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INTEGRATED SYSTEM OF TRANSPORT SAFETY

ZINTEGROWANY SYSTEM BEZPIECZEŃSTWA TRANSPORTU

Ryszard Krystek[1], Marek Sitarz[2], Józef Żurek[3], Stanisław Gucma[4]

(1) Gdańsk University of Technology, Faculty of Civil and Environmental Engineering
Politechnika Gdańska, Wydział Inżynierii Lądowej i Środowiska
80-952 Gdańsk, ul. Narutowicza 11

(2) Silesian University of Technology, Faculty of Transport
Politechnika Śląska, Wydział Transportu
40 – 019 Katowice, ul. Krasińskiego 8,

(3) Air Force Institute of Technology
Instytut Techniczny Wojsk Lotniczych
01-494 Warszawa, ul. Księcia Bolesława 6,

(4) Maritime University of Szczecin, Faculty of Navigation,
Akademia Morska w Szczecinie, Wydział Nawigacji
70-500 Szczecin, Wały Chrobrego 1/2

e-mails: (1) rkrystek@pg.gda.pl; (2)msitarz@psl.edu.pl; (3)jozef.zurek@itwl.pl; (4)) gucma@am.szczecin.pl

Abstract: In January 2007 following a competitive bidding process the Minister of Science and Higher Education decided to award the PBZ 2/2006 contract to deliver a three year research project Integrated System of Transport Safety to a consortium of the Gdańsk University of Technology, Silesian University of Technology, Air Force Institute of Technology in Warsaw and Maritime University of Szczecin. The subject of this paper is to present the problem, project outline and its objectives.

Key words: road transport, rail transport, air transport, water transport, safety, accidents, fatalities, safety systems, reliability, integration

Streszczenie: W styczniu 2007 Minister Nauki i Szkolnictwa Wyższego, na podstawie konkursu na projekt badawczy zamawiany PBZ 2/2006, podjął decyzję o przyznaniu prawa realizacji trzyletniego projektu pt. „Zintegrowany system bezpieczeństwa transportu" konsorcjum naukowemu w składzie: Politechnika Gdańska, Politechnika Śląska, Instytut Techniczny Wojsk Lotniczych w Warszawie oraz Akademia Morska w Szczecinie. Przedmiotem niniejszego referatu jest opis problemu, założenia do projektu oraz jego cele.

Słowa kluczowe: transport drogowy, transport kolejowy, transport powietrzny, transport wodny, bezpieczeństwo, wypadki, ofiary śmiertelne, systemy bezpieczeństwa, niezawodność, integracja.

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1. Introduction

Because road crashes occur on a daily basis, we seem to have grown so accustomed to the problem, we hardly notice it anymore. It is only air, rail or sea disasters usually involving many deaths that make us stop and think. Because these crashes get extensive media coverage, politicians take interest and make promises to investigate the causes and make safety a top priority so that the same disaster is unlikely to happen again. But what is the actual strategy of lessons learned and what do we do to use our experience to create a better future?

Looking back on the history of transport systems we will come across a number of disasters known to have been caused by human error with enormous consequences. Today we see them as milestones on the road to better safety of transport. But they also demonstrate that we do not always learn from our mistakes and use tried-and-tested solutions. What we certainly do not do well enough is improve the law or respect the safety conditions as evidenced in the recent air crash in Poland.

We are still looking for the right answers to some basic questions about the type of structure which could effectively prevent transport accidents (Sweedler 2007):

- How can we improve safety through a better understanding of the features that are common to accidents in different transport modes?
- How can integration of knowledge and experience from different modes of transport help with improving the effectiveness of prevention in the entire transport system?
- How can the collecting of knowledge on transport disasters, crashes and incidents gathered from research and analysis of the causes and circumstances be helpful with creating a better transport policy?
- How can international cooperation provide the key to solving the problem of transport risks?

2. Transport losses

According to the World Bank the total number of transport deaths is now more than 1.2 million people annually and continues to grow. The World Health Organisation estimates that transport accidents are the ninth biggest cause of death for external reasons and the forecasts for 2020 suggest that it will become the third (WHO, 2005). In EU countries transport accidents especially road accidents are the

primary cause of deaths for external reasons among people up to 45 years of age, generating a total loss of more than 200 billion Euro annually, which exceeds the annual budget of the European Commission. Poland loses about 30 billion PLN annually which is more than 2% of GDP and the number transport fatalities is as high as 5,200 annually, ten times that of injuries with about 20% of them disabled for the rest of their lives (GAMBIT, 2005).

Transport accidents also inflict enormous loss to public morale as a result of the destructive impact they have on the quality of life of the victims and their families. Until now economic loss was considered the main factor that accelerated the efforts to build a Europe wide system of transport safety. But since 2001 with the intensifying threat of terrorist attacks, the pace of work on transport safety has been significantly accelerated, especially because the risk to transport infrastructure is the highest. This is why the most developed countries are now seeing transport safety as one of the criteria of quality of life and transport safety has now become a special priority. With transport safety included in the Framework Research Programme as strategic research area 9, Poland has clearly joined the process.

3. The problems of dissimilarities and mutual links

Transport safety is that feature of the system which allows us to use it without accidents or undesirable events. Transport safety is a new field of study and its basic terms, norms and measures have not been firmly established yet. Other open problems include studying the threats to safety and assessing safety (Żurek, 2003).

A review of safety systems enforcement and safety levels by transport branches showed a variety of systems and accident causes. The reason for this differentiation of how safety is organised, enforced and managed is that they each operate in a different space and use different facilities depending on the type of transport. Despite the differences what does not change is the safety philosophy, the causes of risks and the target that all decision-makers and transport users want to achieve. Studies of the safety of transport systems generally look at the following factors:

- risks to safety within the transport system and its environment;
- the transport systems' and external rescue systems' ability to prevent the threats and their effects;
- mutual relations between threats to safety and the effectiveness of prevention and mitigating the effects.

When analysed for their safety, transport systems can be divided into these sub-systems: technical facilities (means of transport), crews or operators, support sub-systems and system management centres. Each of the sub-systems generates risk which may be caused by an external disturbance (e.g. weather or environment) and internal disturbances produced by organisational and functional features, the

"human factor" and ageing technologies, wear and tear of materials and other system deficiencies.

The errors of a transport system generating risks can be analysed using a simplified man – technical facility – environment model. When analysing the effects of human activity on safety, we should take account of the operator delivering his mission without disturbance and when faced with a threat to safety. The modern operator of a land vehicle, ship or aircraft is an educated specialist who oversees systems in an automated cabin and selects the incoming information, looks for answers to questions as they arise and takes decisions to solve problems in a sequence as they appear. The operator provides the backup for automated controls operated in an open system. Even with modern technologies and automated controls, the operator is taken by surprise when unexpected circumstances appear and his mistakes are important causes of accidents and disasters.

Observations of real transport systems show that man as operator is the system's weakest link as can be seen from accident statistics. When operators make mistakes and cause risks, the reasons for the mistakes can be traced back to:

- lack of professional knowledge (low level of education or failure to understand the task);
- forgetting the task because a procedure or activity have not been repeated or practiced (routine, lack of practice);
- insubordination because of their personality, lack of control or motivation;
- no predisposition for the job (health, personality traits).

The mistakes of a transport operator can be analysed if we have access to training documentation, aptitude tests and personality tests. If these data are available from a computer database, they can be processed to formulate some general conclusions and improve the training process and practice. If applied to an error model, which processes classified sequences of events placed on axes of working time, length of simulator practice, length of professional life, etc., the data can be used to determine the likelihood of these risks and how the risks will change. To ensure that we draw the correct conclusions about the influence of man on transport safety, we need other probabilistic characteristics of the random processes when mistakes are made (Smalko, 2007).

When designing a means of transport, to be considered are the aspects of utility and safety set out in regulations and standards, in design theory and methods and the latest technologies of production. Consequently, a means of transport generates risks because:

- the structure is deficient;

- the programme for operating the machine does not take account of the nature of the operation or wear and tear;
- operating standards are not observed;
- operating procedures and technologies are wrong;
- functional elements and systems suffer accidental damage.

The system of driving causes a threat when:

- the mission is poorly prepared and communicated;
- wrong or incomprehensible information and decisions are given;
- the weather or environment are wrongly identified;
- communications is disturbed, etc.

4. Independence of transport research

The public have a right to objective opinions about the causes or circumstances of a disaster, accident or incident within the transport system when people have lost their lives, have been injured or exposed to a risk. This is why the public should be given a legal guarantee that there will be an independent transport safety examination to be carried out irrespective of the circumstances of the disaster, accident or incident. The world's first organisation to have given such guarantees to the public was established in the USA in 1967. The then president Johnson asked professor Haddon to establish an independent institution to integrate road, rail, air, water and pipeline transport safety research. That gave way to the establishment of the National Transportation Safety Board (NTSB), a body appointed by and answerable to the Senate and President.

Almost half a century into the USA's transport safety system history, Americans are certain that to achieve any improvements there must be an independent organisation whose objective is to study the causes and circumstances of incidents, accidents and disasters in all five transport branches. They will also say that by bringing together in one organisation many specialists from different fields, and particularly those whose expertise applies to several modes of transport, such as psychology, medicine, meteorology, theory of systems, encourages the development and progress in transport safety. A combination of independent research and multi-disciplinary approach to safety is the key to the NTSB's success and its future development.

In Europe the Netherlands is the only country to have achieved this goal: in 2005 the Parliament established the Dutch Safety Board (DSB). Its fundamental assumption is that "the right to **independent research** is the only way to establish what really happened and why". Independence is also a way to promote democracy because objective opinion lies at its foundations (van Vollenhoven, 2001).
Other countries are also beginning to introduce concepts of an integrated system of transport safety research. Australia, Canada, Sweden, Norway, Finland and New

Zealand have already built their structures, although with some differences in terms of the powers and scope of operation. Air traffic agencies have the longest history of being separate organisations. They have a huge advantage over other modes of transport in the form of the strong worldwide organisation of ICAO, which is understandable given the frequency and density of modern aviation and the need to operate modern standards that are applicable all over the world.

The NTSB has gathered a lot of experience over the forty years of integrated efforts to improve transport safety. In his 20 years of work for the NTSB Sweedler also helped build the organisation. Today it is divided into four departments:

- finance and operations,
- exchange of knowledge between teams from different branches of transport,
- development of new research techniques,
- key issues in transport safety.

4. Outline of ZEUS project

The initial objective of the project is to integrate efforts for building a transport safety system which will operate as a consistent, statutory and research-based policy rather than a set of ad hoc measures when a disaster happens. Today worldwide many countries have built and are operating similar systems. Poland's objective should be to join the mainstream policies and help build a Europe-wide transport safety system. The important first step in opening project work will be to develop methods for identifying the differences and mutual links between safety systems in road, rail, air and water transport (including urban and regional transport) in Poland and Europe. The basic criterion that should be followed in planning transport systems is the "safety first" principle with emphasis on interdisciplinary data and knowledge bases (Krystek, R. 2008).

The main goal of ZEUS is to develop a model of an integrated transport safety system for decision-makers as a tool for making informed decisions about the development of transport means and infrastructure and for specialists that will implement the decisions. Modern transport is a complex activity requiring politicians, decision-makers and specialists to integrate goals, strategies and measures to ensure a safe transport. If it is to be delivered successfully, the transport safety policy must have a well defined vision, main goal, intermediate objectives and indicators for measuring effectiveness. If it is to be integrated, Poland's transport safety policy will bring together the fragmented parts of the structure from different branches of transport. They involve the different functional arrangements, information, organisation, legal, technical, spatial and human resources elements. To do that will require models and simulations of the operations of an integrated system of transport safety taking account of human factors, environmental protection and technical and technological factors (Gucma, S. 2008; Mieloszyk, E. 2008).

Designed to build the European Road Safety Observatory (www.erso.eu), the SafetyNET project first analysed different ways to define **independent research** in the area of transport safety. In building an independent structure we are always faced with the problem of how to establish an organisation which will be funded by the government but at the same have the right to critique it. But this is how it actually works in countries with highly developed democratic structures and well functioning transport safety systems! While the USA's National Transportation Safety Board or the Netherlands's Dutch Safety Board are funded by government administration, they have the right to be critical about the government and its agencies.

5. Conclusions

Because major disasters do not happen often, public pressure is not constant and demands to establish an independent body to ensure transport safety and carry out an investigation when an accident happens will eventually subside. Public and political pressures only appear shortly after a disaster. In 1994 the UE issued Directive 94/56 which said that investigating the causes and circumstances of transport disasters, accidents and incidents can be done by an independent agency. What this means is that it took 30 years to shape the political will to establish such a body, that is since the establishment of the NTSB in the US. In addition it is important to say that it was not until ten years later in February 2005 that the Dutch Parliament passed the act to set up Europe's first independent organisation, the Dutch Safety Board.

Developed by a Consortium of representatives of road, rail, air and water transport, the assumptions of the Polish Integrated System of Transport Safety project are as follows:

- we have to have a uniform system of national transport safety councils in all European Union countries to gradually integrate the individual national commissions from different transport branches into a single structure;
- in Poland the first step could be to integrate the State Aviation Accident Commission with the State Rail Accident Commission;
- the model for introducing changes in the countries should be the Dutch model; the Dutch Safety Board – the official Partner in delivering ZEUS.

When comparing the different levels of risk in the transport branches, we are usually quite surprised to see such high disproportions; as much as 95% of the casualties are road accidents victims. Compared with that the other three branches of transport combined have small losses. Perhaps this is now the right moment to remember this well-known quote "We all know that flying is dangerous. But maybe this is why it is so safe". Another important quote is from dr. Lauber, a former NTSB director "Lack of accidents does not necessarily mean the existence of safety".

References

[1] GAMBIT (2005): *Krajowy Program Bezpieczeństwa Ruchu Drogowego – Wizja zero*. Politechnika Gdańska, Katedra Inżynierii Drogowej. Ministerstwo Infrastruktury. Warszawa 2005.

[2] Gucma, S. red. (2008): *Metody symulacyjne w inżynierii ruchu morskiego.* Wydawnictwa Akademii Morskiej, Szczecin, 2008.

[3] Krystek, R., Michalski L., Żukowska J. (2008): *Integrated System of Transport Safety*. 9th World Conference on Injury Prevention and Safety Promotion. Merida, Mexico. 15-18 March, 2008.

[4] Mieloszyk, E. (2008): *Nieklasyczny rachunek operatorów w zastosowaniu do uogólnionych układów dynamicznych*. Wydawnictwa IMP PAN, Gdańsk, 2008.

[5] Nowak A., Sitarz M., Verbicki W.: Analysis of Brake – Wheelset Railway Dynamics Turing the Motion, Mechanika 2004, Nr 2 (46), str. 52 – 59 Grant KBN Nr 4T12C 03524 „*Projekt szybkich połączeń kolejowych w Polsce w ramach europejskiego systemu transportowego*".

[6] Smalko, Z. (2007): *Charakterystyki spolegliwości układu człowiek-maszyna-otoczenie*. Materiały Szkoły Niezawodności PAN, Wydawnictwo ITE ,Radom 2007.

[7] Sweedler, B. (2007): *Improving Transportation Safety – the Integrated Multimodal Approach.* First International Seminar ZEUS, Pułtusk, 20-22 June, 2007.

[8] Van Vollenhoven, P. (2001): *Independent accident investigation: every citizen's right, society's duty.* 3rd European Transport Safety Lecture. European Transport Safety Council. Brussels, January 2001.

[9] WHO (2005): *World Report on Road Traffic Injury Prevention*. Geneve, 2005.

[10] Żurek J. (2003): *The method of evaluation of transport system availability*". Safety and Reliability International Conference *To Safer Life and Environment,* KONBiN'03. Materiały Konferencyjne, Wydawnictwo ITWL, Warszawa 2003, Nr 3/2003