Introduction

Concern about the human suffering caused by road accidents has been voiced in many quarters ranging from technical fora to the public media. This concern emerged from the halcyon era of automobiles as depicted by Toad of Toad Hall in *Wind in the Willows* where patron's of horse drawn carriages were alarmed by the new horseless carriages. In the seventies, Ralph Naider's book *Unsafe at any speed: the designed-in dangers of the American automobile (1965)* challenged the safety design of vehicles. Recent concern has been that in spite of substantial awareness in design, enforcement and education, road accidents are likely to be the third highest cause of death by 2020. (Klein 2001)

The Australian Government commits substantial resources to programs that improve components of the road safety system, for example Police, hospitals, road safety initiatives, vehicle inspections and registration. Each of these initiatives indubitably reduces the human suffering related to road accidents but there seems to be few adequate management processes to explain yet another tragic accident on the road.

A conclusion that could be drawn from the inability of current management processes to produce socially acceptable safety outcomes is to suggest that a new approach for analysing the system of road safety is required. One analysis technique that is ideal to explore complex situations, particularly where the responsibility for control is decentralised, is Systems Theory.

This paper examines the differences between the traditional approach to road safety and the Systems approach to analysing the problem of road safety. Existing approaches to analysing road safety are reviewed, and suggestions made for developing descriptions of the System of road safety. The advantage of considering road safety as a system is that it enables specific road safety initiatives to be understood in the context of the whole system. This has the potential to provide more integrated and effective decision-making.

Specifically, this paper outlines the approach being taken by a current review of safety on the National Highway in Tasmania, and provides a strong case for the application of Systems Theory to road safety problems.

Traditional view of Road Safety

The traditional approaches to the analysis of the road safety problem are classified into four approaches *OECD Road Transport Research report IRR892483 Road Safety Principles and Models (1997*). These four approaches are summarised below in order of their application to the road safety problem.

1. The Descriptive approach: Control of the vehicle was seen as the problem. Consequently the failures to control the vehicle were described, eg. a collision

diagram. Accidents were recorded but provided little information about the cause or remedy of the accident.

2. The Predictive approach: Control of the interaction of vehicles was seen as the problem. The management approach was to apply engineering, education and enforcement to modify driver behaviour and accident outcomes. By aggregating accidents of similar types, predictive models were developed that enabled the identification of generalised situations that were unsafe. Eg. roundabouts were identified as reduced accident severity junctions.

3. Risk modelling approach: The response of drivers to risky situations was seen as the problem. By analysing the perception, acceptance and control of risk more appropriate driver behaviour was anticipated. Examples of this analysis are the solutions of Traffic Calming and Defensive Driving.

4. Accident Consequence model approach: The management of the transport system as a whole was seen as the problem. By refocusing on the provision of transport generally issues such as traffic mix, modal shift and accident consequence reduction devices such as air bags or prestressed cable fences are seen as the solution.

With each of these approaches to analysing the problem of road safety it is obvious that the analysis has presumed what part of the problem should be analysed and thus has predetermined, to some degree, the type of solutions produced by the analysis.

The approaches yield little information as to why accidents continue to happen in spite of the measures taken. This inconclusiveness about the cause for continuing accidents is a product of the analysis technique used in each of the approaches. By assuming what the problem is and then reducing the problem into component sub-problems, the interconnectivity of the system of road safety is lost.

This reduction of the problem into sub-problems is known as Reductionalism, and is the traditional approach to the analysis of a problem. Reductionalism assumes that by reducing a problem into sub-problems that the whole problem can be understood by combining the understanding of the sub-problems.

Limitations of a Traditional approach to Road Safety

This section demonstrates that the application of this traditional, reductionalist, approach is sub-optimal for many aspects of the system of Road Safety.

The *National Road Safety Strategy* 2001-2010 prepared for the Australian Transport Commission by the Australian Transport Safety Bureau details a tradition or reductionalist approach to managing road safety. This is demonstrated by a number of features including:

1. The distinction between planning and implementation in the Strategy and Action Plan documents;

2. The presumption, evidenced in the Action Plan, that the improvement of any one component of the road safety system will constitute an improvement to the whole system outcome;

3. Due to the distribution of control, accountability for attainment of the road safety targets is unallocated.

These three features are discussed individually to more fully describe the consequential limitations of these assumptions.

1. The artificially categorisation of activities into planning, as detailed in The National Road Safety Strategy, and implementation, as detailed in The National Road Safety Action Plan, is to ignore the inter-relatedness of planning and implementation. There are three points that are noteworthy:

   - That this distinction, into planning and implementation, is typical of a traditional approach to strategy formulation and is demonstrably artificial (Mintzberg 1994)
   - That this distinction is a reductionist assumption (Checkland 1999),
   - That this assumption about a system limits the likelihood of a successful outcome (Piercy and Thomas 1984).

2. The assumption that an improvement in any one component will constitute an improvement of the whole system also ignores the inter-relatedness of the system of road safety. This assumption is also typical of a reductionalist approach to problem solving. Systems have a unique ability to establish an equilibrium condition between system components. This is often observable in the system of road safety. The introduction of a new safety device such as Speed cameras or safety belts, yields a temporary improvement but then the system tends to revert to an equilibrium condition only slightly improved from the prior condition.

3. The National Road Safety Strategy has an emphasis on the multifaceted nature of road safety and allocates various actions to various components. To this extent the strategy adopts a systems approach. However the distinguishing feature of soft systems analysis is that it emphasises the interconnectedness of the components. The strategy does not link these components together except to say that if high standards for each component are achieved, by comparison to international experience, improvements in performance can be achieved (*National Safety Strategy 2000*):

- 19% through improved safety of roads;
- 10% through improved vehicle occupant protection;

- 9% through improved road user behaviour; and
- 2% through new technology to reduce human error.

The footnote on this analysis acknowledges the lack, in the original analysis, of consideration of the inter-relatedness of these various improvements. Thus these numbers, that are the basis of the 40% improvement specified in the strategy, are revealed as an educated guess and unsupported by any modelling of the road safety system as a whole. Thus while individual program areas may achieve their targets, there is no overarching guarantee that the targeted 40% reduction will be achieved.

In applying the traditional approach to analyse the problem of road safety there is a presumption that there is a centralised control component that is responsible for the overall coordination and achievement of stated objectives. In the case of the National Road Strategy it is presumed that engineering improvements to the safety of roads is being coordinated with improved road user behaviour. However these two activities are carried out by different management structures with no centralised authority responsible for the attainment of the 40% goal.

The National Road Safety Strategy has been revealed as a traditional approach to problem analysis involving the fragmentation of the system of road safety to a level where the significance of the inter-relationships between system components is lost.

Systems Approach

A system is composed of a collection of elements connected together to form a whole. The key theme of the Systems approach is the recognition that the lines of communication allow the decentralisation of control in the system. The characteristic of systems is to have decentralised responsibility for control and yet to achieve stable outcomes. Ecological systems are a good example of these stable outcomes being achieved with no centralised control system. This stability, without centralised control, is what is being sought to manage road safety.

A Systems approach is characterised by commencing the inquiry process by seeking to understand the system rather than trying to understand the problem. By first providing a model of the system that aligns with the observed behaviour, confidence is gained that the interconnectivity of the system components is understood. The next stage is then to focus on the problem situation and to develop predictions and counter-measures knowing that the response of the system as a whole can be anticipated.

Soft Systems Methodology

This methodology was developed by Checkland (1981) from General Systems Theory to accommodate qualitative modelling situations. It draws a distinction between reality, as experienced by humans, and the model created to explain the experienced reality. By objectively examining this analytical model of the system, an appreciation of the flow

of cause and effect through the system is elicited. The process of developing this model of the system achieves two outcomes.

Firstly, an appreciation of the true inter-connectivity of the system is gained. This is useful for the Client of the systems analysis as it clarifies the range of related factors in the problem situation. (Checkland 1999)

Secondly, the process of eliciting this model achieves organisational learning where the client, who are themselves part of the system, place greater emphasis on understanding other people's perspectives and on the importance of combined action to resolve the problem situation. (Senge1994)

Systems view of Road Safety

Soft Systems Methodology has two principal processes, developing a model that accounts for all perceived inter-relationships and the development, based on the modelling, of action plans to improve the system. The individual steps are shown in Figure 1.

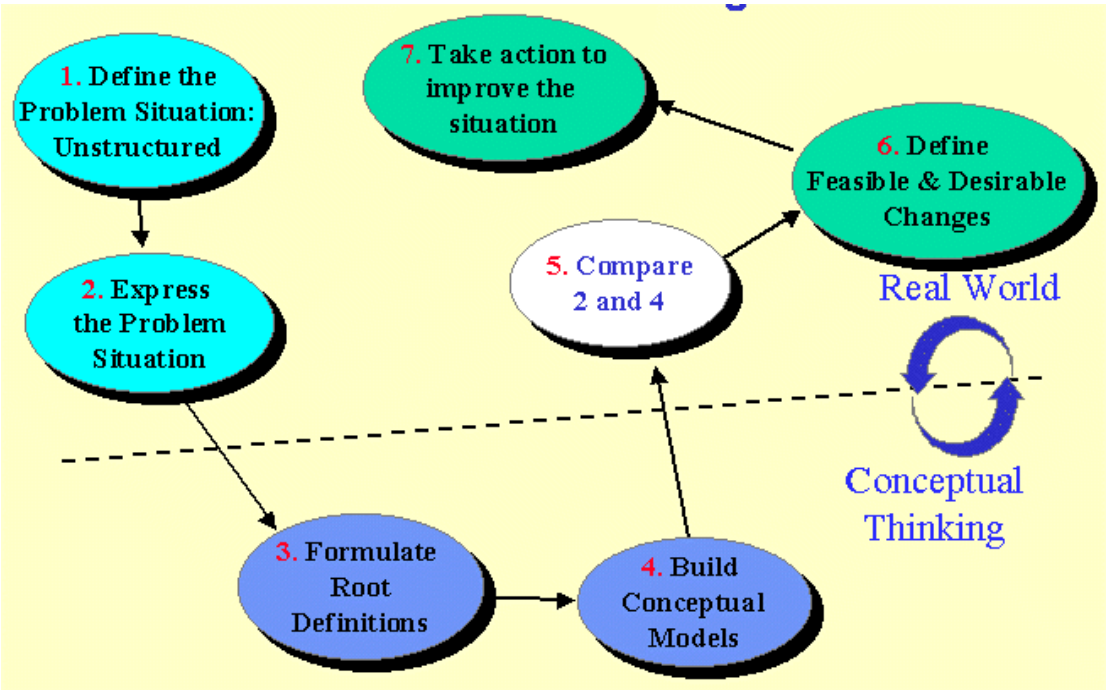

Figure 1 Soft Systems Methodology

The two consequences of applying a System approach, a comprehensive appreciation of the inter-connectivity of the system and systems learning for human agents within the system, are uniquely appropriate for the analysis of road safety.

Appreciating the inter-relatedness of the Road Safety System

Drawing out the inter-relationships between system components provides managerial opportunities in the areas of planning, managing and implementing improvements to the system of road safety as a whole.

Due to the analytical philosophy underlying the current structure for managing road safety, groups with similar technical competencies are grouped together and are sometimes referred to as "management silos" to identify the vertical specialisation within groups. Specialist managers who are responsible for the interface with other specialist units then manage these groups. Thus Police and enforcement authorities have only minor involvement in law making, or the determination of suitable consequences for illegal behaviour, etc. In this structure the opportunity to identify the inter-relationships of the underlying technical processes is reduced because the specialist managers may not appreciate the technical detail of the processes being studied. Current organisational efficiency programs have reduced the number of these specialist managers to a level where appreciation of the technical content of the area they supervise is reduced. Indeed there is a popular concept of a "Generalist Manager" who, while responsible for a management silo, is only marginally aware of the technical discipline of the area.

This style of management, whilst efficient, is ineffective at establishing interconnectivity between technical specialists. In the domain of road safety, this interconnectivity of the technical detail is important. A systems approach allows these inter-relationships to be identified through a formal process. The incorporation of the understanding gained from the system analysis is then an appropriate input to the specialist managerial processes.

The consequences of this specialisation of the managerial function are clearly demonstrated by the funding allocations made under this approach. Different management functions will be funded differently in spite of sharing the same community objective, ie safe transport. Areas such as Police, road infrastructure and hospitals have had major government funding for the whole of the twentieth century. Conversely driver education has been relatively poorly funded by government and is still largely funded by the individual driver.

Conceptually, the funding of the various programs to improve road safety needs to be on the basis of anticipated improvement. Currently actions are funded mostly on the basis of ability of the financial transactions to accommodate the cost of the improvements. Thus vehicle design improvements are relatively easy to accommodate within the financial transactions of vehicle ownership. The sales emphasis is one of paying a premium cost to improve the personal safety of the purchaser. However the proposition that a premium price should be paid to improve people's safety, other than the driver/purchaser, is not an easy product to sell and thus implement. Such improvements such as brake lights, or the recently publicised pedestrian air-bags, are usually implemented through legislation and are thus impeded due to the rigours of legislative process.

In summary, it has been argued that the application of a systems approach is an appropriate input to the management processes of organisations that manage the community objective of safe transport.

System Learning for people in the system of Road Safety

The following paragraphs detail two opportunities for systems learning and the consequences of this learning on the management processes within the system.

One of the well-documented problems of modern management processes is the ability for organisational units to misconstrue activity as the objective ie. 'to lose the plot". One possible example of this is that the road authority could build roads for the sake of building roads rather than balancing the community objectives of safe access and the availability of infrastructure investment finance. The current popularity of Output Budgeting is due to the desire to manage this possibility. Output Budgeting is an econometric solution to this problem but it necessitates the presumption of an omniscient Program Manager who is able to balance the competing requirements for funds in an impartial way. An alternative approach is to provide an increased awareness within the management units of the interconnectivity of the units in meeting community objectives and to allow greater flexibility between these units in resourcing improvement programs. Note that resources are not limited to financial resources but could include analytical skills, communication skills, project management skills.

Thus one potential benefit of a applying a systems approach is that the consequential organisational learning aids the co-ordination of program delivery. Another potential benefit to the delivery process is in the response to unusual situations. This response seems to be gaining importance.

In the case of the Sydney transport system changing to accommodate Olympic transport demands, there was the need for considerable investment in transport planning. This planning activity focused on anticipating the unusual situation and developing strategies to manage existing resources. This approach of planning prior to acting is management intensive. Having established these plans it was then a relatively easy management task to then accommodate the Paralymic transport demands because the system had learnt how to adapt to the new conditions. By investing in system learning, in the first instance, the management intensity of planning may be reduced. Systems knowledge promotes the self-organisation ability of system.

Thus the adoption of a systems approach facilitates organisational learning that has benefits for a number of aspects of the managerial process.

Conclusion

The preceding analysis has identified some limitations of a traditional, reductionalist approach to managing road safety. A Systems approach has been described that seems

to resolve a number of these limitations and provide opportunities for improvement to the whole system of road safety.

Specifically, Soft Systems Methodology has been identified as having unique application to the problems faced in understanding the system of road safety.

A consultancy has been let to investigate the system of Road Safety for the National Highway in Tasmania. The consultancy report will develop this model and produce a recommended strategy to improve road safety for the National Highway in Tasmania.

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