

# THE “TECHNOLOGY” OF PEOPLE

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## **SUMMARY**

Transnet Freight Rail is at a growth and revival stage in its evolution and is implementing an extensive capital investment programme to modernise, standardise and expand the railway system. Introduction of new technologies over at least a decade is characterised by the coexistence of old and new assets contributing to significant operational complexity.

The delivery of new locomotives since 2008, enabled the identification of lessons that served to highlight safety, human factors and operational issues relating to the integration of new generation assets into a legacy system. Lessons prepared the railway for the delivery of the largest-ever order of locomotives in the history of rail on the continent.

Operational readiness includes interventions for employees involved in all aspects of introducing new assets. The Human-Machine interface is significant and requires an underlying culture change whilst achieving the safe performance potential of new technology and best global processes.

This is the journey of The “Technology” of People that has to be most carefully and adeptly managed. The Man must be guided with empathy and consideration in an even more delicate manner than the Machine is tested and maintained through its asset life cycle.

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## **1. INTRODUCTION**

An overview of Transnet Freight Rail (TFR) is provided indicating the strategic direction of the company at this stage of development. This also indicates the extent of the amalgam of modern and legacy aspects in Transnet Freight Rail's vertically integrated railway. The complexity of the systems, processes and procedures during transformation and the impact on employees is described.

The relationship between TFR and the Rail Safety Regulator is outlined to reflect the collaboration of the two organisations in managing and assuring safety.

The acquisition and deployment of new locomotives for the export lines provided significant lessons that the business is now able to apply as classes of new generation locomotives are introduced on a much larger scale to the more complex general freight business.

The most profound lessons are being applied to the development, training and streamlining of all aspects of readiness to optimise the Man-Machine interface – the railway is as strong as its people.

In conclusion, it will be shown that, if closely planned and managed, modern and legacy systems can, and do, coexist. The safety and operational performance attest to this achievement.

## **2. TRANSNET FREIGHT RAIL OVERVIEW**

Transnet Freight Rail is a vertically integrated freight railway, the largest railway in Africa and the Middle East. The railway operates the world class heavy haul Coal and Iron Ore export lines and is developing the Manganese export corridor to heavy haul standards.

The division transports a broad range of bulk general freight commodities and containerised freight. Commodities are railed across the 30 100 track km (20 500 route km) rail network of which about 1 500 kilometres comprise the heavy haul lines. The network includes 3 928 kilometres of branch lines that serve as feeders to main lines. The core network is predominantly 20tons/axle, heavy haul lines are 26tons/axle on the coal line and 30tons/axle on the export Iron Ore corridor.

The rail industry in South Africa has undergone significant changes in the past three decades. This evolution has had an impact on the role that rail has played in the economy and the competitiveness of the country.

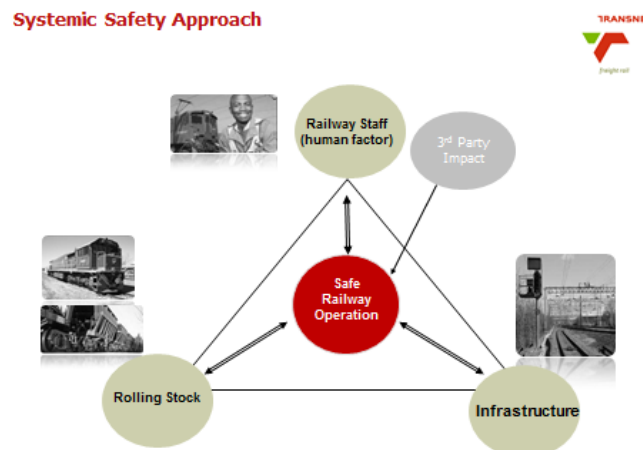
Changes have also had a considerable impact on the current state of the railway – maintaining equilibrium between legacy and modern aspects – and requiring transformation of people and the fabric of the organisation's culture.

## **3. SAFETY STRATEGY**

The Railway Safety Regulator is responsible for overseeing safety and is independent from the railway industry. The delivery of all locomotives – and other resulting changes to operations and aspects of the

integrated system – therefore proceed through a specific process prior to locomotives being commissioned into service, and before training on new locomotives can commence.

Safety cannot be compromised – a philosophy that is prominent in the introduction of new assets, and particularly new generation locomotives, into the legacy system. The safety strategy adopts an approach of systemic safety. This implies that all elements of railway production are interdependent. The deployment of technologies serves to enhance railway safety systems and processes through the continuous development of people, skills and tools. Figure 2 below illustrates the integration of all rail elements in operating safety.



**Figure 2: Systemic Approach to Safety**

The aim of the safety strategy initiatives is to develop the organisation culture such that the railway progresses along the Bradley curve achieving greater levels of safety maturity as the entire system is transformed from a legacy to a modern system.

#### **4. TRANSNET FREIGHT RAIL TODAY – AMALGAM OF MODERN AND LEGACY**

Starting in 2005, Transnet Freight Rail embarked on a strategic turnaround programme to stabilise, re-engineer and position the business for growth. Strategies were implemented for the freight business focussing on customer service, operational efficiency, safety, development of people and a capital investment programme to address the backlog of the past 20-plus years and to create capacity for the nation's growing demand for transport.

By 2011, it was clear that a more aggressive strategy was required and the Market Demand Strategy (MDS) was crafted. Transnet had committed to investing more than R300 billion over a seven year period in the development of the nation's transport system. The bulk of this capital programme is being invested in TFR. The goal of shifting the transportation of freight from road to rail, has been the key driver for the implementation of the investment programme.

In 2015, TFR is midway through the MDS. The accelerated progression of the capital programme has meant that the railway is currently in a challenging situation of operating legacy systems and assets –

and specifically the locomotive fleet – in conjunction with modern and new technology. This is a double-edged blade in that:

- Older assets have to be retained and maintained to an appropriate level of functionality and safety. Drivers have to retain their licenses in the old technology before new locomotives are deployed
- A unique opportunity exists to benefit from rapid learnings. As new assets are introduced into the system, the railway is able to apply the “lessons learnt” to the next wave of new assets in a relatively short time horizon

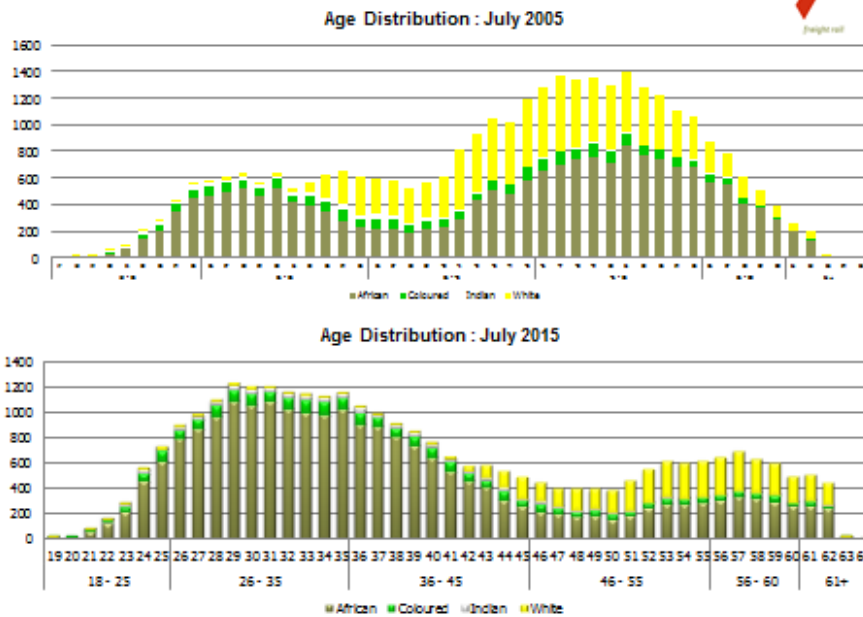
This situation has huge implications for employees – decision-makers, planners, trainers, operators, drivers and technicians – as the interface between “Man and Machine” rapidly changes. The transformation has to be managed to assure that the technology of the investment in machines is optimised, and that the “Technology” of our People is uplifted and connected.

Extremes between the legacy and modern aspects in TFR present in 2015 cover most systems which impact on operations and the management of the “technology” of people:

- Locomotive design and acquisition processes
- Locomotive fleet size, type and standardisation
- Mixture of locomotive age and technologies
- Wagon braking and coupling systems
- Network standard and complexity
- Variety of Train Control Systems in use
- Train Crew training, development and career pathing
- Management Information and Decision Support Systems
- Safety
- Organisational culture

The change in the employee profile of the railway is of particular relevance and the coexistence of old and legacy aspects. Figure 5 below depicts the change in the employee profile over the past ten years and some interesting deductions can be drawn.

## Employee Profile



**Figure 5: Changing Employee Profile**

In 2005, at the time of development and implementation of strategies for turnaround and revival of rail in South Africa, Transnet Freight Rail had an ageing workforce. The majority of employees that held engineering and management positions were older, white males. The African population mostly held lower level positions with just a few African employees in management positions.

The culture that had emerged from the legacy of the past resulted in a rather stagnant and unimaginative organisation culture. The ageing workforce presented a primary challenge for the railway of the future as loss of skills would increase as the workforce aged further without a sustainable base of new talent to take the organisation into the future.

The current employee profile not only represents a racial profile representative of the demographics of the country, but is significantly “younger” with a much greater spread of employees below age 45. This illustrates the success of strategies to attract and develop new talent to enable a sustainable organisation in future.

Challenges are also present in that the predominantly young workforce is inexperienced and less committedly loyal to the organisation. Also, as seems typical of the contemporary younger generation in general, they are less subservient to rules and less disciplined, which could be a concern for a rules-stringent organisation such as the railway. Older, experienced employees (affectionately referred to as silver foxes) are currently active in operational areas to mentor and coach the new talent.

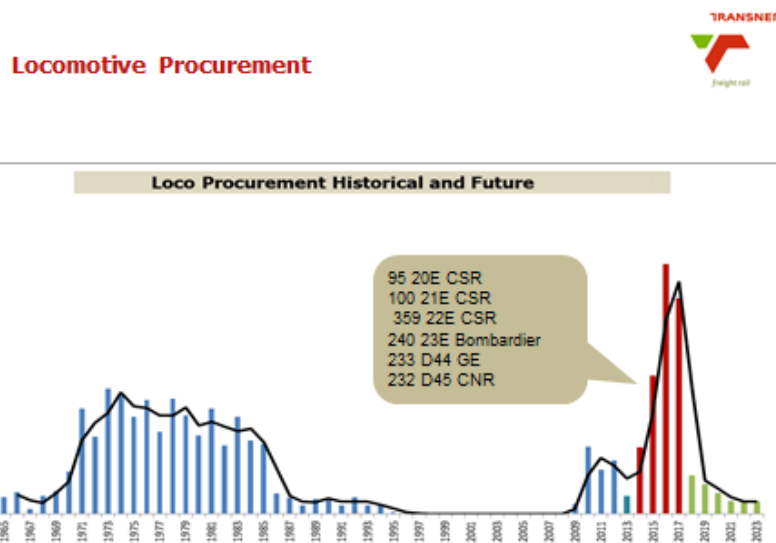
The transformation currently taking place in Transnet Freight Rail is far-reaching and the integration of these developments aims to bring Transnet Freight Rail steps closer to becoming amongst the top five world class railways. Furthermore, the degree of difference between old and new technologies in use reflects the challenges, and corrective strategies required, in training, maintenance, standard operating procedures and safety systems. This also indicates that the systems can coexist safely, provided that

strategies are in place and that the transformation is managed and supported by employees whilst a new culture must evolve.

## 5. THE LOCOMOTIVE FLEET AND LIFE CYCLE

Transnet Freight Rail had maintained a balanced fleet of locomotives since the 1960s. The development of the heavy haul coal and iron ore corridors in the mid 1970s saw the introduction of new locomotives during this period. Fleet modernisation, and the periodic acquisition of new locomotives, continued into the 1980s enabling the railway to remain abreast of – and often lead – prevailing railway technology.

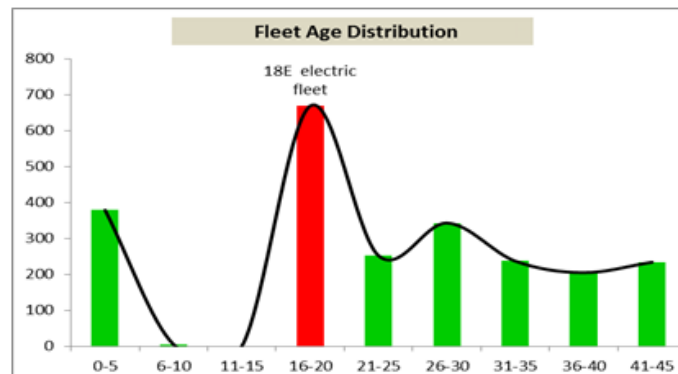
The deregulation of the freight transport industry in the late 1980s placed constraints on fleet revitalisation and an insignificant number of new locomotives were introduced into service in the decade between 1985 and 1995. A barren and dismal period for the railway followed with no new acquisitions being made between 1995 and 2007. Older locomotives – purchased since the 1960s – had to be kept in service with major negative consequences on maintenance costs, customer service delivery and overall employee morale.



**Figure 1 : Locomotive Procurement : Historical and Future**

The legacy and circumstances that directed the revitalisation, and deterioration, of the locomotive fleet had resulted in an aged locomotive fleet as depicted in Figure 7 below. This had dire and strategic consequences for the sustainability of the railway in a growing transport market

## Locomotive Age Distribution



**Figure 2 : Locomotive Age Distribution**

The strategy for rail turnaround began with the introduction of new locomotives on the heavy haul export coal (19E) and export iron ore (15E) lines. The locomotive fleet for general freight business still lagged revitalisation, and it was only in 2013 that new locomotives began to be acquired to serve this vital and growing aspect of the railway. An unprecedented and accelerated order of approximately 1 100 locomotives for the general freight business is currently underway to bridge the gap.

The “locomotive generation gap” between 1995 and 2007 had profound consequences for the organisation. In addition to the fact that the organisation is currently operating services with a hybrid of legacy and new generation locomotives, the railway has had to adapt to the sudden and dramatic technological evolution in rail developments that had taken place globally over the past 15 years.

Technological changes from mechanical to electronic, analogue to digital and increased tractive powers of new generation locomotives have advanced at a rapid pace. One can appreciate the technological advancement of new generation locomotives when considering the basic mechanical technology and features of a 1960s VW Beetle relative to a VW vehicle today with Blue Motion, Bluetooth and other advanced driving, braking and safety features! The impact of this abrupt change from old to new technology has an impact on *The “Technology” of People* that cannot be taken lightly.

The acquisition of new locomotives for deployment to the world class heavy haul export corridors, surfaced key learnings regarding the integration of new generation assets into a legacy system that has started evolving into a modern world class railway. Lessons highlighting safety, human factors, technical and operational issues have been identified. Integration of all production and human factors also amplified the need to upgrade the rail network to A standard in a paced manner aligned to locomotive delivery. All of these developments need to be accomplished in a period of competitive efforts to grow rail volumes and market share.

The fleet modernisation plan aims to standardise the locomotive fleet to five locomotive types. Locomotives are to be delivered at a rate of between 270 and 400 locomotives per annum over a three to four year period. The modernisation of the general freight fleet is characterised by a number of



technological features with benefits and implications for rail operations. Efficiencies to be leveraged are based on the capability of technical aspects and adaptation of dual power.

The introduction of new technologies, not only have implications for the modernisation of the fleet, but also in terms of training of employees and the way they operate, think and behave. New technologies and greater tractive capability of new locomotives enable the operation of longer trains, reduced stopover places and times, shortened throughput times, “on the fly changeovers” as well as technical and maintenance differences.

## **6. LESSONS LEARNT IN COMMISSIONING NEW LOCOMOTIVES**

Lessons learnt in the delivery of locomotives to the heavy haul lines have served to contribute to streamlining preparations for the delivery of the largest-ever order (~1200) of locomotives in the history of rail on the continent. It must of course be acknowledged that, although valuable experience was gained from the heavy haul locomotive delivery processes, *the general freight delivery is significantly more complex.*

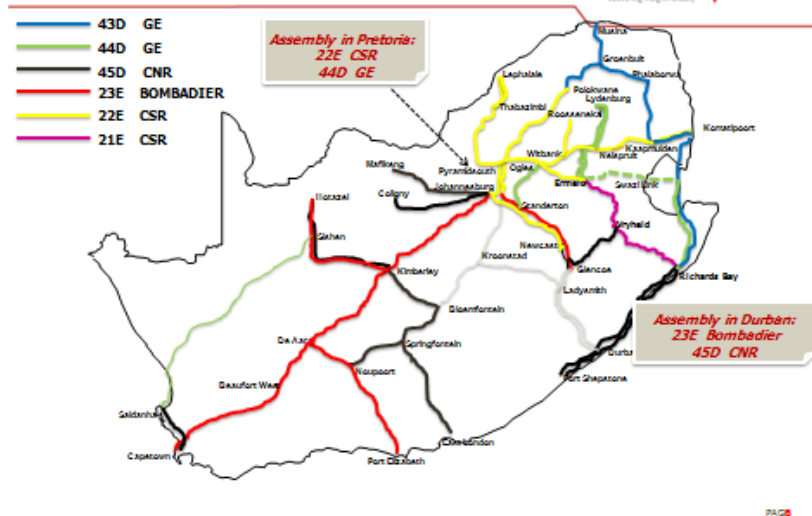
The design, delivery and deployment of heavy haul locomotives involved a fraction of the number of locomotives; a single locomotive type; and deployment to ring-fenced corridors; in a phased time horizon.

The general freight locomotives are being delivered, tested, commissioned and deployed in an accelerated and compressed time horizon planned for three to four years. A far greater number (almost 10 times the number) will be delivered and they will be deployed to operating depots and business units countrywide. The new locomotives are being provided by four different Original Equipment Manufacturers (OEMs) from different countries.

The locomotives will be deployed across the general freight network. This network reflects legacy technological and geographical complexities with varied voltage, electrification and non-electrified lines and a mix of legacy and infrastructure standards. The six different Transnet Freight Rail business units will take delivery of specific locomotive types and at different time periods depending on best deployment for freight traffic flows between customers and operational areas.

The supply of locomotives makes provision for innovative forms of localisation and local supplier development as the bulk of the locomotives will be assembled at two different depots in South Africa under the leadership of Transnet Freight Rail sister company Transnet Engineering.

### New locomotives to be deployed across the General Freight network



**Figure 3 : Locomotive Assembly and Deployment**

It can thus be shown that the new locomotive deployment is on a much greater and more complex scale than has ever been experienced before. Despite the enormity of the process, the more recent heavy haul delivery has highlighted challenges, potential pitfalls and valuable lessons that are enabling preparation for major transformation and operational readiness for the new deliveries.

The application of lessons to the new order processes, are summarised in Table 8 below:

Process	Application to 1064 Delivery
<i>Timing of locomotive delivery relative to timing of training</i>	<ul style="list-style-type: none"> <li>• OEM supplies operator manual prior to delivery.</li> <li>• Learning material is developed, adapted and updated during commissioning tests</li> <li>• Locomotive delivery interface process in place and communicated during planning stages</li> <li>• OEM capacitates Functional Master Practitioners</li> <li>• New locomotive contract warrant includes specific locomotive simulator models</li> </ul>
<i>Availability and Readiness of Drivers</i>	<ul style="list-style-type: none"> <li>• Master Practitioners certified prior to locomotive acceptance in Operations.</li> <li>• Training plans and schedules developed, signed and executed accordingly.</li> <li>• Weekly teleconference to monitor training progress.</li> <li>• Dedicated special train introduced for practical training purposes.</li> <li>• Assessors deployed full time in specific area based on signed practical training plans to conduct assessments.</li> </ul>
<i>Commissioning Process duration</i>	<ul style="list-style-type: none"> <li>• Commissioning process significantly reduced</li> <li>• New equipment delivery interface process in place</li> <li>• Cross functional Master Practitioners receive practical exposure and certification during commissioning tests</li> </ul>
<i>Driver Training</i>	<p><i>Introduction of Continuous Professional Learning (CPL) methodology</i></p> <ul style="list-style-type: none"> <li>• Introduced as part of Crew Management System – Continuous training comprises Theoretical, Simulation and Practical route training and testing to ensure that licensing is continually validated</li> <li>• Training combined with periodic medical and fitness assessments</li> <li>• Licensing and categorisation of driver levels according to career</li> <li>• Drivers rostered and deployed according to competence and standards</li> </ul>

<b>Process</b>	<b>Application to 1064 Delivery</b>
	<ul style="list-style-type: none"> <li>• This learning methodology also applied to driver training for neighbouring country railways. Eg. Swazi Rail and Mozambique Railways as they operate Transnet assets and cross borders into South Africa</li> </ul>
<i>Availability of Simulator Software</i>	<ul style="list-style-type: none"> <li>• Simulator requirements included in locomotive fleet contract</li> </ul>
<i>Technical Aspects</i>	<ul style="list-style-type: none"> <li>• Improved incorporation of specifications into design, building of prototypes and testing t. Increasingly streamlined process that reduces time required to six weeks</li> <li>• 15E, 20E and 21E increasingly modular. This enhances trouble-shooting and enables the isolation and rectification of specific components during the testing stage</li> <li>• All new locomotives are fitted with On Board Computers and video cameras as well as Locomotive Condition Monitoring Systems.</li> <li>• Defective parts or systems can be isolated and automatically shut down</li> <li>• New locomotives are delivered fitted with self-diagnostic systems with Wi-Fi streaming capability. This enables technicians to rapidly diagnose and rectify faults. This capability, in conjunction with the modular designs reduces maintenance and downtime</li> </ul>
<i>Prototype Development</i>	<ul style="list-style-type: none"> <li>• Once the first two prototype locomotives are built, tested and approved. Another 4-6 prototypes are rapidly delivered. This allows for more extensive testing of locomotives in a consist in local conditions thus shortening the “teething problems” stage and enabling adequate numbers of locomotives being available for commissioning and driver training</li> </ul>
<i>Driver Comfort and Ergonomics</i>	<ul style="list-style-type: none"> <li>• Train drivers actively involved in all aspects of design, mock-up and prototype building. This allows for the optimal incorporation of features for improved comfort and controls ensuring best practice</li> </ul>
<i>Locomotive Interoperability</i>	<ul style="list-style-type: none"> <li>• Increased ability for locomotives in the new generation fleet to be interoperable and can be utilised in the same consist or in the same train</li> </ul>
<i>Timing of loco delivery relative to timing of training</i>	<ul style="list-style-type: none"> <li>• Locomotive order included information for developing simulators and training material. The School of Rail then began engaging with OEMs to ensure that training material is prepared and ready ahead of locomotives being commissioned into service</li> </ul>
<i>Systems</i>	<ul style="list-style-type: none"> <li>• Increasing use of decision support tools to optimise planning and operations. This is to be accompanied by change management initiatives to overcome employee resistance to new tools. Approach will encourage employees to use own experience and knowledge in applying the results of tools to optimise the use of assets</li> </ul>

**Table 1 : Lessons Learnt and Application**

## **7. MAN-MACHINE INTERFACE**

Substantial effort and attention is given to the technology aspects of new locomotive design, building and testing. For the “Machines” to achieve their designed performance, the “Man” aspect has to be given equal – if not more – attention. Key elements of assuring the appropriate preparation for “The Technology of People” address Training, Human Factors Interface, Safety aspects and, a potentially neglected aspect, the culture and transformation of all people involved in the processes.

Technical and engineering training has also been addressed in line with delivery. Training is afforded to maintenance engineers, technicians and artisans. Requisite training is provided both abroad and locally and involves the OEM, The School of Rail and the School of Engineering.

It was important to establish a well-developed competent Human Factors Management structure drawing from accredited institutions of learning. New locomotives are more ergonomically designed for driver comfort and contain features that simplifying and enrich the driver experience. Such aspects, in addition to the training methodology, have contributed to driver acceptance of the new technology

The introduction of new locomotives requires close planning and collaboration between the railway and the RSR. An integrated training methodology is being implemented for each new locomotive to be delivered.

The locomotive fleet modernisation plan that will be implemented over a compressed time frame encompasses an integrated operational readiness plan. Key elements being addressed include wagon building and refurbishment, operations planning systems, maintenances planning and practices, integration with ports, customers and terminals.

The full implementation of a custom designed Integrated Safety Management System which includes a certification process for ISO 9001/14001 and OHSAS 18001 has assisted in addressing a wide range of safety issues. This has also assured compliance with legislation, and specifically the Railway Safety Regulator.

Safety performance and culture is being further enhanced through the roll-out of the Roadmap to Safety (R2S) This intervention views safety management in an integrated manner to ensure a Safe railway operation. A key objective of the programme is to demonstrate that a change in attitude towards safety requirements can penetrate the entire organisation by a growing, sustainable safety mind-set;

## **8. THE “TECHNOLOGY” OF PEOPLE**

High tonnage growth is planned and anticipated during this phase of major technology change and transition. Harmonious integration of old and new technologies operating simultaneously over a transition period of about five years will only be possible through the preparedness of people.

To meet the migration challenges, TFR has augmented the Human Factors Management capability to align with world class standards. “Human Factors” is now incorporated in the capital investment programme and operations, ensuring that the human-equipment interface is addressed proactively.

The imminent delivery of new locomotives has been extensively communicated and is eagerly awaited as an historical milestone in the evolution of the railway. This has generated excitement and anticipation of the benefits and growth to come.

As with all new developments, the introduction of new technologies is a journey. There is always the risk that excitement and anticipation may prove to be an anti-climax. In much the same way as new locomotives follow a “bathtub curve” of an initial high incidence of faults before settling to a prolonged period of consistent performance, so employees are also exposed to a similar “change curve”. Initial excitement may be replaced with fear of ability to drive or repair a new locomotive, frustration at not seeing promised benefits immediately. There may even be distrust and resistance as technologies

reflect high failure rates and people may feel inadequate in their speed of learning new operating mechanisms.

Excitement may also be coupled with fear of their own future in a workplace regime where rosters, trips and processes are changing at a rapid pace that could lead to uncertainty. Where new systems and tools are introduced, such as decision support and simulation tools, employees may be suspicious and reluctant to accept information provided by the tools – choosing instead to rely on what they know.

This is the journey of The “Technology” of People that has to be most carefully and adeptly managed. The Man must be guided with empathy and consideration in an even more delicate manner than the Machine is tested and maintained through its asset life cycle.

## **9. CONCLUSION**

The implementation of the fleet modernisation strategy, combined with the development of the people of the railway, are key elements of the MDS. Performance improvements are already being achieved in safety, volume growth and efficiency.

Improved operational and workplace safety performance is critical for the successful implementation of the Market Demand Strategy. Continuous improvement requires the combined effort and commitment of management, labour, individuals and teams.

The size, pace and extent of the locomotive programme represents one of the most significant capital investment developments in the history of the railway. Whilst this investment programme is underway, the system will experience an amalgam of modern and legacy assets contributing to significant complexity in operations and thus in optimising rail operations, employee readiness, performance and safety.

It has been shown that, if closely planned and managed, modern and legacy systems can, and do, coexist. The safety and operational performance attest to this achievement.

It ultimately depends on our people – their productivity and performance in making the machines work. We are building pride in our people whilst we build a railway that is fit for the future in our developing country.