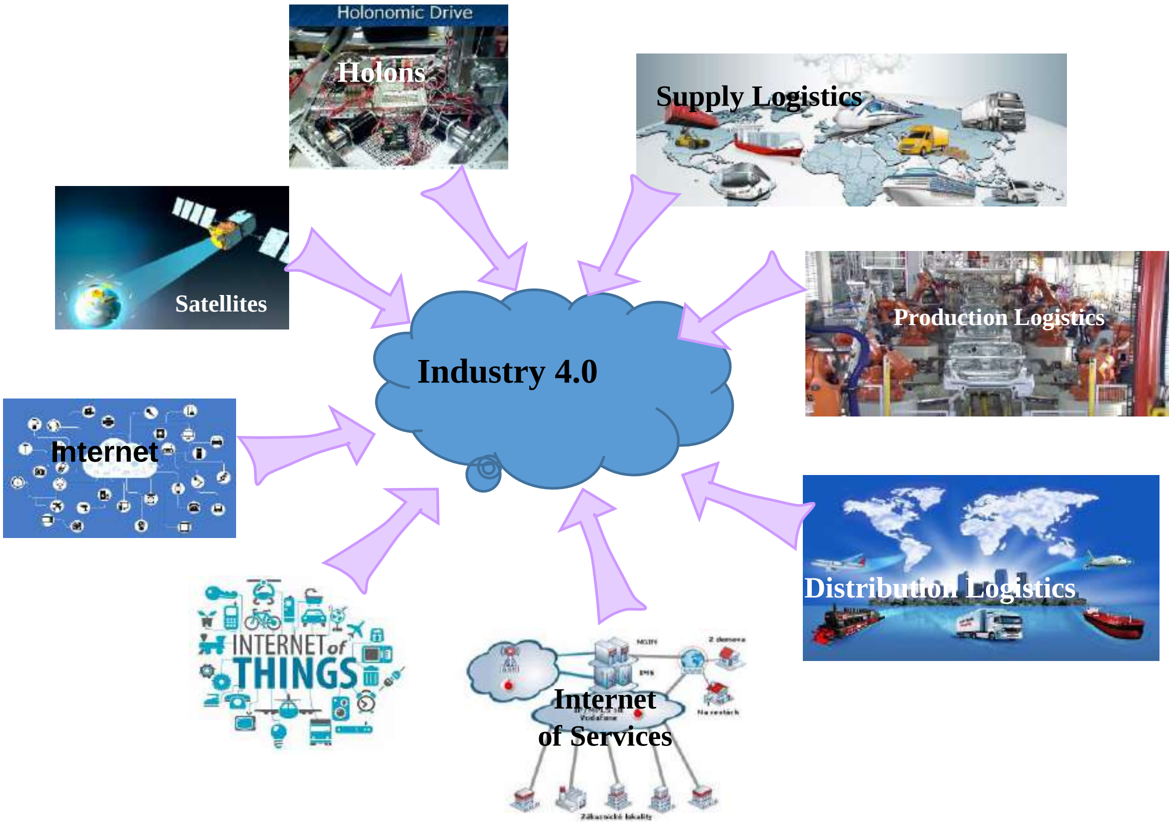


Fig. 6 All modern technical and non-technical elements create conditions for the integrated development of technology rightly titled as Industry 4.0

Because it really is a radical change in the life of society, the concept has been recognized under different names by all developed countries. China has come up with the term Made-in-China 2025 and the USA has established the Advanced Manufacturing Partnership (AMP) or the Industrial Internet Consortium (IIC). All these initiatives aim to merge all the modern technical means into human life.

Figure 6 illustrates major current activities with great prospects for further development which will bring a complete integration of cybernetics into our contemporary society and our lives. Even though logistics is not often emphasized so much in this context, the concept of Industry 4.0 would not be feasible without various fields of logistics. Intensive production is not possible without the supply of input materials and semi-finished products and complex distribution of the final products to the consumers. Large space in which the supply of raw materials for production and the distribution of products for sale take place requires perfect logistics systems. The above paragraphs make it clear that the author is strongly focused on the concept of cybernetics as a science studying the control in living organisms and machines, and the current activities contained in the Industry 4.0 which aim in the same direction.

CONCLUSION

An excellent conclusion may be found in the words of professor Vladimír Mařík who notes that the success of Industry 4.0 in our conditions will be ensured if the society is adequately prepared and responds accordingly. This is the main task. Professor Mařík is convinced that the main obstacle will not be in any potential technical problems and difficulties, but in the issues related to education and the labor market. Problems can arise with spreading the ideas of the Fourth Industrial Revolution into services and other sectors such as the energy industry, electromobility, and transport. It is therefore extremely important that the government clearly declares that the ideas of Industry 4.0 are stimulating and worthy to be followed and supports their successful application with clear and resolute measures. The most important thing is to alter customary conceptual patterns of people and prepare them to accept the concepts of the Fourth Industrial Revolution.

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PROCEDURES FOR AIR TRANSPORT OF SPECIFIC CARGO

POSTUPY PRI LETECKEJ PREPRAVE ŠPECIFICKÉHO NÁKLADU

Ing. Juraj Vagner, PhD.[7]

Faculty of Aeronautics, Department of Flight Training
Technical University of Košice
e-mail: juraj.vagner@tuke.sk

Ing. Edina Jenčová, PhD.[8]

Faculty of Aeronautics, Department of Air Transport Management
Technical University of Košice
e-mail: edina.jenčová@tuke.sk

Ing. Stanislav Ďurčo, PhD.[9]

Faculty of Aeronautics, Department of Flight Training
Technical University of Košice
e-mail: stanislav.durco@tuke.sk

Ing. Žaneta Miženková[10]

Faculty of Aeronautics, Department of Flight Training
Technical University of Košice
e-mail: zaneta.mizenkova@tuke.sk

Abstract

The article deals with the technology and specificity of air transport of animals. The animal cargo service takes only small percentage of the whole cargo, but is connected with using the most demanding procedures and technology. This paper shows the procedures of animal air transport provided at the airport in Zurich. The cooperation among the ZOO of Zurich, Zurich airport and air cargo companies results in the procedures of exotic and wild animal transport.

Abstrakt

Príspevok sa zaoberá technológiou a špecifikami pri preprave živých zvierat. Aj keď sa jedná čo do objemu leteckej prepravy z celkového ročného objemu o malú časť, ale čo do zložitosti postupov o najzložitejšie prepravné technológie. Konkrétne sa zaoberá spoluprácou a postupmi v leteckej preprave živých zvierat na letisku Zürich. Ide o postupy a spoluprácu medzi Zoo v Zürichu, Letiskom Zürich a leteckými prepravnými spoločnosťami zaoberajúce sa takýmto druhom prepravy špecifického nákladu - preprava exotických zvierat. V príspevku sú popísané spôsoby, akými Zoo v Zürichu spolupracuje pri preprave exotických zvierat.

[7] Assistant Professor
[8] Assistant Professor
[9] Assistant Professor
[10] Internal PhD. student

Key words
air cargo, transportation of exotic animals, Zürich airport
Klíčová slova
letecká nákladná preprava, preprava exotických zvierat, letisko Zürich

INTRODUCTION

The air cargo transport of goods can be provided by charter or business airlines. Nowadays, the income from cargo transport is about 15 % of the whole air traffic income. The air cargo transport is about 15 % of the whole cargo services in the world; however it is about 30 % of a transport value. The biggest advantage of air cargo transport is its speed. It is the fastest way of transport especially when time becomes the important issue. Air cargo transport follows the rules and regulations, which describe the conditions for movement and transport of air cargo. These rules and regulations are controlled by international aviation organisations such as IATA, ICAO and others. Specific conditions are applied for air cargo storage, transfer and the staff working and manipulating with air cargo. These people are employees of airline cargo services, handling agents or delivery companies. Fast loading and unloading is a key task for everyone. Special procedures and own innovations with using different kinds of transport influence the amount of customers´ orders. [1, 2]

In this paper, we describe the procedures and experience in transport of animals of the Zurich Zoo. Transportation is very stressful period of time for animals.

The preparation of animal for transportation begins 2 or 3 weeks before the flight. The special staff and vets take care about animals. A vet is the one who can allow all procedures and movements that are necessary for transport of animals. Air cargo companies have different experience in transporting different kinds of animals. Space for animals is specific according to the needs, and a special crew is required as well. Air cargo transport is provided in real conditions, and it is always very important to make some innovations of animal transport.

1 ZÜRICH AIRPORT

The Zurich airport is the biggest airport in Switzerland. This international civilian airport is situated in the district of Zurich. The airport is located in the town Kloten that is about 14km from the city centre of Zurich. Official opening of Zurich airport took part in 1953. It spreads around 88 ha. Zurich airport provides services for more than 26 mil passengers every year. The airport has 3 runways and cooperates with the biggest airlines like SWISS (hub airport), Lufthansa, American Airlines, Air France, Air Berlin, Emirates, Qatar, Thai Airways and others.

Air cargo at Zurich airport

The Zurich airport is the biggest airport in Switzerland. This international civilian airport is situated in the district of Zurich. In 2014 the airport in Zurich was nominated in Air Cargo Excellence Award in the cargo service category. In 2013 and 2014 the airport was awarded with the 1st place in the list of Europe over 399 999 tons. The magazine „Air Cargo Magazine„ awarded the Airport in Zurich for the quality of their service, and manipulation with the cargo, infrastructure and service provided by the airport. The area for manipulation with cargo is about 100 000 square meters.

The development of cargo services of Airport in Zurich – between 2002 till 2015 and its annual increase – Figure 1.

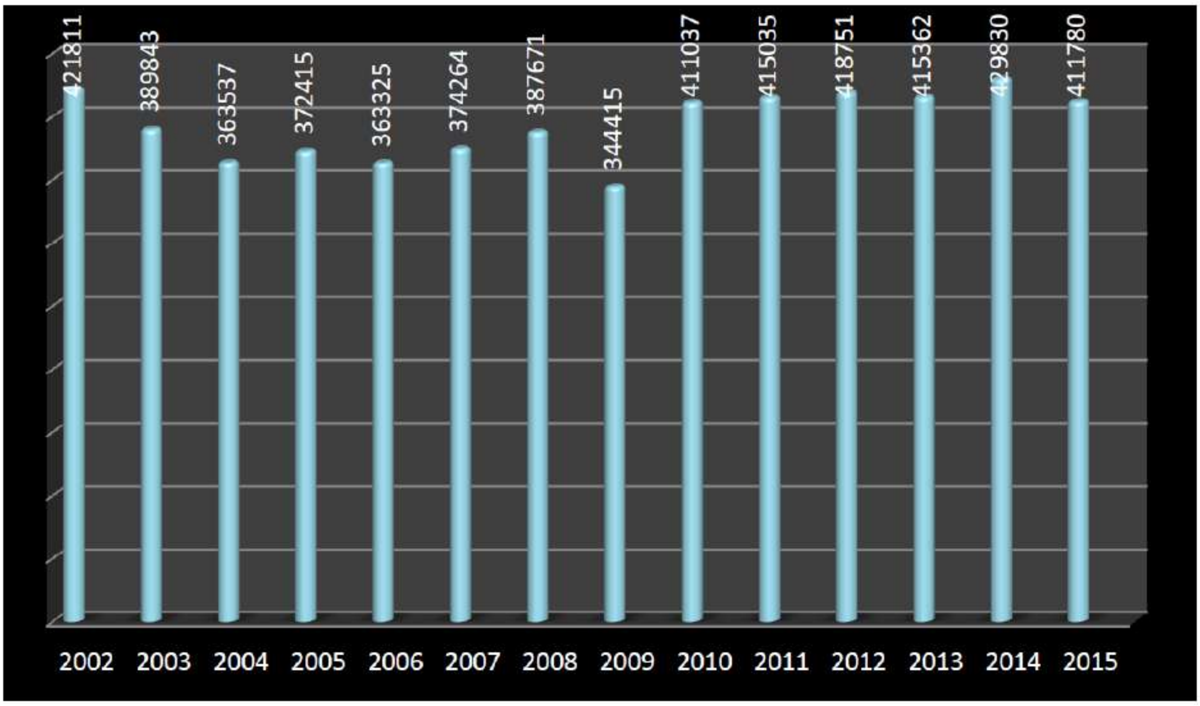

Fig. 1 Development of Air Cargo Services of Zürich Airport in tons 2000 – 2015
Source: Own Source

An advantage of this airport is that cargo loading into the aircraft is provided very fast and in a short period of time, because the cargo infrastructure is situated in one place and is near the aprons. At the airport you can find specific cargo of different companies like: Cargologic Ltd., Dnata Switzerland, Swissport Cargo Services, Ferrier Air Cargo, Lufthansa Cargo, AC Aircargo Logistics. All of them provide well trained staff using the most modern technologies. The airport of Zurich always has the first places in the list of different awards or in different statistics of magazines when competing with the excellent services of airports.

2 AIR TRANSPORT FOR ZOO ZÜRICH

The Zoo in Zürich was open in 1929. It has spread at the space of 15 ha. The Zoo has more than 4000 animals that come from 6 continents. The Zoo is involved in different projects. One of them is a programme of preservation of endangered animals that includes animals like Siberian tigers, snow leopards, Indian lions, giant tortoises and many others. The ZOO in Zürich employs more than 100 employees, who care about the reproduction of these animals using new modern technologies, ethology and hunting researches. All of the animals are included in different programmes and are transported by ground or air transport. Airports are very open for the transport of exotic animals and they need to follow all of the rules and regulations.

2.1. Procedures for transport of individual kinds of animals

In the following part we deal with the transport of exotic animals, their division into groups and description of carriage containers that are used for the transport. The whole process is very difficult for timing and needs to be done without any mistakes. As it is transport of animals, that are volatile, dangerous, quite huge so it is very important that only qualified person can do this job. All of it begins with administration of medical documents of the animals followed by special preparation for transport e.g. adaptation of animals for smaller space in the box, where they can drink water from a special bucket. The preparation lasts about 4 weeks and it is done under the control of a vet, who monitors animals´ stamina and condition. Transportation of animals in the European Union is faster than transportation into other continents. The whole process of transport of animals can last a few months. The Zoo in Zurich transports 52 animals per year. Some preparations are very unique and can be done once in 10 years.

Transport of rhinoceros

Transport is mentally difficult for black rhinos. The vet, who perfectly knows the behaviour of animals, supervises the preparation of transported animals. A black rhino is a very unpredictable animal, which can strike at any time. His eyesight is not well developed, but the hearing and sense of smell is at a high level. Transport of rhinos is especially difficult because they are very shy. When the shipping box is prepared to the empty enclosure it must meet all the requirements of IATA and LAR. It should be made of wood, made to measure of rhino. The front and rear part of a box is exactly the same. There are doors on both sides which serve to open the box and there are also tubes which prevent rhino from leaving the box. These gaps are important during feeding. An animal must be trained to be shipped before transport. The rhino must have stable fluid intake. During the preparation to be shipped, the same container with fluid is always given to the rhino. After this training, rhino is trained to drink during the transport, because it has been drinking from the same container before transport. The size of the box isn't exactly specified, but the box must be big enough for rhino to stand up and lay without any troubles. It's very important, that box must be isolated from wind and other adverse conditions. That's why the box is made of wood, because the wood has good insulating attributes. Air enters from the top, circulates inside and comes out through sides. Because of better air circulation, there are also vents on the floor, but there are vents only on half of the floor in the boxes for rhinos. The protective lining is under the floor. This lining is removable and after the transport the lining must be cleaned. Sedatives are served to animals two days before transport. Sedatives affect the animal approximately the week.

Fig. 2 Box Ready to Transport the Rhino
Source: Own Source

Rhinos have hearing perfectly developed and the sound of engine can cause a stress to them so their behaviour can be unpredictable. Fear plays a major role here, that’s why it is necessary to use chemicals to calm them down and benumb their senses. Second reason for using chemicals is the climate change after landing in the final destination. This is also a stressful situation for rhinos. This part is very dangerous because of the behaviour of animals. Chemicals also work well during the transport to the quarantine. The whole transport of rhino is accompanied by a breeder. The breeder will bringer a rhino to transport and then he will move to the final destination, where he will stay with the animal for a couple days and after this he will fly back to his workplace. The documentation, checked before the departure, establishes the temperature at which the animal must be shipped. Black rhinos can be transported at the temperature of about 15 °C. Rhinos can be shipped together with horses because they need the same temperature.

The transport of terrestrial mammals

The box should be made of a material which is strong enough. It should withstand any work during its manipulation and it ought to have rigid framework to make sure the box is firm. The inner surfaces of the box mustn´t contain any sharp edges or juts. If the box is painted it must be sure that the colour is not poisonous and it does not contain any substance which could harm the skin of an animal inside. In case the box has been constructed from several pieces, the pieces must be designed so there would not be any troubles with moving and manipulating with the box. The floor of the box ought to be made of grill patterns and designed so there would not be any chance of animal´s leg to get stuck in any hole of the box´s floor. The floor may be designed by web pattern in case of smaller animals. The floor must be waterproof and absorptive enough. The top and sidewalls of the box must be made of solid construction. Additionally they must be reinforced by sheets of metal in case the animal has claws. The floor must be soft enough for animals such as kangaroos. Metal bars should be placed in the front part of the box. The door ought to be adjusted to animal´s size, be shifting and made of the same solid material as the other parts of the box. Feeding should be safe. Any holes should be made for airflow but they must be small enough to prevent any contact between a man and the animal. [3]

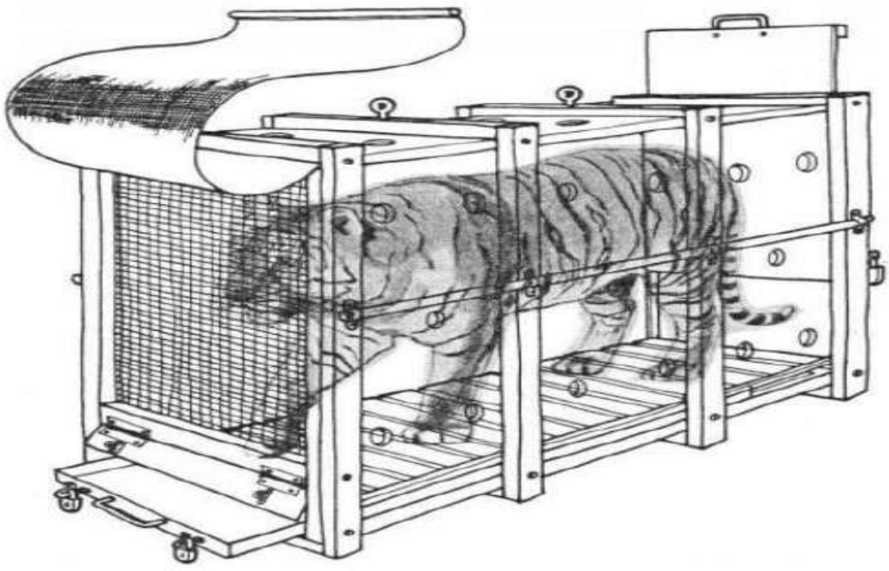

Fig. 3 Box for Transporting a Tiger
Source: https://cites.org/eng/resources/transport/mm1.shtml

The transport of marine mammals

The box must be watertight so it should be made either of metal which is resistant to corrosion or strong and stable plastic material. The box must be strong enough so any damage could be made during its manipulation. The box must be wide enough so a distance of an animal´s fin from the sidewall of the box would be sufficient. The opening must be on the top of the box. Any manipulation with the box must be provided by a crane or forklifts. Foam mattresses should be placed around the animal´s fins in the box. The box ought to be filled by water so approximately a half of the animal would be in the water. If needed there should be so called mechanical hand atomizer, which moisten and cools down the animal´s skin. [3]

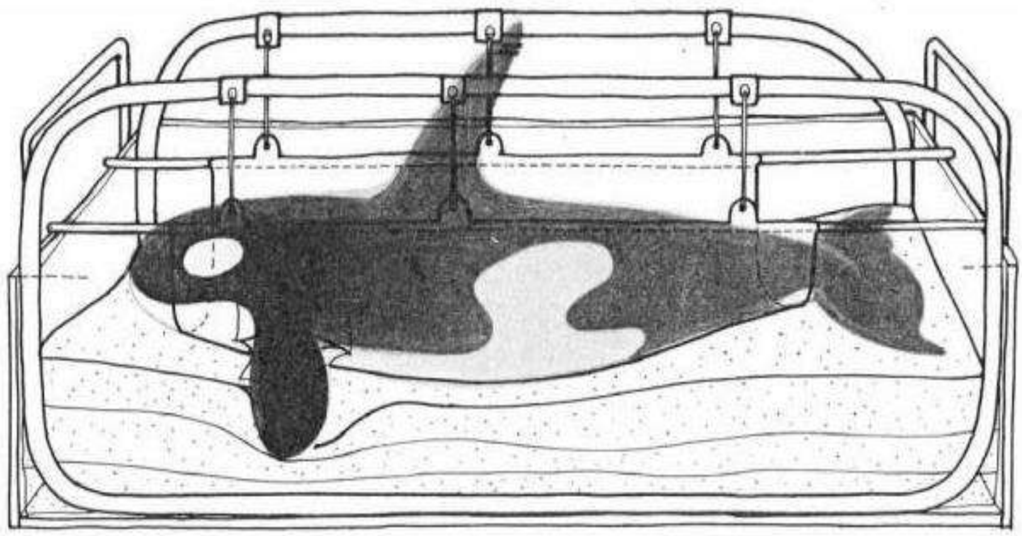

Fig. 4 Box for Transporting Marine Mammals
Source: https://cites.org/eng/resources/transport/mm4.shtml

The transport of mice, rats and other small mammals

The box should be made of laminated wood and it must be strong enough. It mustn´t contain any sharp edges or juts. The floor of the box must be waterproof and it should be padded by any absorption material. Filters on vials for feeding must be sterile. Food and water must be in such amount it would be sufficient for 48 hours. Holes for airflow should be round and covered by a web or a mesh on the outer side of the box.

The transport of reptiles

The box must be made of wood, fibreboards or expanded polystyrene. It mustn´t contain any sharp edges of juts it the inner side of the box. The box ought to be small enough to resist reptiles, such as turtles, clamber on each other and it also minimizes a risk of injury. A lid should be mounted safely enough. The holes for the airflow should be covered by gauze from the outer side. Snakes and lizards should be placed in suitable bags which are tight and marked as venomous or non-venomous reptiles. Chameleons mustn´t be transported in bags, therefore they are placed in boxes where sand is so they can bury themselves. There can be more reptiles it a container in case of small ones. Some kinds of reptiles require peat or foam brash other salt water in their containers. [3]

2.2. Requests for animal´s transport

Requests which must be met while transporting animals:

- full name and address of a receiver,
- hotline number,
- scientific and general name of the animal, number of animals transported in the box,
- if the animal is venomous, the container must be signed as venomous,
- if the animal is aggressive, the box must have a sign "this animal bites",
- a box with exotic fishes must have exact time of packing written on,
- exactly stated temperature of the exotic fishes must be listed (both in °C & °F). [4]

Biological definition of living animals relates to all kinds of animals including also sea corals, jellyfishes & insect. Also all eggs, which are intended for breeding, are considered as alive animals. They are transported as perishables. The animal's mustn´t be in the same transport area with big amount of fruit & vegetable (more than 20% of all the space during transport). The animal's mustn´t be transported together with human corps. The animal's mustn´t get in touch with dry ice during transport. Although the dry ice is not considered as toxic gas it exudes gas which is heavier than air and keeps shallow onto the ground. The animals and toxic materials or even cryogenic fluids must be separated in a sufficient distance from each other in cargo area in the aircraft. [5]

CONCLUSION

We have paid attention to some important things that must be noticed while transporting specific kinds of animals by airline companies in the article. It is appropriate to use the airliners which have good skills for transporting such animals. One of the most common airliners for animal´s transport is the Zoo Zurich. They are joined with a company which saves endangered species and they also try to multiply the species to save the animal´s kind. Animals in zoos are transported into other zoos. The transport of the animals is a complicated process which usually takes 2-3 weeks. A specific worker makes the animal ready for changing the climate and food. Every step of the process is accomplished under control of a vet, who knows the animal the best. The vet watches the animal´s change in behaviour. The animals are transported in special containers which are suitable for their size and their specific requirements. The boxes are made by the newest technologies from the best materials. The airliners take care of the animal´s safe. The sender is compulsory to fill a special questionnaire about the company before an agreement on the transport is signed up. Even a single negative answer means rejection of the transport. The offered services and the access to costumers are getting better. The air transport of the special kind of cargo is requested for its undeniable advantages. It uses the most modern technologies and highly skilled employees.

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