



2.7 electronics external – Reliability and Redundancy

Reliability and Redundancy Definitions and specific examples with international 9900i semi-trailer truck

Reliability

Reliability in a system is an electronics concept. It is the chance of an electronic system (Electronic systems are groupings of electronic circuits and components which are designed to accomplish one or more complex functions) to not fail over a period of time. Reliability of a system is used to counteract the risk of a system failing. Risk can be defined as both the chance and severity of a failure within the system. Reliability can involve the interaction between different components of the sub system, predictions of reliability can be found through the probability of components failing and the implications that individual components have on the system as a whole. Preventing system failures can be done by different methods ONE of which is redundancy.

- Fault tolerance used to allow an electronic system to continue functioning after a fault or changes within the system. Components can therefore still work even if a subsystem fails as each component is generally separate from each other, superior components can be used to ensure the system's continued function.

A general example of this can be seen in general Fault-tolerant computer systems which are designed specifically to be able to deal with these component failures. The most common way achieved is hardware components; this can be achieved by multiple backups and can be separated to isolate issues.

- Maintainability can be defined as how easy a system is to maintain at an acceptable functionality. This is includes finding and fixing faults and how practical it is to fix these issues without affecting the rest of the system.
- Repair ability of system is about both the individual component and system as a whole. It refers to how easy it is to repair or replace components which compromise the systems function. This also includes how easy it is to replace components with minimal effect on the rest of the system.

For example the specific sound card within a computer and how easy it is for that soundcard to be replaced with a new one or repair it.

- Availability is the chance of a system to be able to function as it is needed for the required time period.

For example a truck would be required to function for the time it takes to travel a load from point A to point B

Redundancy is only used within a system where reliability is important even with correct components and function of the system is required for safety and practicality/issue. (E.g. lack of maintainability and reparability). This ensures function after these aspects and components fail.

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Redundancy:

Redundancy in electronic systems is back up components or contingency plans when a component fails. This in turn increases the reliability of the system as a backup as it reduces the chance of complete system failure. Redundancy can be the use of back up components which can be three additional. This decreases the chance of failure largely as the chance of every sub component failing is smaller than one component failure. Redundancy of a system improves the reliability however redundancy remains a statistical probability and there are no guarantees. Although calculating redundancy in a system is complex the simplest way to maintain a strong redundancy is multiple high quality reliable components. Components which are used in redundancy often do not work until that original component fails; this means that it reduces the risk of an issue with the redundant component. In some cases the component is functioning in unison with the original component and therefore generally works with less proficiency when the original component fails as they work best together. E.g. Two eyes, when one eye fails you can still see but at a limited angle and with limited depth perception.



There are two types of functions to prevent function decline called passive and active redundancy

- Passive redundancy is focused on reducing the impact of failures which affect function. An example of this passive redundancy is the cables on suspension bridges they provide extra strength and allow some components of this system to fail without the bridge collapsing.

Biological systems can work in the same way and show redundancy through multiple components such as 2 ears 2 eyes and 2 lungs, this is passive redundancy as if one of the components fail the other can continue to function e.g. if one eye loses some vision it affect the depth perception of your vision but does not compromise the visions function as a whole.



- Active redundancy eliminates performance decline by monitoring the performance of one device, this redundancy uses the idea that multiple sub components can be used to ensure the function of at least one of them and therefore the function of the system is conserved.
- Backup redundancy: This is when you get a secondary component to replace the primary component when it fails.

When the components switch i.e. when component one fails and component two is required to take its place this can create a downtime. However there is a way to get around this by having both components powered at the same time while this does shorten the downtime and is required in some systems. For example an aeroplane and other automobiles can have no downtime for safety reasons. It is also riskier as variables that affect the first component are more likely to affect the second component as well.

Redundancy and Reliability

In systems there is a limit to how much redundancy is needed in a system. This depends on how much reliability is present and how safe the system must be. Most systems must reach a certain level of reliability however in less crucial systems reliability just increases the cost and function. Redundancy ensures the function of systems however extra components increases expense.

Semi-Trailer Truck: Function and Importance.

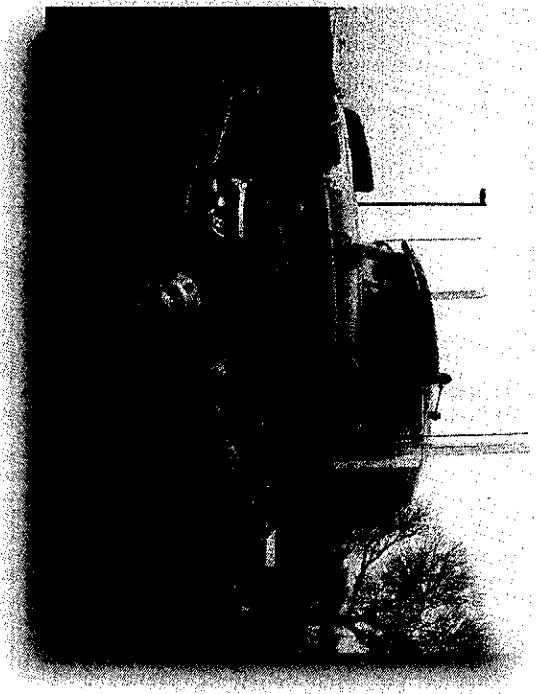
Redundancy and Reliability are required in this system as The semi-trailer truck often functions on the road with other vehicles and due to the complexity and size are often seen as a hindrance. The purpose of these trucks is to safely transport loads which can be fragile and important. Trucks are often on rough roads or motorways at speed of up to 100km/h and required to interact safely around other vehicles such as pass turning vehicles etc. While trucks are mostly designed for safety reliability plays an important role in the efficiency of the vehicle.

Redundancy and Reliability in Semi-Trailer trucks:

The International 9900i

This is a truck which is manufactured and designed for specific functions and efficiency. When released in 2013 the design was maximising safety and efficiency and improvements on this model included the ISX15 engine.

Redundancy can be seen within this system making it a safe and reliable vehicle.



What is a Semi-trailer Truck?

They are large vehicles designed for the transport of large and heavy loads over large distances. They consist of two parts the Main truck or tractor and then the load which is connected by the pivot point or couplings. Despite their larger size and weight they share the same roads and routes as many cars and are required to adhere to their laws and road codes, Often slowing down to let cars pass etc. This means that the system requires a certain amount of reliability in order to be safe enough to travel the roads and optimally travel the required distance and carry the load. This pretty much means the generic Availability of this system can be a 10-15 hour load transfer. Manufacturers are constantly improving the quality of components used and improving the function of the system. Improvements can be seen in the International 9900i from superior transmission/engine components and streamline body kit redundant components etc.

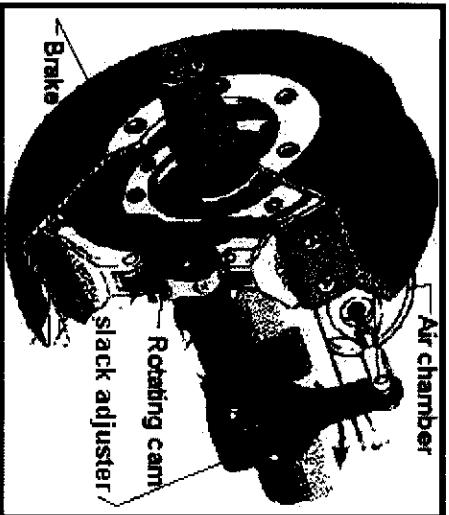
The important aspects of the 9900i are the engine, braking systems and safety in accidents.

“A trailer with a set or several sets of wheels at the rear only, with the forward portion being supported by the truck tractor or towing vehicle.”

Brakes:

Another aspect of redundancy/reliability in trucks is the brakes on the trailers.

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- When the trailers are not connected the brakes are automatically applied, when the trailer is then connected the engine provides pressure which releases the brakes. This is redundancy as it prevents the impact of a failure in the connection of the two parts of the truck.



The importance of this aspect in the International 9900i is to create a safe and reliable connection between the load and the truck-tractor. This is an example of reliability as it prevents the strain on the vehicles brakes (non-air pressure) and will continue to function if the brake pads wear down etc. (redundancy)

The brakes used in a Semi-Trailer truck are different from other ordinary vehicles; this is due to the added strain of the larger vehicle and the importance of reliable and safe braking for the system. This is a method of redundancy as it provides extra strength to the brakes as both air pressure and spring brakes are used. Having two different components for braking not only makes it more reliable but provides redundancy when one fails.

Fault tolerance is seen in the system can be seen in the wheels of the 9900i – 18 wheels are provided when the truck is connected to the load, however they are all placed in pairs (except the front two). This means that when 1 wheel is dislodged the vehicle can continue to function perfectly well. The front two wheels are not placed in a pair as they are the turning part of the vehicle and therefore can't be ignored and a required for functionality.

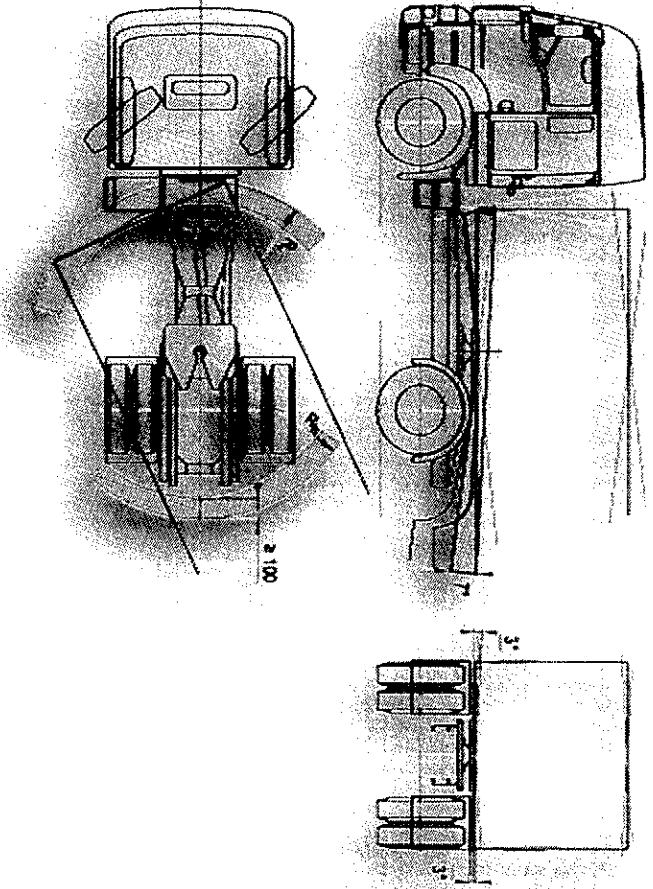


Lights:

Redundancy is also seen in Semi-trailer trucks through the lights on the truck. Many different lights are required on the large vehicle and they are all in pairs. Having two components obviously allows for one component to work after the other is damaged. The ability of one light to work is not inhibited by the other as they are all connected separately. In this situation both lights are working at the same time. This creates a zero downtime situation where the moment one light fails there are more to perform the function. This is also created to the standards presented by New Zealand transport agencies. This is important as when a light fails it reduces the visibility and awareness of the truck to the surrounding vehicles. However this is redundant as there are other lights on the vehicle, it merely presents more visibility.

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Couplings between truck and load:



The couplings are an example of reliability this is where the Towing

part of the truck is hooked up to the load and it is secured by a fifth wheel coupling and prevents the towed load from rotating and locks up to prevent the load from swinging around and hitting the main vehicle. A large kingpin is attached to large metal plate called a "fifth wheel" the kin rotates within the coupling but the wheel does not rotate. This allows for safe turning and also prevents the back of the truck rolling or skidding along the road if the vehicle is suddenly stopped or turns quickly. This shows reliability in the system and the components of the vehicle and fault tolerance as it allows the vehicle to turn properly even if a component is compromised and was to swing around further than the allowed angle. This is also redundancy as in the case of an accident it prevents further harm to the system and allows limited function of the vehicle in the case of a crash etc.

Components used:

Reliability is also seen in the condition of components used within the vehicle. In the 9900i only the best and safest components are used to ensure functionality. The specifications of the components sourced are of optimal power and weight; it is created for heavy duty situations. The purpose of optimal components is to increase the main ability and the length of time at which the vehicle can function at its maximum capacity.

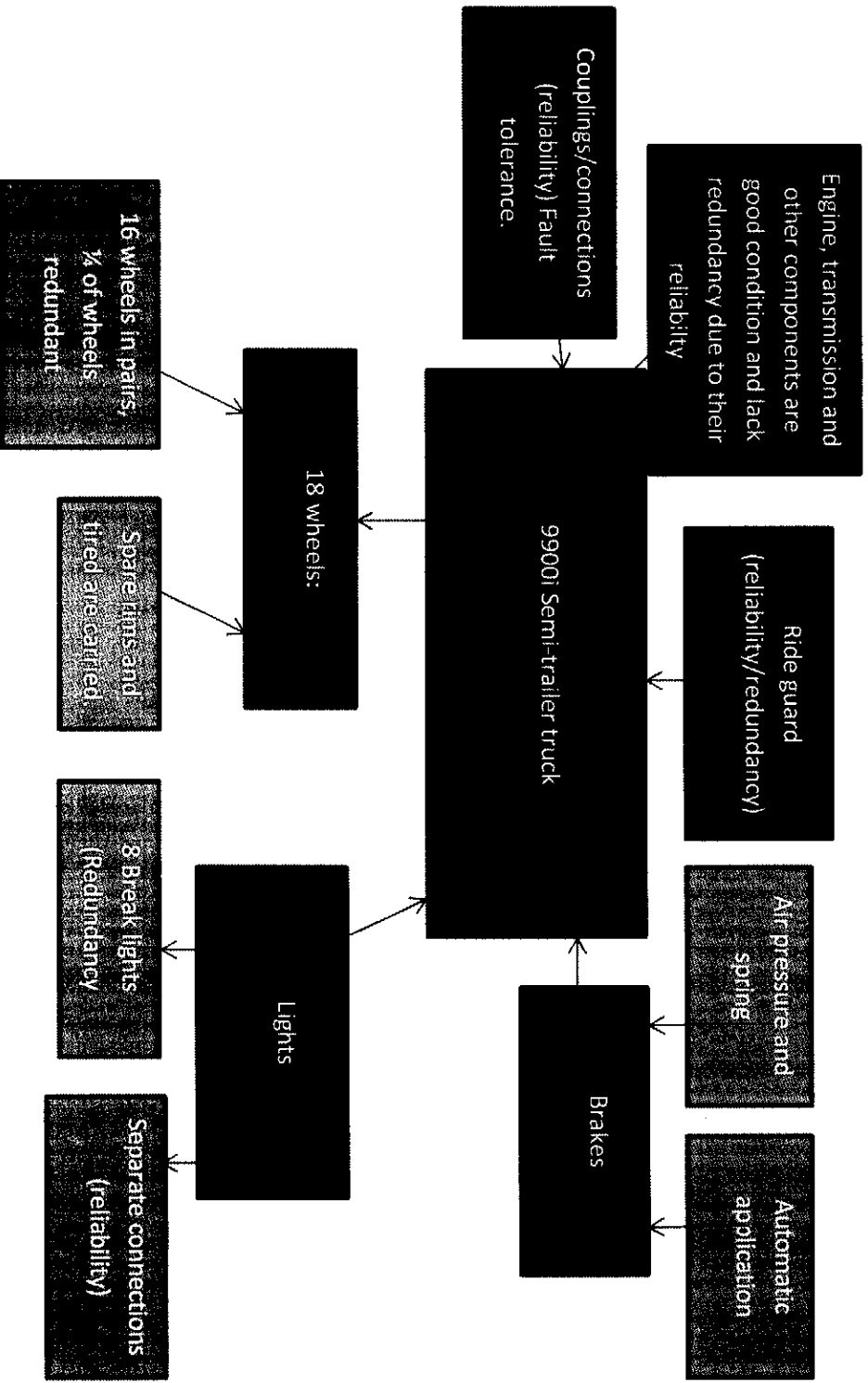
- The back of the truck has an under ride guard attached to it and is designed to protect car's which may ram into it both protecting damage to the truck and the car. This protects the system affecting it reliability by preventing damage to the internal components.
- "Semi" transmissions are more useful for maintaining an efficient engine control due to its ability to provide maximum torque (high horsepower Cummins ISX15 in the 9900i). This ability to have multiple gear ratios means the driver can hold the truck in optimal range

regardless of road speed. The purpose of an optimal road speed is for maintainability of the system, it prevent damage from wear and tear of the system and prevents stress on the internal components such as the transmission and engine.

Specifics to the International 9900i

In the specific truck system I chose (The International 9900i) Steps have been taken to ensure Reliability and Redundancy that is seen within other truck systems which has also been improved in the 2013 models. However the most important aspects of reliability (and therefore redundancy) were already used in much earlier models (2006) etc.

Diagram of Reliability and Redundancy in the 9900i system:



Sources:

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