IMPLEMENTING LEAN CONSTRUCTION IN A SOUTH AFRICAN CONSTRUCTION COMPANY

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ABSTRACT

The Aveng Group, listed in South Africa, are active across Africa, Australasia, the Pacific Rim, the Asian sub-continent and the Middle East. The Group initiated an ambitious program to implement LEAN in their Operating Groups in the fall of 2006. The activities of The Aveng Group range from multi-disciplinary Construction, Manufacturing, Mining and Engineering as well as Management Services, with a total turnover of US$3.2 billion.

In 2006 the Aveng Group embarked on an exercise to benchmark its organization versus best practices in the areas of Risk, Organisational Health, Talent Development, Procurement and Operational Efficiency. For each area a number of gaps versus world class standards were identified and an improvement program set up. To deal with the issues identified in the Operational Efficiency stream it was decided to embark on a Lean journey.

The Roads & Earthworks (R&E) Business Unit within the Construction Operating Group was chosen as one of the units to initially pilot. The overall objective was to implement LEAN in this Business Unit using the Toyota Production System (TPS) as a benchmark to achieve the goals of Best Quality, Lowest Cost, Shortest Lead Time, Best Safety and Highest Morale. It was the first time in South Africa that LEAN would be implemented in the Construction sector.

The paper will focus on the implementation of a number of basic tools and systems to achieve the foundations of the TPS which are: Visual Management and Levelled Production. The paper will give practical examples for each.

The results of the first pilot sites – which show an average improvement of 2–3% EBIT - and the lessons learned are shared.

The last part of the paper discusses the way forward based on lessons learned, i.e. the creation of a suitable project organization to combine planning, safety, quality and operational efficiency activities in one department

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COMMENCEMENT OF THE INITIATIVE

The idea to initiate Operational Efficiency at the Roads & Earthworks Business Unit was decided 18 months ago. The main focus was to install basic Lean tools as visual boards, 5S, which was to become the foundation of the R&E production system.

The basic implementation structure was to work initially with a team of experts from Head Office skilled in the application of Lean techniques and to have pilots with a duration of 3-4 months. During these pilots the R&E personnel would be trained. In a later phase these people would drive the initiative throughout the sites themselves with limited Head Office support.

IMPLEMENTATION APPROACH

The implementation approach consists of three phases, viz:

- Diagnostic
- Implementation
- Sustainability

DIAGNOSTIC PHASE

The main activities are communication to site management and personnel describing the purpose and process of the program, mapping of relevant work processes and the execution of loss and waste analyses to determine technical limits and improvement targets. During all these phases site personnel are actively involved and engaged to create buy in during the implementation phase.

IMPLEMENTATION PHASE

A number of basic Lean construction tools are implemented such as visual boards, toolbox talks, performance management dashboards, etc. Site personnel, including the site manager, are coached to recognize the different kinds of waste and the corrective actions to eliminate them via problem solving sessions and techniques. A number of frequent wastes identified are:

- Waiting: People waiting for equipment, plans, or instructions on how to proceed. Waiting for material because of ineffective supply.
- Over Processing: Redundant or unnecessary reporting, expediting material orders, or excessive coordination between suppliers.
- Material Movement: Moving materials from one staging area to another, handing over work between crews.
- Inventory: Material staged on site too far in advance of when it is needed.
- Motion: Construction teams returning to the office to pick up plans, tools or materials not available at the site.

SUSTAINABILITY PHASE

The production output is monitored and necessary ad hoc assistance is given to site management if required. Regular site assessments versus a list of best practices take place and improvement actions are undertaken. The tools described below are focused on Load-Haul processes in Earthworks.

It can be argued that based on the TOC of Goldratt, the overall chain of processes should be looked at and that

the focus of action should be on the bottleneck.

There are specific reasons to start with Load-Haul:

- It is the first activity deployed in an R& E project.
- In new projects there is no history build up to create a TOC analysis.
- It is a key process and a major cost contributor.

Nevertheless, the Author agrees that there is a need and a benefit of using a TOC approach in the sub-processes of Load-Haul i.e. Road-Bed, Sub-grade, Sub-base, Base to limit inventory build up.

Due to the fact that the elementary operational basics were not in place in the first projects, a cascaded approach was chosen to implement first a number of basics tools per process to assist operators immediately, and then to deploy more sophisticated Lean construction tools such as Last Planner, Kanban, etc., in the later phases.

VISUAL MANAGEMENT

Since the commencement of the program a number of basic tools have been implemented. In a country with 12 official languages, where a large proportion of the workforce is illiterate, the use of visual management – certainly on an operator level – is key to communicating to the staff what is expected from them and to measure how well they are performing. The application of the daily operator boards (Figure 1) and toolbox talks showed in some instances a production increase of 100% and more.

DAILY OPERATOR BOARDS

Visual boards are used in every implementation of Lean. Typical usage in the R&E environment is at the 'borrow pits' from where the earth is hauled. These boards show hourly targets, as well as the actual data, and are positioned in such a way that the truck drivers can see whether they are meeting the targets or not.

The targets are simplified to make it specific for the operator, so that instead of 'm3/ hours' the wording metric 'trucks per hour' is used.

DAILY TOOLBOX TALKS

At the start of each day the previous days' production results – visual on the daily production boards - is discussed at the Toolbox Talk (Figure 2), where all the frontline operators are assembled.

During these talks the reasons for not meeting production targets are discussed, as well as the countermeasures to prevent this.

Figure 1: Daily Operator Boards

Roads & Earthworks
Daily Tool Box Talk

Date & Time

General note on previous days production

What affected production

Corrective Action to be Taken

What problems need to be discussed with management

Plan for the day

What safety issues are there?

Corrective Action to be Taken

What Quality issues are there

Corrective Action to be Taken

Name Signature

Figure 2: Daily Toolbox Cards

PRODUCTION MANAGEMENT AND FINANCIAL REPORTS

A number of management and financial reports have been redesigned to produce the information in a more visual format, e.g. site dashboards.

Site dashboards (Figure 3) are produced based on weekly production and cost reports for each Production Manager and show the status of each of the operations for which the manager is responsible.

GRINAKER-LTA

VIC HAUSER

Senior Production Manager - Earthworks

Week 3 (30 April - 6 May)

THE AVENG GROUP

AREA	KEY PERFORMANCE INDICATORS									
Operational	UNIT	THIS WEEK			LAST WEEK			TO DATE		
		target	actual	status	target	actual	status	target	actual	status
Load & Haul Fill and Subgrade	m3/week	12,469	10,951		12,469	11,321		44,531	48,539	
Processing: Subgrade	m3/week	2,993	4,265		2,993	5,533		10,688	16,851	
Processing: Fill	m3/week	11,970	9,121		11,970	6,150		42,750	33,823	
Utilization: Primary Plant	%	95%	98%		95%	96%		95%	95%	
Financial	UNIT	THIS WEEK			LAST WEEK			TO DATE		
		target	actual	status	target	actual	status	target	actual	status
Load & Haul (free-haul 0.5km)	P/m3	4.88	6.37		4.88	4.60		4.88	5.16	
Processing: Subgrade	P/m3	8.94	10.30		8.94	12.80		8.94	10.04	
Processing: Fill	P/m3	5.97	11.87		5.97	10.47		5.97	9.29	

Figure 3: Site Dashboard

The core operation in R&E is the moving of earth and processing it into layers for the building of roads. The following examples show some of the tools used to plan, track and record the operations for future improvements and feedback.

LEVELLED PRODUCTION – KPI TREES

KPI Trees (Figure 4) are used to illustrate responsibilities, processes and units of measure on which the site will be measured. From these trees, targets are set for the different areas on site.

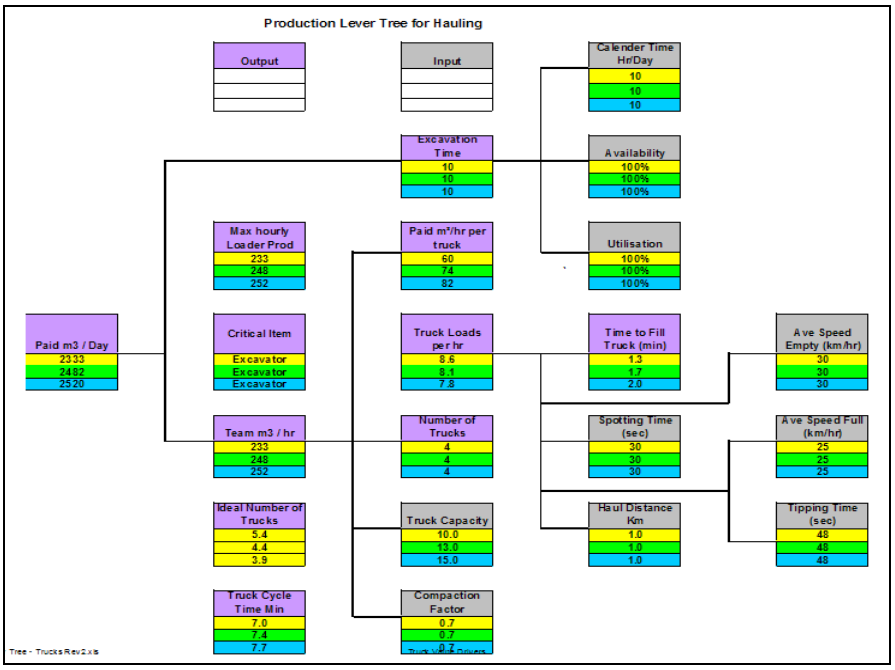

Figure 4: Production Lever Tree for Hauling

LOAD HAULER BALANCING TOOL

Since hauling earth is the major purpose of the operation, a Haul Balancing Tool (Figure 5) was developed to assist the foreman in determining how many trucks (haulers) should be used to complete the job as efficiently as possible.

	Planned vehicles and targets					
Teams	Haul Distance	Vehicle Selected 10 Cube	Bells	Target production (m3/day)	Vehicle target loads/hour	Excavator target loads/hour
Gert van Wyk	1000	3	0	925	5	16
K Kokoro	500	0	2	959	5	11
Kenneth Mashame	800	5	0	1611	5	23
Moretsi	600	3	0	867	4	12
Vehicles available		**15**	**4**			
Vehicle short/available		**4**	**2**			
Notes*						
When vehicles are mixed in team planning sheet the production total will not be accurate						

Figure 5: Load Hauler Balancing Tool

To assist the foreman even further, should the haul distance change during the course of the day, a quick reference guide was developed (Figure 6).

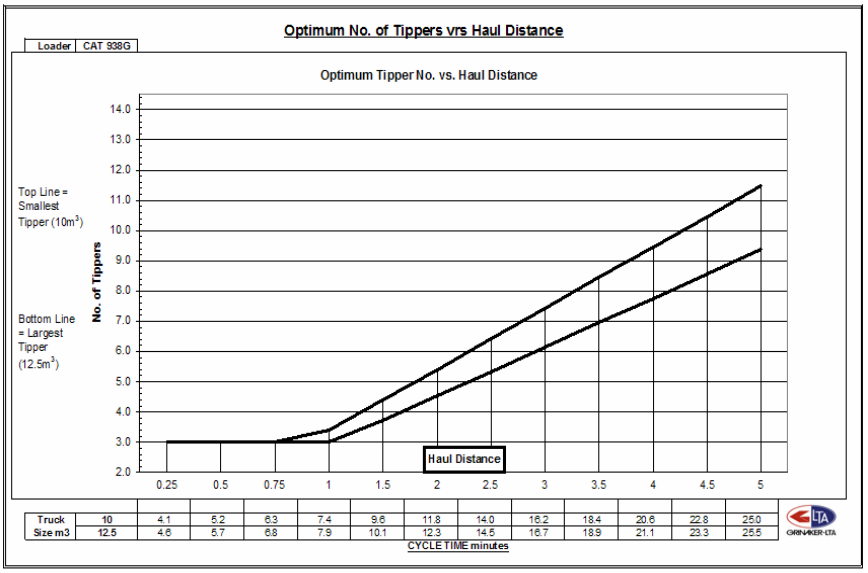

Figure 6: Reference Load Haul Tool

RESULTS

The results (Figure 7) of the first pilots confirmed the opportunity of Lean in a construction environment. Productivity improvement of a factor of 2-3 was not an exception. The bottom line impact is around 2-3% EBIT improvement.

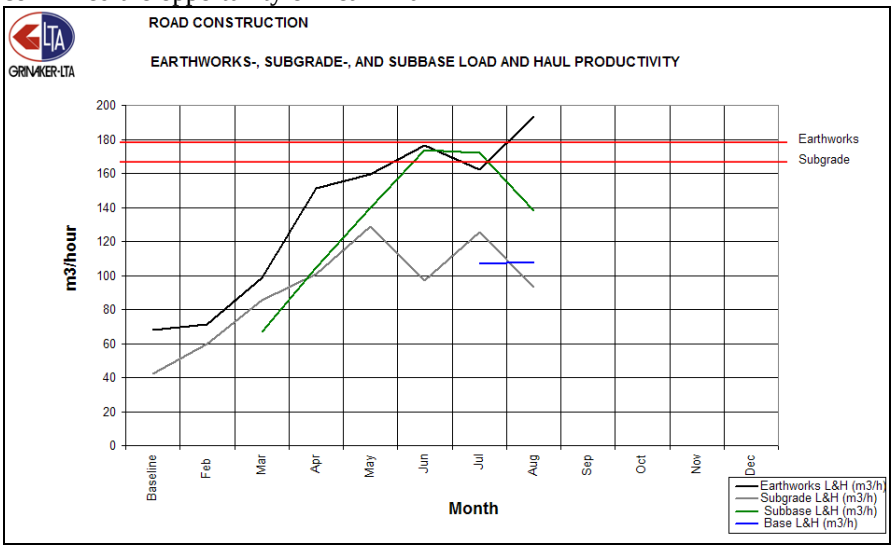

Figure 7: Load and Haul Productivity

LESSONS LEARNED

- Ensure that you have the right resources on your teams (committed and willing) – take out 'wet matches'.
- Employ people who have the experience of such a process.
- Ensure that top management understands Lean principles.
- Ensure buy-in from all management levels (top down) – identify any 'lost generation' levels of management.
- Must be one of the focus areas of the business (part of the performance contract).
- Ensure that there is a structured and well thought out methodology to implement Lean, good solid case studies throughout pilot studies, and,
- Communication, communication, communication!! to all stakeholders.

ORGANISATION STRUCTURE

In many construction companies the functional entities such as Operational Efficiency, Quality, Safety and Planning are seen as separate departments with limited or no interaction between them. This is in contradiction to the principles of the TPS, where the objective is: Best Quality, Lowest Cost, Shortest Lead Time, Best Safety and Highest Morale and which immediately implies a strong interaction between the above mentioned departments.

The lessons learned confirmed that the existing split in departments leads to a sub-optimisation of the departments. For example: The Quality department reports non-conformances, but there is no subsequent follow up. The objective is to have an immediate follow up of the non-conformances by the Operational Efficiency department.

To facilitate this interaction and to align the TPS principles, the R&E Business Unit united all four functional departments - Safety, Planning, Quality and Operational Efficiency – into a CIP - Continuous Improvement Plan (Figure 8).

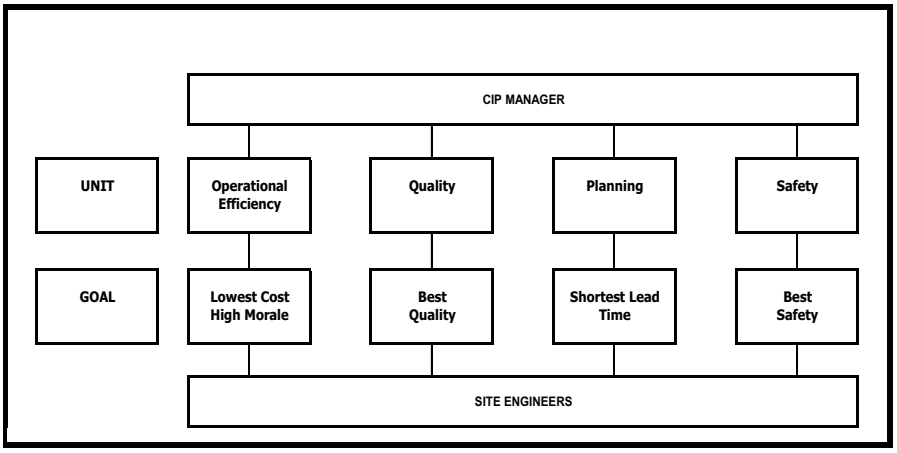

Figure 8: Continuous Improvement Plan

CONCLUSION

During the last 18 months there was a definite transformation in the R&E BU. Initially there was no buy-in on any level for applying Lean construction techniques. After the first successes were demonstrated to the EXCO members, a growing hub of believers was created and a Continuous Improvement organization built. The principles are rolled out now to every new site to create a critical mass of Lean practioners. There are still major challenges ahead to sustain the early successes and to expand the application of Lean techniques.

To date we have only applied the very basics of Lean in Construction. The higher level techniques such as Kanban and JIT have not been applied. The objective is to apply these on one or two pilot sites, expand the scope from Primary Improvement Levers to Secondary Levers, e.g. concrete structures and crushers in the Roads & Earthworks environment.

We would like to continue going forward in our Lean initiatives by:

- Introducing more advanced Lean tools, e.g. Value Stream Mapping, and Last Planner, and establish an Operational Efficiency certification system.
- Integrating current training methodologies with operational efficiency tools.
- Focus on Lean implementation in supporting services and,
- Create Operational efficiency leadership throughout the Group's Business Units to share best practices and roll out lessons learned between BU's.

REFERENCES

Womack, James P., Jones, Daniel T., and Roos, Daniel (1991), *The Machine That Changed the World: The Story of Lean Production,* Harper Perennial, ISBN 0-06-097417-6

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