INTRODUCTION

Our objective is to conduct a study that will determine the best approach to developing the integration of information and communication technology (ICT), in the growth and management of the land transport of hazardous materials.

We are especially interested in:

- Determine the best technology in use, applicable to the requirements for management and control.
- Determine the requirements and necessary procedures to apply the technology.
- Sketch a design for a control system in agreement with current norms.

We will suggest a solution to the control of the land transport of hazardous substances within the parameters of information and communication technology.

Our view is open to all technology and the current situation of the urban land transport is used as a starting point to reach a definite solution.

This work is focused on the area of land transport made up by the different types of vehicles for transporting hazardous substances: tanker trucks, bulk liquid trucks, coupled-bed, cold or refrigerated cargo trucks with varying level of security in their body.

Although many of the conclusions reached are applicable to other areas of transport, railroad for example, they are not part of this study. It is concerned, then, with the logistical chain for the transport of hazardous materials in different types of vehicles allowed.

If we understand that the goal of the urban transport of cargo is the movement of good necessary to the economic activities carried out in the city, the quantity and type of cargo transported corresponds to the growth of economic activity. On the other hand, the urban transport of cargo is an essential part of the growth of the business supply chain, representing a relevant percentage within total costs, and requiring caution when placing restrictions on cargo transport.

We want to analyze the transport of hazardous cargo in the road system with a goal of maximizing the management, control and fiscal regulation of the variables created by this distribution link.

It is common to note that distribution refers to the process of placing merchandise for consumption or use within the reach of factories or production centers and to refer to transport as the process of carrying supplies or goods from these zones of influence. Nevertheless, from a conceptual point of view, this is incorrect.
A series of cargo regulations exist in Santiago. The Urban Transport Plan also includes a series of measures to mitigate the effects caused by trucks.

Certainly, although cargo transport is only a small fraction of total trips, this does not mean the problems caused by trucks should be ignored. For example, we know that congestion in streets authorized for cargo loading and unloading causes important costs and the location of some activities during peak hours (The Vega for example) causes traffic problems in adjacent streets. But in many cases this involves traffic problems that should be handled on a case for case basis, not through general policy.

The transport of hazardous residuals or materials is an item of no small consequence in the transport of cargo, recognizing that they represent a potential risk to health and property such as installations, machinery or buildings. In Chile, nine classes of hazardous substances, classified by the NNI according to potential risk, are transported: explosives, gases, flammable liquids, flammable solids, combustible agents and organic peroxides, toxic and infectious substances, radioactive materials, corrosive substances and divers dangerous goods. The chemical, petrochemical, combustibles, compressed gases and large mining (explosives) industries are those basically involved.

According to the registers of the Logistic Association of Chile (ALOG), there are few companies in the carrying of hazardous goods, since “it is a market niche with high entrance barriers in relation to infrastructure, equipment and personal qualification”.

As a result of commercial agreements, Chile must adjust its norms to international standards. But there are large deficiencies in the training and preparation of personnel involved in the handling of dangerous goods and failures in the ability to regulate and sanction that “the authority can effectively exercise over those that violate the norm”.

Nevertheless, the Department of Contamination Control (CONAMA) has stated that a resolution of the environmental authority in order to transport dangerous substances is needed and that when the Regulation for Hazardous Residuals goes into effect, all industries that produce dangerous substances will be required to present a management plan and report on the substances they produce, in what quantities and what percentage of those are reused, recycled stored or transported.

PROPOSAL FOR A SYSTEM OF IMPLEMENTATION OF MODULES

I. Development of a module system:

The first objective is to determine a starting point of the proposed solution. This solution could be structured in stages, each one progressively more complex in relation to the previous one. Create an efficient system of management and control of the transport of dangerous cargo. This could be done with a system that, taking currently existing regulations and structures, will allow for non-intrusive, low cost solutions which can be implemented on the short term. This will lead to more complex systems that will have more efficient control through monitoring devices and in-site registry, where, in space and time, the transport event is carried out.

II. Initial phase: First phase model.

The model for an initial system or first phase, that will allow the efficient control and regulation of all management of hazardous cargo, basically emerges from the solution of logistic problems already studied for this type of transport. These can be summarized as the following:

a) Complete compliance with existing rules.
b) Exchange of expertise between service providers and the regulating agents.
c) Utilization of existing points of control.
d) Utilization of existing technological tools.

III. Description of the model in four steps:

1. Information from on-line security data sheets to provide preventative information and not in reaction to an emergency.
2. Codification of information of contents transported to be read by a long distance device and without the need for regulation that would stop the transport in route.
3. Portable devices in order to provide a regulation tool that recognizes the relevant type of cargo being transported and its agreement with the information on-line.
4. And emergency system that communicates information immediately and simultaneously to emergency agencies.

IV. Description of the technological agents to be used:

1. On-line checking of information that can be done through a Web site or direct Intranet communication between the companies providing transport services and the bodies involved in regulation and emergency assistance.
2. The information can be codified via a device to save information, such as a bar cod or data transmission system.
3. Free Flow Systems to read the data from afar and in real time.
4. Communication system, via cell phone, wi-fi or GPS alert system.

V. Structure of the first stage system:

1. Truck leave clearance:

Personnel qualified and certified in knowledge of substances identified as “hazardous”, will create and on-line report, via Intranet, to the regulating and emergency institutions. This will also store the information concerning the emergency locations along the trucks route. (Reading points)

2. Capture and checking of information:

The capture of information can be done in a route through writings in places such as:

- Highway toll booths (Tag)
- Available points for tool booths
- Overpasses of tunnel entrances
- Route monitoring:

In this last case, route monitoring conducted by regulatory personnel, who can check the cargo information not only on the security sheet, Which the driver must carry, but also by reading the on-line information (Web). They will also rely on a portable device to read the coded information.

In all of the previous cases, information should be issued simultaneously, including the cargo (weight, volume distribution, chemical characteristics, radiation, etc.), as well as the route information (GPS) and the transport vehicle’s characteristics.

VI. Steps to a larger system, development of an integrated control system for the transport of hazardous materials (SIGCAP)

The design of a “Management and Control System for the land transport of hazardous cargo” (SIGCAP) is a totally understandable need, in light of information and communication technologies (ICT) and their application for transportation such as Intelligent Transport Systems (ITS). The importance of this project is in providing an intrusive regulatory system, in other words install devices on trucks in such a way as to recover data in real time, providing information related with cargo and sending it to a central system that will integrate information to give data about the vehicle, cargo and route in real time.

Sensor system: installing in the vehicle a wireless network of sensors will provide information such as temperature, humidity, radiation levels, pressure and data on cargo movement. These parameters, in addition to other methods for supervision like GPS, to coordinate the truck’s speed and position, is constantly sent to a central control system that will monitor and organize an alarm system in case any of the parameters indicate a risk that could lead to an emergency situation.

VII. Description of the system

The system (SIGCAP) in its entirety can be seen as two sub-systems: An internal portable monitoring system (IMS) carried inside the vehicle and the central supervisory system (CSS) The IMS and the CSS are integrated by wireless communication systems.

- **IMS**

The IMS module is made up of a pocket PC connected to a cell phone, a GPS receiver and the respective sensors, all of which are integrated by a wireless network easily installed in the vehicle. The sensors are distributed in the cargo bin in a strategic manner so as to obtain maximum security and effectiveness in their measurements. On the other hand, the pocket PC, cell phone and GPS will be in the driver’s cab within easy reach and monitoring information in real time.

- **CSS**

The central supervisory system (CSS) is made up of an office-branch computer that receives data from the vehicle’s onboard systems and can send information like a route map to be followed and answers such as alarm signals in case of an alert of a dangerous situation. The CSS should have a direct, simultaneous line to respective security bodies.

VIII. Technical innovations and benefits of the system:

There is actually a system currently in use to improve the distribution of cargo, sealed devices to prevent damage or theft. Systems exist, for example, that can close the truck’s interior compartments or shut the truck’s engine in case of a threat. Our SIGCAP system proposes an innovation through a process of continuous, versatile and easy functioning control modules and sensors. The system recognizes failures, adverse situations and provides rapid answers in the case of emergencies. Our project exhibits the following technical innovations:

- **Dynamic and interactive monitoring:** while current communication systems only allow for unidirectional communication, our system can establish bi- or multidirectional information connections.
- **Universal interface sensors:** the cabin module can be used with any type of sensor.
- **Sensor WLAN:** each sensor is a node in a network with access points to the pocket PC.
- **A remote data base of hazardous cargo:** Direct transfer of data on the specific
hazardous cargo and the best placement for sensors in the CSS.

- **Portable and flexible:** the system is completely portable and can be located in the driver’s cab as well as in any vehicle in a critical area.
- **Real time monitoring of cargo:** a continuous interaction of transport information between the IMS and CSS.

IX. **Consideration for its implementation and engineering:**

Our project requires a design that balances the hardware and software. The need for an easy operating system is an important point in the design process. The tools anticipated for its implementation are based on technological devices and tools that have been used in implementation system at a worldwide level; communication protocols that are every day increasing and more at hand. Our nation has a level of engineering software development that allows confidence in the ability to develop and apply high level solutions.

X. **CONCLUSIONS:**

In a society where the value of prevention and protection of life is each day more important, a system capable of preventing accidents, avoiding exposure to critical work situations and human error, above all in the sensitive area of the transport of hazardous merchandise, is a priority need. Above all, natural or new external factors or unforeseeable threats such as terrorist violence are factors to keep in mind in all sew systems. The advantages of SIGCAP refer to:

- **Real regulation measure in this form of transport:** Whatever the level to be reached in developing a hazardous materials regulatory system, we believe that using the stages outlined here will provide a significant advance in dealing with this area of transport logistics so highly necessary and constantly growing in our nation’s economic development.
- **New reaction to emergency events:** the computerized system developed can enter simultaneous contact with all corresponding agencies. This is accomplished with an on-line, simultaneous and real time system, a real difference to the current sequential nature in emergency situations.
- **Minimize the environmental impact:** an accident involving the transport of hazardous materials can contaminate an area for a long time. Real time supervision of cargo can prevent an oncoming explosion of accident. It can detect a leak of chemical, gas or high level radioactive agents through sensors of any irregularities so effective measures can be taken to avoid or minimize such an event.
- **Avoid the threat of terrorist attack:** In case a rapid rescue of a vehicle or cargo that has been compromised is needed. This is accomplished with rapid contact to the appropriate agencies to fight these types of events, supplying information for a proper response.
- **Economic savings:** this proposal has great advantages for transport companies, regulatory agencies and those in charge of actual management. It facilitates the work of Chile’s Fire Fighters and the Carabineros, in that the system allows quick responses to whatever event that would impede or put behind schedule transport in respect to schedule or stages of completion.
- **Increase of reaction speed:** the computer system developed can enter into simultaneous contact with all corresponding agencies, via an on-line, simultaneous and real time system the difference in an event like that studied in the chapter on reaction and accidents.
- **Efficient and effective system:** The lesson learned from the Trans-Santiago Plan about being cautious but effective in the implementation of changes that will not alter social conditions and dynamics.