# Applying systems methodology to the road safety challenge

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**In 1999, the estimation of fatalities in road crashes worldwide was 800,000 per year, forecast to grow to between 1.1 and 1.2 million in 2010 and to between 1.3 and 1.4 million by the year 2020 (Silcock, 2003). Specific time-proven strategies like databases or black spots are being introduced worldwide, but to no avail. But in the same undeveloped countries, with the same people, the level of safety in other modes of transport, like air or maritime, is improving every year. It looks as if in road transport we are doing something wrong, and more of the same old recipes will not be the answer.**

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Road safety is handicapped by the terminology we use. Words have the power to convey impressions as well as meanings, starting with the concept 'road safety' itself. For years the words 'road safety' have been understood to apply to activities that properly belong to roads and, by extension, to the roads authorities. By implication this has reduced the role of activities in a number of different areas, in spite of their potentially significant contributions (Del Valle, 2007).

For example, in the UK, Burrough, (1991) indicates that only one-third of the target reduction will be delivered by road safety engineering measures while Koornstra ( 2002) indicates: 'The contribution of local road engineering to the fatality reductions between 1980 and 2000 is estimated to be 4% for Sweden, 10% for Britain, and 5% for the Netherlands'. TEC (2003), quotes research from Imperial College, London, that indicates that progress in medical technology and care has made a significant contribution to the 45% fall of fatalities during the last 20 years, and accounts for 700 lives saved annually, and further proposes that the lack of appreciation of the benefits coming from the medical area, suggests that road safety is probably less effective that thought. It is implicit that the author of the research did not consider medical activities as a component of a road safety management system, but something that is external to it.

Another handicap is the concept of 'problem areas' which reduces road safety policies to a simplistic problem-solving approach. Ogden (1996) indicates: 'An approach based in notions of cause and blame is simplistic in the extreme'. It is more correct to recognise that road safety activities do not solve problems. For instance, when a safer road design is implemented, hopefully the number of incidents, or their seriousness, will reduce, but they will not disappear. This is not a problem that will be 'solved'. Instead a systems approach would permits us to view road safety as an area where the situation can be improved thanks to a fully developed management system which implements the correct conceptual approach and allows policies and programs to evolve to reduce casualties and damage to property.

It is useful to learn from the different results between road and air transport safety, the latter, an area full of risks but with very low numbers of accidents and victims (in the order of 500 fatalities per year worldwide in commercial aviation). In systems methodology terms we can say that in air transport, the design of the control apparatus of the risks is up to the job. The reason why road transport has such a high and growing number of fatalities is, simply stated: the design and activities of the management system are not up to the complexity of the situation. This means that it is necessary to see road safety prevention as a system, and develop a comprehensive, holistic design of this management system, and implement it in a self-sustaining way. It is clear from this definition that commitments to specific projects instead of the design of the control apparatus for this public health emergency, is at the root of this collective tragedy in many countries.

An example in the Air Transport Sector is the exemplary program run by the FFA and ICAO called International Safety Oversight. (FAA, 2002). The program's goal is to determine the ability of individual States' authorities to oversee regulatory programs in compliance with ICAO Standards. As can be seen, this program is devoted to analysing the design of the management system to control air transport safety, and it is not concerned with specific actions over the controlled entities. A typical checklist can be seen in the reference.

An implicit preoccupation of road safety policy has been to define the scope of activities or, in other words, what are the components of a road safety management system. One of the early propositions as to how to identify road safety prevention components, developed in the 1920's in the USA, was the 3E's (Enforcement Engineering, Education), and referred to as a doctrine by OECD (1997). This early and limited vision promoted a flurry of analytical activities, which resulted in significant improvements, for example, by introducing design specifications for highways. But is worth noting that until the work of Ralph Nader (1965) vehicle design starts were not considered as part of the engineer's component of the 3E's doctrine. Obviously, this early approach missed significant opportunities to save human lives, for instance, by not considering explicitly the activities of emergency service responders or the role that infraction systems oriented to modify erroneous behaviors could play.

## DIFFERENCES BETWEEN ANALYTICAL AND SYSTEMS METHODOLOGY

Before developing a management system based in systems methodology it is necessary to define some elements of it, following the definition of Ackoff (1981). This is necessary because we are so used to analytical approaches that most of us will be hard pressed if asked to identify an alternative to analytical methods. The analytical approach is a three-stage process (1) taking apart the thing to be understood, (2) trying to understand the behaviour of the parts taken separately, and (3) trying to assemble this into an understanding of the whole. A cause-and-effect is used to explain interactions, hence to build an understanding of the whole.

But this approach runs into problems when applied to a system, because when a system is taken apart it loses its essential properties (Ackoff,1981). For example, it is not possible to understand a barrier's contribution to road safety without reference to its interactions with specific groups of vehicles.

A systems approach starts with developing an understanding of the whole and after that we look at the components in relationship to the whole. The crucial difference is that in systems methodology we don't start by developing a diagnosis, but by developing an holistic image of the future. This is presented in Table 1, with its qualitative targets in Table 2. Only then can we look at the different components to assess how to progress from presents states to future states.

## DESIGN OF THE CONTROL SYSTEM

If we criticise old designs, such as the 3E's doctrine, it is time to propose a new design, which explicitly considers road safety as a system, bearing in mind that we are interested in gaining control of it. In fact, we are interested in the design of the management apparatus for this situation. To help us we can use the powerful definition developed by Ashby, (1956) called 'the law of requisite variety'. This states: 'The control apparatus needs to have a variety equal to or greater than the variety of the situation to be controlled'. In simpler terms, if you need to install signals at an intersection with three conflicting accesses, a two-stage controller will not be capable of controlling it, but a controller with three or more stages will. In fact, in order to design a control system, we need to investigate the complexity of the road safety situation.

The most effective effort, that the author is aware of, to develop a comprehensive, holistic design of a road safety system, with the direct participation of 123 persons representing different areas of activities, was done in Chile, (CONASET, 1993), utilising the methodology for the design of social systems developed by Del Valle (1992). The result was a definition of the whole system included as Table 1, called 'Road Safety System', defined by its components.

An informal test of this completeness can be done simply by considering this management system without any of its components, for example if we remove emergency service response we simply lose opportunities to save human life arising from activities in this area.

It is worth mentioning that an important property of systems methodologies is that there is no priority among the components nor is one component more 'important' that another. Old words, typical of the traditional analytical approach such as 'prioritise' don't make sense in well developed systems, but unfortunately 'Let us get our priorities right' is a common cry. Yet in a holistic account of an interactive system, the cry makes no sense. (Beer, 1993). For example, in air transport only an unsafe airline will priorise between safety activities, perhaps delaying the inspection of the front wheels to divert resources to more 'urgent' safety necessities. The extended use of the word 'prioritise' in road safety programs is a clear indicator of how badly chosen the methodological approach to road safety has been compared with approaches in other modes of transport.

Table 1 was utilised in Chile to evaluate which of the areas can be considered 'developed', based on a set of criteria developed by Del Valle (1992). It means:

(a) They have organisations dedicated to the subject with a clear mission;
(b) Appropriate level of resources; and
(c) With a permanent capacity for innovation.

These lines are identified in capital letters, as line A-7. In total, only 16% of the lines where found to be 'developed', and this small number is the answer to the question of why in 1993 Chile had such a high levels of fatalities, increasing by up to 7% per year. It clearly shows that the capacity to control this situation was marginal.

**Table 1: Definition of a road safety management system**

| Road Safety Management System | |
|---|---|
| **A. Drivers, training & licensing** | **E Enforcement** |
| A-1 Training of professional drivers | E-1 DRIVERS ENFORCEMENT |
| A-2 Training of car drivers | E-2 Technical conditions of vehicles |
| A-3 DRIVER'S TESTING | E-3 Technical conditions of roads |
| A-4 Training of driving instructors | E-4 Inspection of transport services |
| A-5 LICENSING OF INSTRUCTORS | |
| A-6 Licensing of practical examiners | |
| A-7 DRIVING SCHOOLS SUPERVISION | **F Judicial action** |
| A-8 Permanent grading of drivers | F-1 PROSECUTION OF INFRACTIONS |
| **B Management of vehicle quality** | F-2 Efficient infraction systems |
| B-1 Technical specifications | F-3 Law modification |
| B-2 Safety Equipment | F-4 ACCIDENT INVESTIGATION |
| B-3 New vehicle's certification | F-5 Civil responsibility of the State |
| B-4 Technical inspection | |
| B-5 Supervision of vehicle inspection shops | **G Accident control and insurance** |
| B-6 Supervision of maintenance shops | G-1 Comprehensive rescue system |
| B-7 Mechanics training | G-2 Comprehensive rehabilitation system |
| | G-3 Insurance coverage |
| **C Management of roads and public space** | |
| C-1 Traffic Management | **H Research & information** |
| C-2 Signs & Markings | H-1 Integrated information systems |
| C-3 Safety Audit | H-2 DRIVERS AND INFRACTIONS REGISTER |
| C-4 Black spots | H-3 VEHICLES REGISTER |
| C-5 Maintenance | H-4 Crashes register |
| C-6 Road safety elements | H-5 Preventive indicators database |
| C-7 Rest areas for drivers and bus stops | H-6 Register of instructors and examiners |
| C-8 Pedestrian facilities | H-7 Crash studies |
| *C-9* Bicycle facilities | H-8 Users information |
| *C-10* Land use planning | |
| **D Management of transport services** | **I Education and communications** |
| D-1 Remuneration systems | I-1 Curricula |
| D-2 Work conditions | I-2 Teachers training |
| D-3 Permanent grading of personnel | I-3 Didactical materiel |
| D-4 Dangerous loads and stowing | I-4 Students protection |
| D-5 School children's transport | I-5 CAMPAIGNS |

| Qualitative Objectives of a system approach to R.S. (Vision)<br>Road Safety (General): A Country with low incidence of transport fatalities | |
|---|---|
| A DRIVERS, TRAINING & LICENSING | Competent and socially responsible drivers |
| B MANAGEMENT OF VEHICLE QUALITY | Safer vehicles with adequate maintenance |
| C MANAGEMENT OF ROADS AND PUBLIC SPACE | Roads and public spaces conditioned for an harmonic use by vehicles and pedestrians |
| D MANAGEMENT OF TRANSPORT SERVICES | Service conditions that don't generate noxious pressure over drivers and companies. |
| E ENFORCEMENT | Behavior and actions maintained inside legal norms |
| F JUDICIAL ACTION | Non - responsible persons sanctioned in a socially constructive form |
| G ACCIDENT CONTROL AND INSURANCE | Timely rescue and assured rehabilitation for victims |
| H RESEARCH & INFORMATION | Actual and Integral knowledge about the road safety phenomenon |
| I EDUCATION AND COMMUNICATIONS | Active public conscience about road safety |

**Table 2: Qualitative targets**

The successful implementation of a national program to develop other lines, still ongoing, resulted in fatalities 30% lower than trend figures in six years, with a net assignment of resources of less than US$ one million per year. The author is not aware of any other country with a medium income level that made such progress with this investment level.

The experience in a number of countries shows that this basic definition needs to be subject to modifications to cover all areas that have the potential to contribute to reducing casualties in a specific country. For example in the UK there existed for many years a subsidy to car ownership in the form of tax benefits to companies that provided cars to employees as a financial perk. In so far as there is a significant difference between the accident rates for cars and public transport, for example, estimated in Germany as 26 times (Statistisches…, 1999), this subsidy moved trips from public transport to company cars with a negative impact on safety. This is another example of how actions in diverse areas influence the results, or as stated by the Forrester law (Forrester, 1969): in any complex system, the results of any action are always counter-intuitive.

## QUALITATIVE TARGETS

A system will need to adopt a set of qualitative targets, included as Table 2. This will be useful to create a framework for specialists to develop further with quantitative targets associated to specific time-frame measures.

## BENEFITS OF UTILISING SYSTEM METHODOLOGIES

A systems approach provides a clear design of the road safety management system to assess different countries and communities, discovering the areas that can provide more collaboration to the ultimate goal of saving human lives, pain and suffering.

It provides a clear test to identify undeveloped areas ie, an area that has no organisations dedicated to the subject with a clear mission, appropriate level of resources, and with a continuous capacity of innovation.

It liberates us from the narrow problem-solutions thinking, typical of the analytical approach. In this new systems scenario if we need to address a specific situation, we have now the obligation, and the opportunity, to develope a systematic search in all areas for counter-measures. The question is: how can the different areas collaborate in this specific situation? This approach will move us away from the crude approach of road-vehicle-driver interactions, and to the recognition that there are more relations than the direct ones identified by analytical approaches. For instance, in the fatal accident of Princess Diana in Paris, analytical methodologies easily identify that a row of unprotected pillars exists in the underpass (still unprotected), but only a systems vision will recognise that this accident also shows that the efforts of the Paris police in the areas of drink driving or inappropriate speed control have not gained sufficient credibility with the public.

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