# Strategy and the TOC Thinking Process

# Using DBR as an Interdependency Model for Innovative Product Design

# Using DBR for Distribution Logistics

This article describes a TOC journey of discovery and solutions, utilizing a collection of TOC (Theory of Constant) application techniques in a large corporate environment.

### SilvaCel - A Company profile

A South African Forestry Company, part of a much larger Timber Company the *Hunt, Leuchars and Hepburn Group (HL&H).* Established in 1850 – and by 1995 had grown to be one of the largest timber companies in the Southern Hemisphere.

Total Employment 11 514 people while controlling, leasing or owning 191 000 ha of timberland under Forest Management. SilvaCel, a timber export Division under the larger *HL&H Holding Company*, employed 2 625 people and managed 60 467 ha of this timberland.

Exposed to International competition– SilvaCel's imperative became to gain a significant competitive advantage on pricing. TOC provided the tools necessary to frame the Transportation and Logistic strategies required to achieve this aim.

### Three phases of implementation:

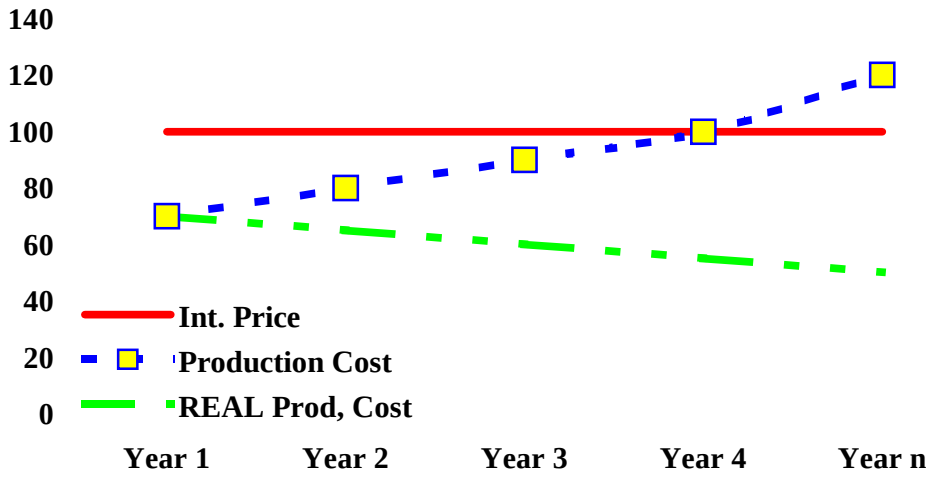
- **Phase I: Using the TOC Thinking Process** – to understand and define the operating environment.
- **Phase II: Using the DBR interdependency model** - to design new products. Truck Tractor and Trailer combination sets.
- **Phase III: Using the DBR / Distribution Solution** - to manage the Timber Logistics over a 1000 kilometer radius raw material draw area.

## Phase I: Understanding the Operating Environment

### Layer 0: The Environment has changed. Adapt or Die.

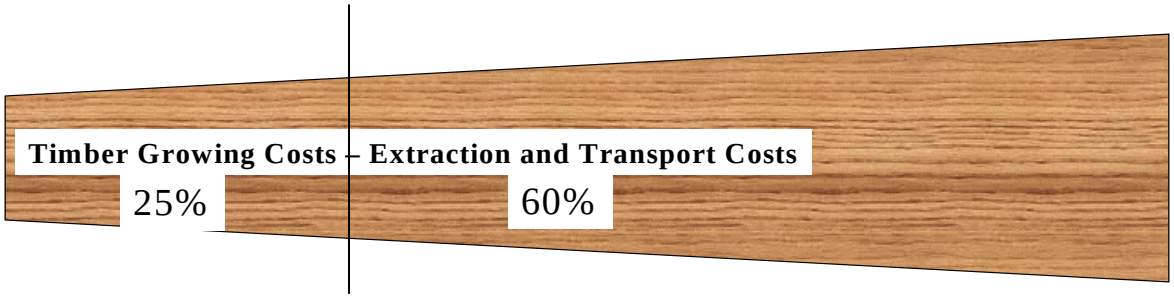
South Africa had developed a closed circuit economy during the apartheid years. Essentially an economy trading within the courtyard of its own borders. To give some indication of the magnitude, in 1994 – when 75% of the shares traded on the Johannesburg Stock Exchange were controlled directly or indirectly to one of three holding company conglomerates.

This cozy arrangement resulted in predictable and controlled inflation, bringing with it the comfort of inflation adjusted annual product price increases. These inflation adjusted increases in turn formed the basis for subsidizing inefficient technology. The net result over time, lead to the tolerance of inferior technology and little pressure to innovate. With the fall of sanctions in South Africa – SilvaCel, a startup export forestry venture, overnight became exposed to International competition. To compete at this new level, there was little choice but to leap frog technology and SUSTAINABLY REDUCE THE REAL COST OF PRODUCTION IMMEDIATELY.




REAL Cost of production: that means reducing the “after inflation” cost of production in real terms.

Diving into the cost structure we realized that 60% of the delivered cost of timber was transport related – the raw timber product itself has relative low value, high bulk and mass associated costs.



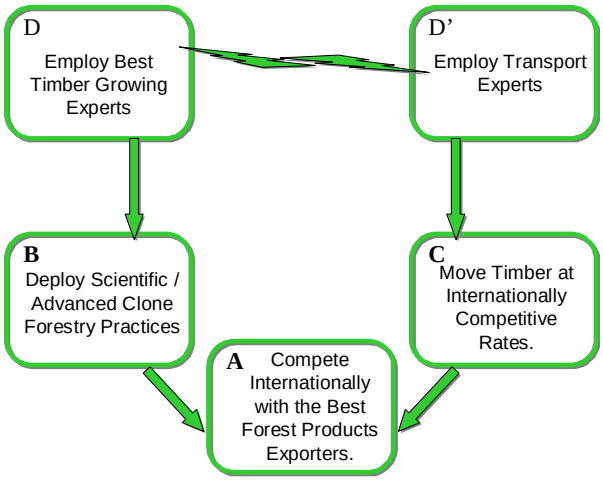

**Layer 1: Defining the Specific Problems.**

This realization changed our thinking - after 135 years of thinking as a ***Forestry Company*** – we realized that by thinking as a ***Logistics Company*** we could make significant progress.

UDEs:

- Over Expertise in Forestry Knowledge leads to Under Expertise in Logistics Knowledge.
- Timber growing experts are not experts in Transportation matters.
- Cost of transportation is 60% of the timber cost and annual transportation rate increases are above the average inflation rate.
- An annual exchange rate fluctuation is no guarantee to compensate for the increase in transportation costs.
- All SilvaCel timber must move by transportation: Road Haul, Rail and Sea. The timber raw product is of low value; yet high in bulk weight and subject to high moisture content variation – resulting in unpredictable load weight on a truck.
- Unpredictable truck load weights are difficult to manage by expert transport operators, let alone managers trained in timber growing not transport matters.

**The Resulting Conflict Cloud:**




Challenged Assumption: That Forestry Managers will not be able to Schedule and manage a superior fleet of world beating; Truck / Trailer production assets.

This assumption is obviously wrong – all the forestry managers needed was superior operational equipment and guidance on effective transport scheduling techniques.

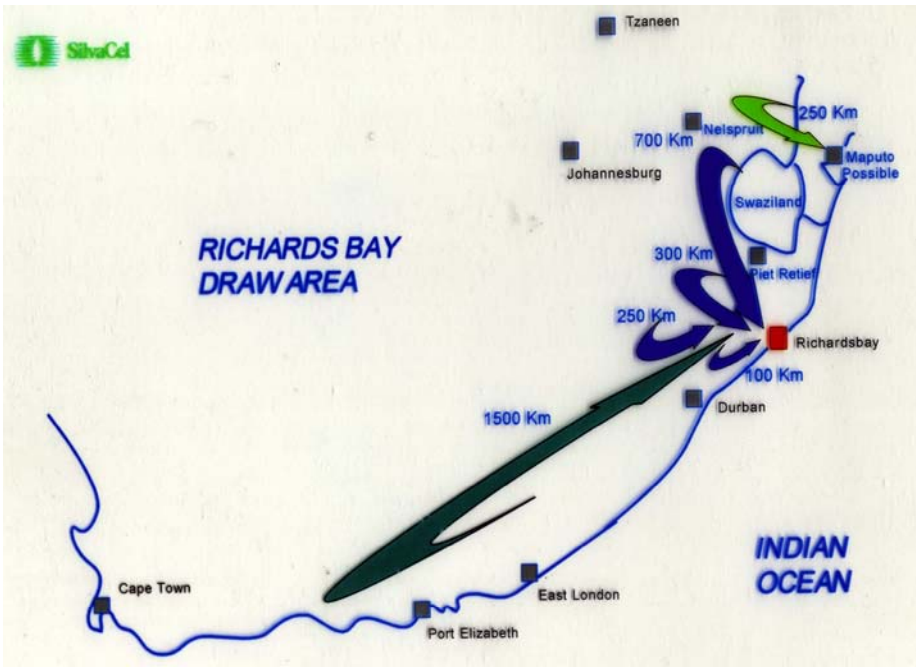
**Our New Logistical Vision of the Forestry Operational Environment:**

**Our forests became a production factory: with 1000km long production lines, no overhead roof and dirt and mud on the floor with physical mountains between departments and functions. Our conveyor belts were combinations of rail and truck transport routes.**

**Direct exposure to the weather elements of tropical rain and occasional drought provided operational blind siding variability.**

**Our New Strategic Goal:**

**To reduce the Real Cost of delivered timber from forest stump to the mill gate.**




**The Specific Injection from the Strategic Objective:**

**Rx: Form a working group called the TTT – Transport Think Tank.**
Founding Members John Thompson and Desmond Armstrong, both Jonah's trained by the National Productivity Institute of South Africa (Ray Immelmann).

**Gather a list of <u>Major UDE's</u>:**

1. Inflation under sanctions really means closed circuit trading and subsidizing the inefficiency by printing more money.
   Breaking out of a closed Circuit Economy.
2. Exposure to compete in world markets with a low value, high bulk, high mass commodity or raw material product. 60% of the cost of delivered timber is transport related.
3. Using old technology to compete:
   a. Old Mercedes Benz truck units – high tare weight, high fuel consumption etc.
   b. Efficiency ratios: $\frac{\text{mass x speed}}{\text{Energy}}$ very low.
   c. Payload to gross weight: Payload / Gross Ratio very low.

4. Truck/Trailers assets are mostly a monument: only spending 30% of the time actually moving with loaded timber – the rest of the time standing idle: standing loading, under maintenance, traveling empty and waiting to be offloaded.

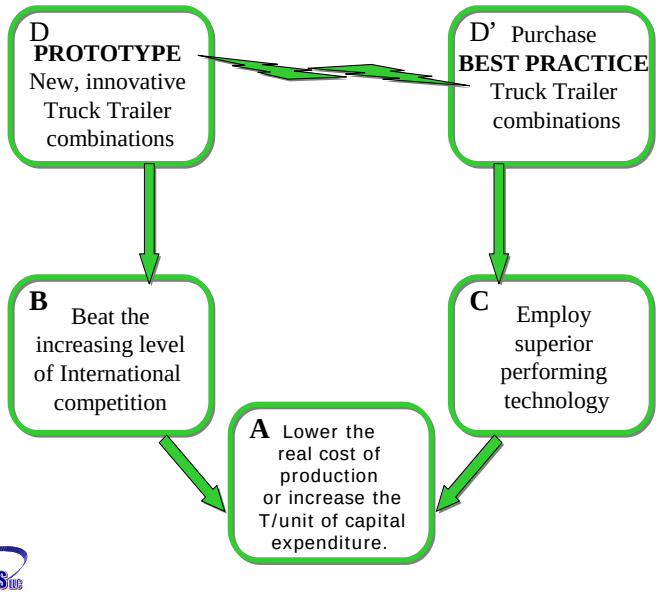
5. <u>Adapt or Die:</u> Simple - the Real cost of production had to be decreasing in real terms or die. Real cost = after inflation adjusted cost.

**Phase II: Using the DBR Dependency Approach in new Product Design.**

**The Challenge: To Leapfrog Technology or Simply Die.**

**SilvaCel had to develop superior technology truck / trailer combination to move timber.**

**Specific Problem:** Purchase whole fleets of superior performing truck tractor/trailer combinations or develop and proto type innovative new designs in-house.




**ASSUMPTIONS:**

D' to C:

- Those whole Truck Tractor units with Trailers (TT&T) had to be purchased as complete entities.
- That suitable TT&T unit's existed somewhere in the World that integrated easily into the South African operating environment.
- That some of the superior designs seen on the world market complied with South African Road Ordinance Legislation.

D to B:

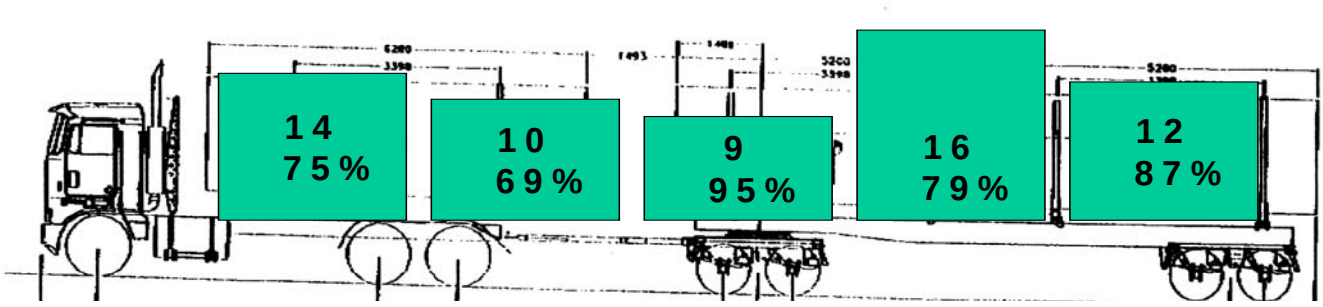
- That we as a company could employ engineers to design break through technology from inception of concept through to Implementation.
- That all components in the break through designs would be superior performers starting out of the gate.
- That we could outperform all other designs available on the world market with our initial attempts.

The more we looked at the arrogance of our assumption and designs that the investigative engineers produced the more uncomfortable we became. By looking at the design through the eyes of TOC – DBR, we adopted an Interdependency component model.

Each new component feature on a trailer or truck tractor was a seen as a local optima unit resource, and each linkage (welding) the components together became an added source of amplified variability.

**Major UDE:**
While designing a truck trailer combination - we built in guaranteed failure – a natural inherent in any new complex prototype design.

**UDE:** Massive Dependency *within* each prototype component *and between* each prototype component – each component directly dependent on the success of all the combined components. If one element failed - the design failed.




The truck Load Bearing capacity and the probability of success of the combined design can be visualized as a production line – comprised of independent resources.

The visible component probability of combined success was a low 33% - an unacceptable business risk. 75%x69%x95%x79%x87% = 33%.

## Improving Links or Linkage?

**Local Optima**

**(1)+ (1) +(1) +(1) + (1) ≠ 5**

**V.s.**

**Optimizing the Linkage**

**1(+) 1( +)1 (+)1 (+) 1 > 10**

The invisible linkage variability represented by balance, oscillation, vibration, chemical compound incompatibility and other unknowns – increased the business risk to totally unacceptable levels.

Added to this was the variability of successfully integrating (bolting / welding together) the individual components:
Assuming an average 85% successful integration (welding linkage) of each component we achieved the PROBABILITY OF A SUCCESSUL DESIGN as follows:

75%x85%x69%x85%x95%x85%x79%x85%x87% = 21% Success?

This combined risk would not impress any investor.

## Rx:

The remedial strategy was to combine “battle proven” components into the design. The only unknown left was how they would perform as an interdependent combination. Referencing operating environments with similar characteristics to those in the RSA.

Assumptions broken:

- That SilvaCel had to prototype and develop the complete truck tractor / trailer combination.
- SilvaCel had to employ new Transport Engineers to develop these superior proto types.
- That superior technology had to be developed by one manufacturer in its entirety.
- That Manufactures will not work together to make someone else’s design succeed while incorporated with their own products.

**Remedial Actions: (Rx)**

**Rx:** Scour the world to find the battle proven components that we needed. Countries visited were Australia, Sweden, England, New Zealand, and USA.

**Rx:** Combine these superior components together to bring the overall project risk into a range acceptable to investors.

**Rx:** Coordinate those product partners willing to assist – Rx they would engineer their individual component "battle proven" products – with compensation based on access to new knowledge and new markets and new global partnerships emerging.

**Rx:** SilvaCel would engineer assembling the units together – even assembled the units after importing the pieces.

No small task - the following criteria were established if we were to win the hearts and minds of our investors. Any strategy we adopted had to work in a relatively short time frame.

| | | | |
|---|---|---|---|
| Unique Breakthrough | Eliminate Learning Curve | Speed up implementation | Reduce Risk |

**Obstacles to Implementation:**

- SilvaCel had No engineers.
- SilvaCel was not willing to invest in Engineers and Facilities.
- SilvaCel had to overcome a Limited Capital Budget.

**Intermediate Objectives**

- Give the OEM Truck Tractor & Trailer (TT&T) manufactures access to our African markets and contract fleet owners in exchange for engineering time.
- SilvaCel paid for and bought any TT&T combination developed.
- SilvaCel would co-ordinate the work of the various OEM engineers together with our requirements.
- We would understand all OEM products before requesting their collaboration. (This ensured our control and true fit of their products).
- We would pre-design the Total TT&T in concept before approaching the engineers.
- Each unit must be self-funding through successful operation in the field straight out of the gate.
- We had to produce overwhelming proof of superior ROI with each Investment.
- Manage the commitment of the SilvaCel Board of Directors by intimately engaging members in various aspects of each project.

**Rx I**:
Adopt TOC Accounting to prove and track the ROI performance.

**Rx II**:
Get the Financial Manager and Forestry Director into the Jonah Program. This they did and we soon had them redesigning the Accounting system to follow a Throughput accounting approach to our Operating Division. The only requirement by the Corporate Holding Company was they received their standard accounting format on time each month. TOC Accounting template was developed and adopted.

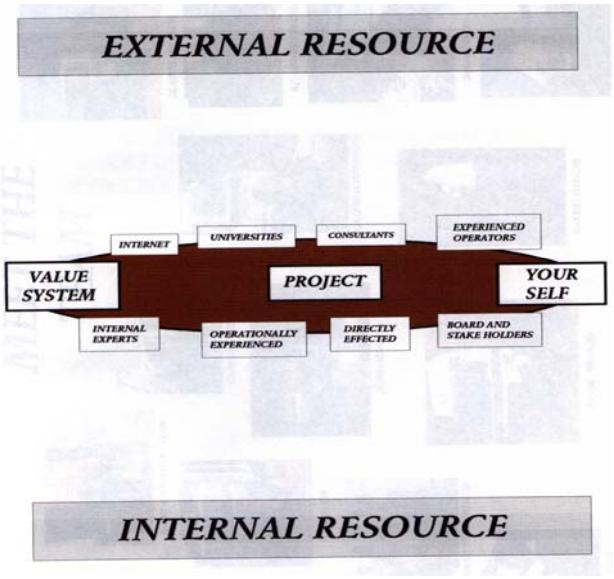
The entire SilvaCel Forest Division adopted TOC Accounting Methods for its Operational Decision Processes.

Example: TVA – Throughput Value Added for Capital Project Justification.

Throughput Value Added Justification

| E.R.F RIGID TRUCK TRACTOR AND BRIAB TRAILER | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| DEPRECIATION PERIOD | YEAR | 1995/96 | 1996/97 | 1997/98 | 1998/99 | 1999/00 | 2000/01 | 2001/02 |
| TONNES TRANSPORTED PER ANNUM | | 18,532 | 18,532 | 18,532 | 18,532 | 18,532 | 18,532 | 18,532 |
| RAND /TONNE SAVING | Rand | 17.02 | 17.02 | 17.02 | 17.02 | 17.02 | 17.02 | 17.02 |
| E.R.F. TRUCK TRACTOR | Rand | 522 000 | | | | | | |
| BRIAB TRAILER | Rand | 283 000 | | | | | | |
| TOTAL CAPEX | Rand | 805 000 | | | | | | |
| CAPEX - COST | Rand | 805 000 | 805 000 | 805 000 | 805 000 | 805 000 | 805 000 | 805 000 |
| CAPEX DEPRECIATION | Rand | 123 846 | 123 846 | 123 846 | 123 846 | 123 846 | 123 846 | 64 616 |
| AGGREGATE DEPRECIATION | Rand | 123 846 | 247 692 | 371 538 | 495 384 | 619 230 | 743 076 | 807 692 |
| EBIT SAVINGS | Rand | 315 415 | 315 415 | 315 415 | 315 415 | 315 415 | 315 415 | 315 415 |
| LESS NOTIONAL TAX RATE 30% | Rand | 94 624 | 94 624 | 94 624 | 94 624 | 94 624 | 94 624 | 94 624 |
| | | 220 790 | 220 790 | 220 790 | 220 790 | 220 790 | 220 790 | 220 790 |
| ADD BACK DEPR. | Rand | 123 846 | 123 846 | 123 846 | 123 846 | 123 846 | 123 846 | 64 616 |
| COST OF CAPITAL 14% | Rand | 112 700 | 112 700 | 112 700 | 112 700 | 112 700 | 112 700 | 112 700 |
| TVA PERIOD | Rand | 231 936 | 231 936 | 231 936 | 231 936 | 231 936 | 231 936 | 172 706 |
| TVA CUMULATIVE | Rand | 231 936 | 463 872 | 695 809 | 927 745 | 1159 681 | 1391 617 | 1564 324 |
| RESIDUAL CASH VALUE | Rand | | | | | | | 201 250 |
| CASH FLOW before Interest | Rand | (460 364) | 344 636 | 344 636 | 344 636 | 344 636 | 344 636 | 486 656 |
| IRR% before Interest | % | 72.9% | | | | | | |

**Managing a Skeptical Board:**




Required individually engaging each member in an appropriate section of the project to heighten their personal awareness and familiarity.

Example: The CFO gave advice on measuring acceptable performance. The Forestry Director provided operational performance criteria and the Technical Director assisted on import advice.

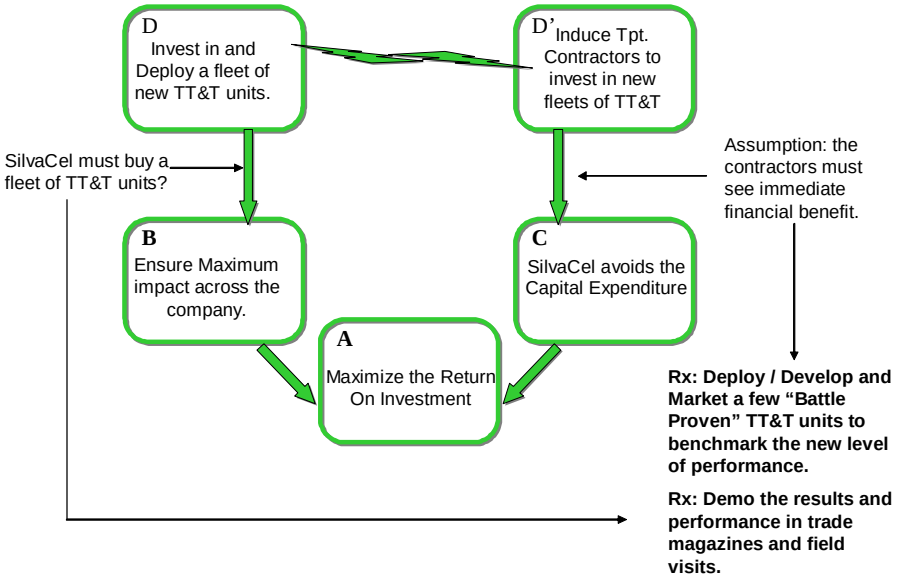
The net result was consensuses during any presentation to the Board. The Chairman observed that any question asked of the presenter was answered by the Board Member who had worked on that section of the project.

This was perceived as CONSENSUS by the Chairman. The Board was in-fact pre-sold on the concept in discrete project parts. The final presentation to the Board required only bundling all the concepts into one whole value opportunity.

**This only revealed maximum value per unit but now faced with the next dilemma. How do we deploy a strategy that only required purchasing a few truck tractor & trailer units yet had a massive impact on the delivered cost of timber across the Company?**

**Most of the transportation was conducted by contractors and out of our hands. Annual inflation adjusted transport rate increases had become the contractor's normal expectation. To inform them that we had set a new benchmark of performance on paper was too theoretical for negotiating – we had to deploy and operate a fleet of superior, high performance transport assets to convince skeptical contractors – or did we?**

**Invest in a Fleet of new trucks (over 200 units)? The cost is too high.**




**Rx I:** Purchase a few units that establish a new benchmark of performance.
**Rx:** Market these units in strategic regions – trade magazines and trade shows.
**Obstacles:**

- Contractors have no will to convert their fleet.
- We have no will to invest in a fleet.
- Truck Manufacturers have no sales opportunity.

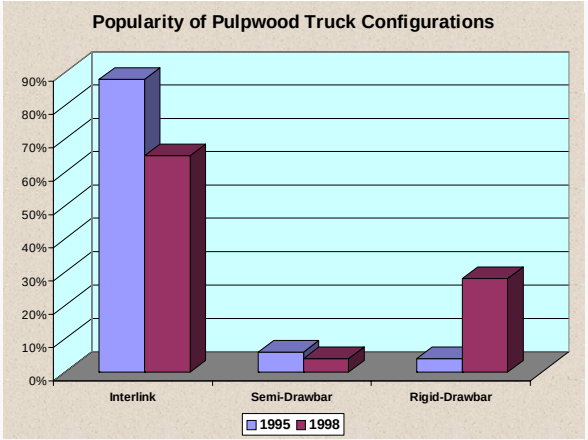
**Rx I:** Truck Manufacturers, Transport Contractors, Forest Owners combine needs.

Assumptions Broken: Manufacturer will only finance Truck Tractor units.
**Rx II:**
Truck manufacturers finance both "battle proven" trailer units along with trucks.
**Rx III:**
SilvaCel pay the monthly fixed cost of TT combinations – Are incented to keep the truck filled with timber – gives the contractor confidence to take the risk of converting to a new fleet.

**Rx IV:**
Contract pays the running cost and maintenance portion - An incentive to lower and manage the truly variable cost.

**Rx V:**
Adjust their haulage rates to reflect a reasonable profit at the new level of performance.

**Results:** List of contractors that switched over to the new fleet. Effectively lowering the NATIONAL overall cost of delivered Timber.


*Impact on Round Wood Transport Prices by Changing Technology in South Africa.*

We needed a rapid method to evaluate the significance of any design potential.

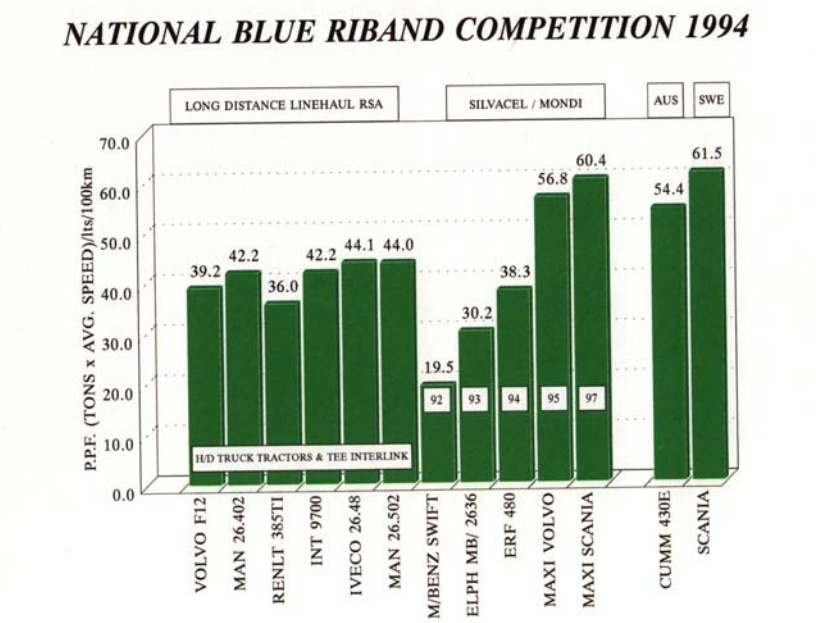
Rx: P.P.F. Payload Productivity Factor was adopted for this purpose.

Essentially:

$$\text{Productivity} = \frac{\text{Mass x Speed}}{\text{Energy}} \qquad \text{PPF} = \frac{\text{Load Mass x Avg. Speed}}{\text{Fuel Consumption}}$$

| **Vehicle Combination Type** | **Load Mass x Avg. Speed / Fuel Cons.** | **PPF ratio** |
|---|---|---|
| 2637 M/Benz & Interlink Trailer | 36 t x 62 kmph / 67 lt/100km | 33.3 |
| Freightliner 460 HP 6x4 Rigid & 4axle Drawbar Trailer | 41.3 t x 70 kmph / 53.6 lt/100km | 53.9 |
| **Improvement %** | | **61.9%** |

The following graph shows the progressive Performance Improvement of each successive TT&T design deployed in the field.




The effectiveness of the new TT&T designs and the adoption by the hauler community placed pressure on the Rail Timber Hauler to find methods for RAIL TO COMPETE WITH ROAD HAUL RATES.

This is unheard of where Rail cannot compete with long haul road transport – the competitive advantage was gained mainly through the elimination of the expensive short haul and double handling required to a rail Depot.

By taking the special adapted long haul TT&T units into the field – short haul was eliminated entirely – effectively halving the overall cost of transport.

Partial list of Initial Adopters of the New Transport Fleet Design – Mainly the draw bar Maxi-hauler design by the National Carriers.

'IMPERIAL GROUP'

'SUPER RENT GROUP

**PROCESS OF ON-GOING IMPROVEMENT**

ALEX CARRIERS
UNITTRANS and UNITRANS SUGAR
UNITY LONGHAULERS
ASSOCIATED CARRIERS
FOREST SERVICES
GASKELLS HAULAGE
BIRKENSTOCK TRANSPORT
M.R.B. (IMPERIAL GROUP)
R.C.GEVERS
F.G.V. HAULIERS
SUPER RENT GROUP

**Phase Three:**

**Using the DBR approach to a Distribution and Logistics System:**

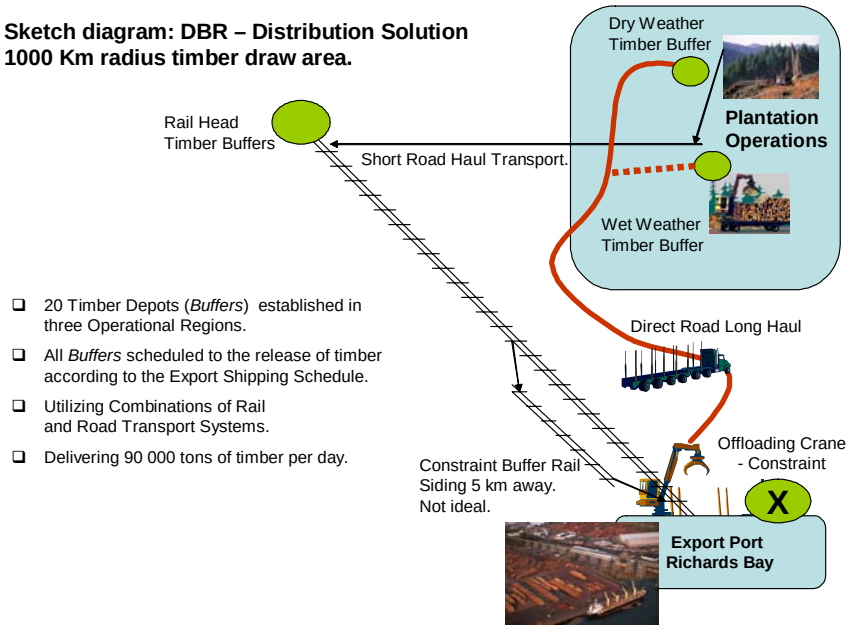
**Converting original UDE's to new DE's for the Logistics Solution:**

**DE's**

- Must introduce technological improvements that will beat inflation immediately and be sustainable in the long haul.
- Must reduce the delivery and handling cost of timber [60% of the delivered price] significantly.
- Must unequivocally prove that the new technology will surpass the test of acceptable risk plus super performance. Well above inflation – now and in the future.
- Must view our business as a massive Logistics Management Company and not just a Timber Growing and Delivery business.

The National Productivity Institute of South Africa (Ray Immelmann) conducted an initial training of 20 Managers on the DBR Simulators. The two Jonah's then revealed the individual proposed new timber flow pattern with Staging Areas (buffers) at Rail Head and Timber Depots –taking into account wet and dry seasonal patterns.

Used the DBR principals to manage the bottleneck – the off-loading equipment at the export port of Richards Bay: The constraint limitation included the physical ability to buffer the # of railcars in front of the off-loading crane – simply no space at the offloading crane – limited to 8 rail cars.



**Short Term:**

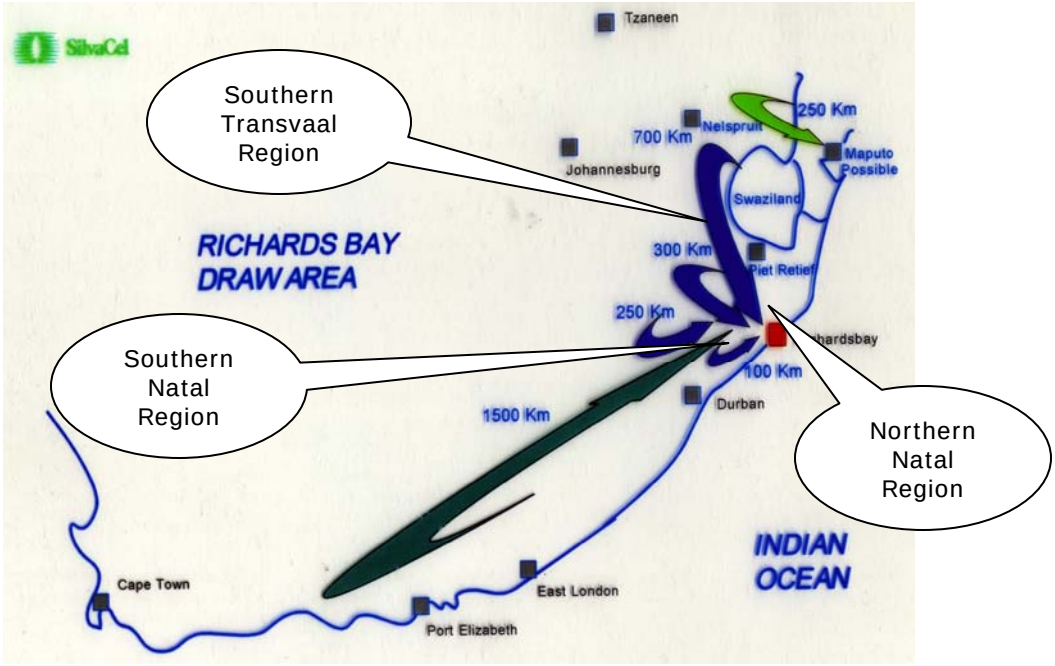
**Rx II:**
Store rail cars at a nearby siding and shuttle them into the offload area – pay the occasional demurrage fee.

**Long Term:**
**Rx II:**
Use the demurrage cost and missed rail cars (lost Throughput) to justify building our own internal rail side line and larger off loading ramp and with larger crane.

**RxI:**
Used the DBR principals to create staging depots at Rail Head and Roadside.
**RxII:**
Create wet weather areas easily accessible during rainy periods.
**RxIII:**
Create timber felling patterns that supplied dry and wet access areas – maintain and change the delivered volumes to create reliable raw material flow.

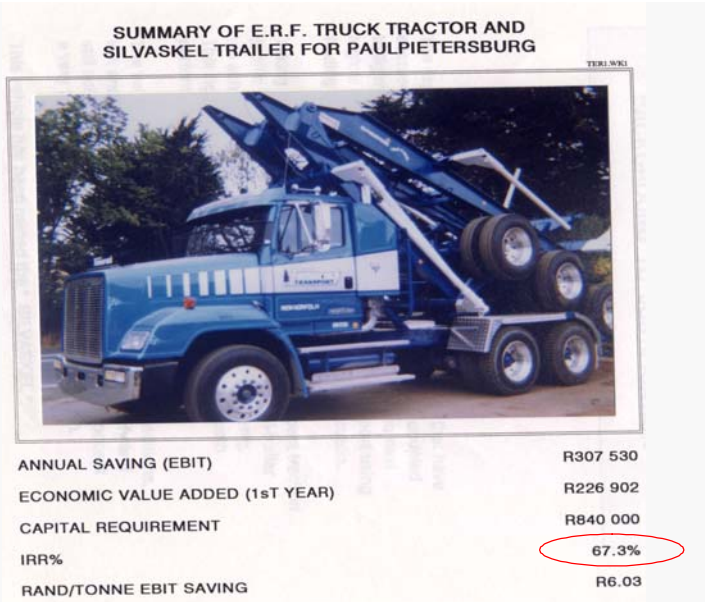
**Major Benefit:**
Accelerate the Company consensus on the proposal and solution. The workshop adopting the plan took only one day of discussion using the TOC buy-in sequence.

**Result:**
Doubled the 40 T/day to 90 T/day delivered Timber from all three autonomous Regions within one month of implementation.


SilvaCel
Tzaneen
Southern Transvaal Region
Nelspruit
250 Km
700 Km
Johannesburg
Maputo Possible
Swaziland
RICHARDS BAY DRAW AREA
300 Km
Piet Retief
250 Km
Southern Natal Region
100 Km
Durban
1500 Km
Northern Natal Region
INDIAN OCEAN
Cape Town
East London
Port Elizabeth

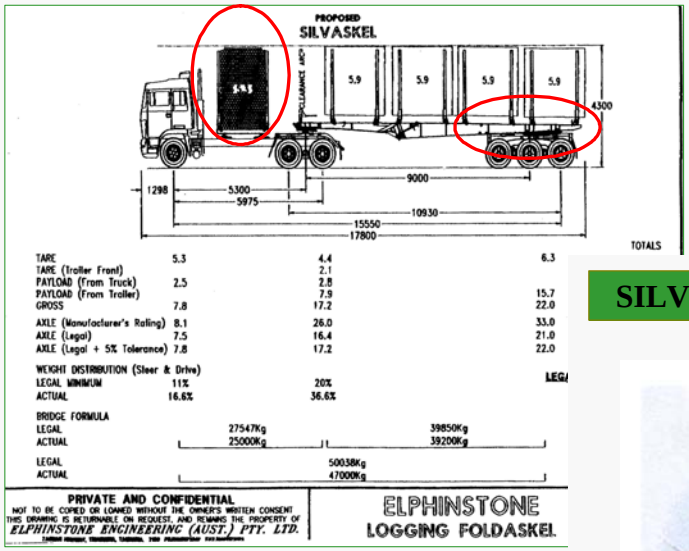
**Summary:**

A montage of designs: Each TT&T configuration provided a specific solution to the long haul and short haul requirements:




The original Australian design.

SILVaSKEL Folding Semi-trailer 1993



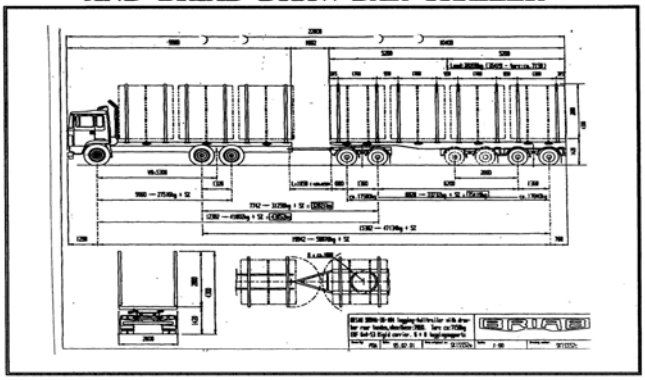

Adaptation to the South African Road ordinance. Adding an effective Five Tons of Timber per road trip.

**SILVaSKEL Folding Semi-trailer 1993**

**2 Minute Folding Time**

**SILVaSKEL Folding Semi-trailer 1993**

## SUMMARY OF E.R.F. RIGID TRUCK AND BRIAB DRAW-BAR TRAILER



| | |
|---|---|
| ANNUAL SAVING ( EBIT ) | R 315 415 |
| ECONOMIC VALUE ADDED (1st YEAR) | R 231 936 |
| CAPITAL REQUIREMENT | R 804 859 |
| IRR % | 72.9% |
| RAND / TONNE EBIT SAVING | R 17.02 |

**SILVaLINE MAXI-HAULER 1995**

**The Future:**

Further innovative designs and….

Improving Loading and Off-loading Terminal Efficiencies will provide the next wave of opportunity.