Safety in Mines Research Advisory Committee

Recommendations related to the most appropriate techniques for training and education of workers in the Gold and Platinum industries

Final Report

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Executive summary

The training landscape in South Africa is undergoing veritable metamorphoses as this report is compiled. The Skills Development Bill and its subsequent influence on the National Qualifications Framework (NQF) and the founding of the Mine Qualifications Authority (MQA) has brought a completely new perspective to most training management efforts undertaken by the mining industry. This outcomes based focus has the effect that all of the existing training material has to be reviewed, and re-purposed into modules that focus on definable outcomes. Most of the respondents to our questionnaire commented that this is a time consuming and enormous undertaking.

The MQA specification of Unit Standards will deal with the outcomes which workers must attain to be declared competent, in order to perform a certain task or procedure in the process of mining, it will not deal with the methods employed to attain that competence. The sister project to this project (GAP609B), GAP609A is focussed on this "outcomes based specification for strata control risks" goal.

Even amongst all this change in the outcomes based specification of training curriculum, the researcher has found some organisations that are actively seeking for better methods of delivery, and assessment of training efforts based on the new content structure defined by the MQA. This is a very encouraging sign, for one could expect that such a wide ranging transformation of curriculum could easily engage all the available resources of an organisation, especially subjected to such unrelenting pressures as experienced in the mining industry.

There is a wide spectrum of discovery represented in this report. It ranges from a traditional training approach, with a strong programmed instruction and evaluation structure, to a very dynamic process driven, systems view, employed by training process designers. Some training efforts are clearly not about training people, but rather finding ways to help them learn effectively and perform competently. In the area of safety, the competent performance of individuals, which is the desired outcome of all these efforts will save lives.

Unique solutions like Industrial Theatre and Performance Support Efforts in the work area are clear indications of lateral solutions found to a very challenging problem. Another interesting trend is the recent movement of training efforts to the context of

work underground. Helping people be competent in very difficult circumstances is a feat greater than most realise.

There is strong theoretical evidence that a systems approach to learning support (training) has great value. Some of the respondents in the mining and industrial training community have a very clear vision of this approach, and are actively striving to change their current reality to an integrated, system focussed on the quality of human performance. This desired performance in the area of underground safety should impact on safety records in the medium to long term.

Prof. Mbigi and Dr. Mandela not only see the systems picture clearly, but also relate it to indigenous traditions and proven learning systems, which have survived culturally. This is an avenue which combined with the Cognitive Apprenticeship Model described by Sue Berryman are worthy of detailed exploration. (Appendix A.4 and A.8)

Findings are derived from analysis of the questionnaire assessment (section 4.5) and the study of the literature survey (section 3) these are categorised as, new guiding ideas, innovations in infrastructure, theories, methods, tools.

Acknowledgements

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1   Introduction

This research started with the goal to find a set of methods, which could be used in combination to improve the efficacy of training related to strata control risks in the gold and platinum industry.

It soon became apparent through systemic analysis that much more than training methods where influencing human behaviour. Expert behaviour is after all the goal of training.

The finding of this widened scope of inquiry is that:

a. organisational structure and learning culture (Who?),

b. performance and competency definitions and models (What?),

c. methods and creative learning experiences (How?),

d. assessment and evaluation (How well?),

e. learning support systems (With what?), and

f. learning paths (Where to?),

all interact to effectively support an individuals performance in the workplace.

The current thinking, world-wide, strongly leans toward organisational structure and learning culture as the basis for successful performance support of workers. All the other major elements of the system are affected by it because it supports the institutionalisation of learning philosophy and guiding ideas, and is the vehicle to effect strategy and policy in this regard.

Learning Paths	Performance and Competency Definitions and Models	Methods and Creative Learning Experiences	Learning Support Systems	Assessment and Evaluation
Organisational Structure and Learning Culture				

Figure 1.1 Main institutional components of a corporate learning system.

Many well-meaning attempts at introducing Human Resource Development initiatives fail because they are conceived in terms of implementing a training course or programme rather than creating a learning system. This applies whether the need is for comprehensive management succession and development programme or computer training for secretaries. The complex and competitive nature of organisations requires a far more sophisticated approach than simply subjecting learners to a sausage machine of pre-packaged courses if true learning and performance enhancement is to occur.

Learning systems comprise the processes, structures and mechanisms, which need to be created to give effect to strategy and policy, and sustain capacity growth. It is in this area that things often go wrong. Systems, by their nature, have to do with the holistic relationship between their components. The absence or a defect in one of the components renders the entire system less effective. It is therefore essential to be able to identify, define, apply and evaluate the components of the learning system as well as its relationship to other (generally Human Resources) systems.

Senge, in his latest effort to describe the characteristics of the Learning organisation, says that we should stop thinking of ourselves as mechanics fixing the corporate machine, but rather think of ourselves as gardeners nurturing the corporate ecosystem.

This organic nature of man and mans associations brings to mind a completely different picture. It is totally congruent with many other fields of study involving humanity. People are not machines, and will never be good at emulating machine like characteristics. We are far better off helping them to grow than we are trying a tool like a wrench to try and change their behaviour. Many of our attempts at training in the past have wholly missed the fact that humans are naturally learning organisms, and that learning is a constant body wide process, not an action reserved for training events.

This report is an attempt to summarise some of the thinking on human behaviour, and learning. It does not claim to be extensive, and is not a cookbook for training in the mining industry.

Following the metaphor of the gardener, change in the way we live and work together, can only be effective if it is initiated from the "Bottom Up". For this to happen, the soil for the growth is prepared by guiding ideas that influence our policies and systems. This report summarises some of the current guiding ideas about human learning.

2 Scope of work

The scope of this research project is to look for solutions, which could influence the efficacy of training and education efforts in the Gold and Platinum industries. The aim of which is to make workers more competent, especially in the area of dealing with strata control risks.

The scope of this report actually covers strategic and operational issues in the social domain of an organisation, not just training per se, or safety training as it intended to. It is impossible to address the best environments and methods for learning without addressing the legacy structures, which where set up to support different methods.

The following aspects where involved in the research:

- Interview stakeholders in the mining industry.
- Interpret their responses, and list the current practices.
- Interview other industrial companies where parallels may be found for worker training.
- Interpret their responses, and list the current practices.
- Compile a report containing all of the current practices, used locally, which appear to be of value for the Gold and Platinum sectors.
- Correspond with international stakeholders in the mining industry.
- Interpret their responses, and list the current best practices.
- Correspond with other companies internationally where parallels may be found for worker training.
- Interpret their responses, and list the current best practices.
- Compile a report containing all of the current best practices, used internationally, which appear to be of value for the Gold and Platinum sectors.

3   Literature review

A literature survey was conducted. The result of the survey convinced the researcher, that there could be no cookbook of best practice that applies to all situations, and drastically widened the scope of our enquiry. For high performance learning to happen in mining efforts, the following guiding ideas will have to find root.

(Appendix A) An *overview* of current guiding ideas about learning yielded the following:

In (Appendix A.9) "Understanding Learning in Organisations" Sue Mehrtens gives the most comprehensive and summarised view of the three approaches to learning currently prevalent in organisations.

There are three fundamental educational variables, which create the critical difference in performance between incompetence and mastery. Unfortunately they are virtually totally ignored in modern educational practice. They are: 1) the *strategy* or internal mental approach used by the student, 2) the *beliefs*, *values* and *motivation* of the student, and 3) the *physiology* of the student. (Appendix A.1)

Human beings are naturally learning organisms, and we learn all the time, not just in training events. (Appendix A.1, A.8 and A.9)

We need to think of the interrelated systems that support learning if we are to move closer to higher levels of human performance support.

The conceptualisation and installation of learning systems have advantages for individuals and organisations:

- the process accommodates the multiple purposes which individuals and the organisations require from learning;
- it addresses the complexity of learning which characterises the modern world of work;
- it integrates the various components of learning systems in a way that generates commitment from various stakeholders and hence sustainability over time; and
- it integrates the components of learning systems with other Human Resources and Organisational systems.

(Appendix A.2)

There are certain foundational learning skills that are essential for any learner to master in order to get the most from any learning experience they are exposed to:

- Concentration
- Perception
- Logical Thinking
- Memory

(Appendix A.3)

Competence encompasses the broad meaning of capability as *the key enabler of performance* in a defined range of performance specifications and results from the effective integration (*ability to apply*) of a range of capabilities such as knowledge, skills, context, content and values, *within the workplace*" (Appendix A.6)

Unit Standards are not descriptions of the content or procedure or methodology of learning, nor do they replace curriculum documents and guidelines. In the same way, Unit Standards are not assessment tools nor do they replace assessment documents and guidelines. Unit Standards do however inform learning program developers about what the outcomes of learning are to be, and inform assessors as to what must be assessed and the quality of evidence required. Unit Standards describe the results of learning and not the process of learning. We teach TOWARDS the Unit Standard and we assess AGAINST the Unit Standard. (Appendix A.7)

Two guiding ideas from authors who live on different parts of the globe fit like hand in glove. These are the Cognitive Apprenticeship Model for Learning and the description of African Collective Learning Systems.

Combining the Cognitive Apprenticeship Model postulated in (Appendix A.8) and the thinking on African Collective Learning Systems in (Appendix A.4). gives the following picture of the elements working together:

- *Content*
  - The principle of focussed learning: Focus on one single task and simple learning objective at a time before moving on to the next level.
  - The principle of portable learning: People learn best if there are learning benchmarks through recognised accreditation.
- *Methods*
  - The underlying philosophy is learning by doing, i.e. reflective learning action.
  - Teach one and learn one. The best way to learn is to teach others. Knowledge and skills sharing is vital. In order to get everything we must share everything. Prof. Reg Revans put it more accurately when he argues that the people learn more from comrades in adversity than from experts on high.
  - Collective learning requires us to celebrate and canonise our interdependence, which is the cornerstone of Ubuntu value systems.
  - The principle of life skills: Being focussed on survival challenges accelerates learning. Adaptive learning is vital. Reg Revans states that collectives and groups that adapt to change effectively have a steep learning curve; their rate of learning exceeds the rate of change facing them.
  - The principle of self directed learning: The best learning is self-motivated and self-directed.
- *Sequencing*
  - The principle of incremental learning: Modules have to be developed for each learning objective.
- *Sociology*
  - Learning is a collective effort and not just an individual one. This is the fundamental philosophy of Ubuntu – "I am because we are" – each one of us needs all of us.
  - The social process of learning is as important as a learning curriculum or content in terms of program design. We need to pay particular attention to social processes in terms of the bonding and learning rituals and ceremonies.

- The spirit of learning principle: The organisational spirit or climate establishes the rare horizons and perceptions of learning.
- The principle of personal destiny (*dzinza* in Shona): Learning is accelerated by a high sense of personal purpose, history and destiny as well as career pathing.

General Peter Schoomaker sees a new world of crisis and conflict that requires "creative solutions in ambiguous circumstances." (Appendix A.11) The principles he talks about are thought provoking when applied to the hard industry of mining, which has many parallels.

He says: "The armies that will win in the future -- and, by extension, those organizations that will wage successful campaigns of any kind, whether they're commercial, military, or otherwise -- will be those that marshal "creative solutions in ambiguous circumstances," says Schoomaker. *"Everybody's got to know how to be a leader."*

Some guiding ideas from the General are:

- Focus Your Mission, Define Your Identity
- Pick the Right People, Build the Right Team
- To Be a Leader, Demonstrate Leadership
- Teach People How to Think, not What to Think
- Core Values Hold the Ranks Together
- Action Learning Is the Way to Learning
- Make Everyone a Teacher

In Japan there is an education revolution brooding at Keio University, Japan's oldest and most prestigious private university. Its Shonan Fujisawa Campus (SFC), established in 1990, has the mission of creating the next generation of independent, creative thinkers equipped to define and meet the challenges of the information economy. (Appendix A.12)

For 50 years Japanese students have been drilled to supply the correct answer to established questions. But in a post-industrial economy where creativity and innovation are the new prerequisites, the old education-as-manufacturing model puts Japan at a severe disadvantage.

Question: How do you create agile participants when the system treats universities as mere finishing schools for students headed for lifetime employment at large corporations or prestigious government ministries?

Answer: Explode the standard curriculum and entrenched teaching practices of the past. Integration is the key word here. The new education system design at SFC scraps traditional academic disciplines in favour of two multidisciplinary faculties to cultivate *"comprehensive perspective and judicious judgement"* among students.

(Appendix B) In the area of *Methods and Creative Learning Experiences* we found the following guiding ideas:

If you want to influence, motivate or change someone, the key to doing so is to connect up the change you want him or her to make with the values they are already operating out of. This approach to change differs from the process of changing people's values. Some values are easier to change than others. Core values are very difficult to change. It is much easier to align change to people's natural motivational flow than to attempt to change that flow. People do things for their reasons and not our reasons.

Combining Clare Graves "value systems" or "world views" which deals with *the deep structural patterns of preferences*, and the meta-programs of the Neuro Linguistic Programming (NLP) world which deals with the *patterns or habits of perception and behaviour*, gives the change agent the maximum leverage to understanding and producing change in human behaviour.

The *learning levels model* defined by NLP is very informative:
Unconscious incompetence – We don't know we don't know.
Conscious incompetence – We know we don't know.
Conscious competence – We know we know.
Unconscious competence – We don't know we know (We don't have to think about it).
Asking the expert to explain or demonstrate is often not enough because many elements used in his strategy are unconsciously recalled and applied. How then do we solve this problem? By formalised modelling called modelling 2 in Appendix B.

Some themes that can be crystallised from all of the literature and discussions are the following:

- Where do you start? You start with a philosophy, and the rest follows from that. If you believe in training and developing people, you don't necessarily need a huge training budget. You begin by imparting knowledge in various ways -- by holding meetings, by talking to people, by coaching them, by mentoring them. If you believe in reciprocal commitments, you start by building those commitments with the people you work with. If you believe in information sharing, you share information with the people you have the most contact. In other words, you begin in your immediate sphere of influence. You start with your own behaviour.

- The shift from an industrial to information economy is affecting the way we think about education and training. Less production line and more boutique solutions are the order of the day.

- A culture of clear and honest communication about the work experience helps to promote learning in a sustainable form. It also promotes personal commitment to the success of the organisation if an individual feels ownership in the solutions applied.

- People are looking for the opportunity to have variety in their work and to tackle challenging assignments.

- Companies that manage people right will outperform companies that don't by 30% to 40%. Studies of the steel industry, the oil-refining industry, the apparel industry, and the semiconductor industry all demonstrate the enormous productivity benefits that come with implementing high-performance, high-involvement management practices.

- The company treats its people as if they were a factor of production. The managers can reel off all of the various economic factors: "We've got capital that we invest, we've got raw material that we use, we've got the waste from the manufacturing process that we recycle -- and, in the same category, we've got our people." It's a workplace that doesn't see people as people, but rather sees them as factors of production. And that's ironic, because what we celebrate as a competitive, capitalistic practice actually reflects a Marxist orientation: People are seen as a factor of production, from which a company has to extract an economic "surplus."

- High staff turnover costs big money. Do what's necessary to keep the people you've got, and you will be much better off economically.

- When you look at your people, what do you see -- expenses or assets? In part, it's because of the financial-reporting systems that we've got. The fact is, your salary is an expense.

- Everybody knows what to do, but nobody does it. For example, a lot of companies confuse talk with action. They believe that, because they've said it, it's actually happened.

- There's another reason why companies don't do what they know they should; they fall prey to the power of precedents. They do something once, and then they get trapped by their own history: This is the way we do it because this is the way we've always done it. They substitute memory ("We did it this way before") for thinking ("Is this a sensible way to do it?").

- A revolutionary notion: Collaboration and mutual advantage are the essence of the organisation. They can create flexibility, resiliency, speed, and creativity - the fundamental qualities of the company of the 21st century.
- You need a process that allows managers and their organizations to be brutally honest with themselves about their successes and failures in the workplace. As a result of that honesty - and the desire to learn from it - the individuals and the organisation all become better.
- The best learning comes from the most stressful situations.
- Learn about what matters.
- Use hard data to eliminate subjective debate.
- Learning requires facilitators who coach rather than lecture.
- Promote a learning mind-set that endures beyond the training exercise.

(Appendix C) In the area of *Organisational Structure and Learning Culture* we found the following:

Engines of Democracy (Appendix C.7)
The General Electric plant in Durham, North Carolina builds some of the world's most powerful jet engines. But the plant's real power lies in the lessons that it teaches about the future of work and about workplace democracy. MUST READ!

Learning for a Change (Appendix C.6)
Senge has a new book out called "The Dance of Change". His comments on the change process and organisational learning are documented in an interview with Fast Company.
Ten years ago, Peter Senge introduced the idea of the "learning organisation." Now he says that for big companies to change, we need to stop thinking like mechanics and to *start acting like gardeners.*
When I look at efforts to create change in big companies over the past 10 years, I have to say that there's enough evidence of success to say that change is possible -- and enough evidence of failure to say that it isn't likely. Both of those lessons are important.

Senge's The Fifth Discipline and others reviewed. (Appendix C.1)
Peter Senge's *The Fifth Discipline* has leveraged systemic thinking into the educational and social mainstream. To millions of people he brought insights about our lives and the world in which we find ourselves that are afforded by systemic thinking. However, there is a wider body of literature on systemic thinking not incorporated into Senge's work. In this material is found both plurality of thinking and recondite understanding that invites further attention.

Personal mastery may empower people by helping them to clarify and deepen personal vision and to come to grips with intrinsic desires. *Mental models* may empower people by educating them about the way cognitive processes shape what they see and define their relationship with other people and the world. *Shared vision* may empower people by generating a common sense of purpose on which they focus energy in a meaningful way. *Team learning* may empower people by educating them about the way cognitive processes shape what they see and define their relationship with other people and the world. *System thinking* may empower people by enabling them to begin to appreciate rather than be confused by the interrelated nature of the world and how this might cast

insights into their experiences. It is systemic thinking, Senge argues, that integrates all five disciplines and brings about the empowering potential of the learning organisation.

Senge offers a view of systemic thinking from the vantagepoint of system dynamics. System dynamics explains people's experiences through systems archetypes and the underlying structure in behaviour that they help to locate, which is one useful insight. However, contributions from other system thinkers locate many more central insights that system thinking can offer and which people might take into account. Senge misses out on these. He therefore stops short of drawing together a wide-ranging and coherent theory of system thinking. Senge's readers are continually referred back to the narrower focus of system dynamics for an account of what systemic thinking has to offer. Consequently, whilst enjoying a certain sense of empowerment from the many valuable insights Senge spotlights, people may still battle with an unnecessary confusion arising from their unconvincing systemic encounters with a profoundly systemic world.

Incorporating insights from other accounts of systemic thinking may enhance the empowering quality of Senge's work. This possibility is explored in review. First, we extract a number of commonalities and similarities sufficient to proclaim our prime movers to be of one movement. Second, we locate two central issues for systemic thinking not dealt with by Senge in any meaningful way.

Change (Appendix C.5)
- Every corporate giant says it wants to change. Few can do it.
- Every young company starts as a natural force for change. Few can sustain it.
- Every organisation has people who think they want to be agents of change. Few can survive it.
- Today the idea of a change program sounds hopelessly artificial, the organisational equivalent of a computer add-on, an off-the-shelf peripheral that gets plugged into the company as an upgrade. Instead of an external program, change today is intrinsic to business, an integral expression of how any successful business operates. It has escaped from the narrow confines of human resources - or any other department or function - and become an issue of personal responsibility.
- You can find people who make change today throughout the organisation. They are individual agents, leveraging their energy, experience, talent, commitment, and connections to make things happen. They are change agents - but only as a way of working, not as a discrete job. They have real jobs, real work - and driving change

is built into how they do their jobs. Creating change is a skill. But getting things done and moving the business is the passion. Says one corporate change agent, "The real challenge of change is not just to come up with a brilliant idea - it's to implement it. The successful change agent can say, This idea is alive in the company."

- Change begins and ends with the business - not with change.
- Change is about people. People will surprise you.
- There is information in opposition.
- The informal network is as powerful as the formal chain of command. And you get to design your informal network.
- You can't draft people into change. They have to enrol.
- It's not a calling. It's a job.
- Forget balance create tension.
- No change agent ever succeeded by dying for his company.
- You can't change the company without changing yourself.
- Even if the company doesn't change, you will.
- Change or die!

4 Methodology

4.1 Introduction

The researcher sent the questionnaire (Appendix D) to as many mines as it could contact in the Gold and Platinum sectors (Appendix D), and to a number of industrial companies in South Africa. The next step was to visit some of the mines and have telephonic interviews with the ones not visited. All the major regions where large scale Gold and Platinum mining takes place in R.S.A. where visited.

All the responses elicited during this process where summarised and categorised then interpreted by the researcher.

4.2 Selection of contributors

Contributors to the study, both questionnaire and general review respondents, were selected to ensure adequate input from pertinent stakeholders, i.e. unions, DME, MQA and relevant mining personnel, e.g. rock engineers, training and safety personnel. In addition, contributors were selected to cover the spread of mining groups, districts, reefs and general diversity of conditions in the gold and platinum mining industries.

We also spoke to industrial training stakeholders, in R.S.A and Internationally using the internet through, e-mail, and interest groups. These discussions are not summarised below but are synthesised as part of our findings, and literature surveys.

4.3 Questionnaire design

One of the challenges of this project was to gather information of relevance from a potentially broad diversity of opinion pertaining to training. In order to properly address the requirement of this project, input was required from union representatives and workers, government representatives, industry representatives from rock engineering, safety and training, the Mine Qualifications Authority (MQA) and mine head office staff.

To achieve this objective, a questionnaire was drafted that was broadly based on the traditional components commonly found in industrial training.

Questionnaires were completed in an interview format as experience has indicated that this provides the most effective results. Individual interviews were undertaken to allow open discussion and frankness of opinion to flow freely. All responses and completed questionnaires have been kept confidential to encourage frank and open answers.

4.4   Completion of the questionnaire

Questionnaires were completed by means of interviews, telephonic discussions, faxed, and Internet Form response. A web site was set up for the latter, which compiled the database for this phase of the project.

Respondents where encouraged to give their broader perspectives to give a good over view of activities in the mining training domain.

On completion of the questionnaire, the following additional questions were asked:

- What problems do you have now?

- Which problems have you found solutions to?

- How was it done in the old days?

All responses were held to be confidential, i.e. no specific interviewee's name or the mine at which they were employed would be indicated.

4.5   Questionnaire assessment

Questionnaires were summarised in a two column format in which, using original questionnaire topics, responses were captured under two columns representing their guiding ideas, *Top Down* or *Bottom Up*.

Definitions:

Top Down

The Top Down approach is the old way of looking at the world. We see the company as a machine. When some part is not working we fix or replace it. We have programs for everything, and we supply the answers from the top down.

Bottom Up

The new way of looking at the organisation as an organic system. After all people, who are our companies are organisms not machines. We sow the seeds of change and organisational learning culture and nurture its growth, from the bottom up.

Many responses where the same. As the aim of the study was to discover the practices and not to quantify the proliferation of their application only different answers are listed in the summary below.

Results of the questionnaire and discussions with industry stakeholders

Planning
Bottom Up
- Our planning efforts are mainly modelling, to varying levels of sophistication, of the task concerned.   - Our training planning is divided into three phases: - Task analysis - Group and Individual.   - Workshops with all role players.   - NGT Nominal Group Techniques.   - Personal Development Strategies guides our training planning.   - Historically Line Management identified the training needs.   - The underground training facility has direct contact with the workers through observers who visit the work area and report to the UG Training facility.

• Needs analysis is the most important part of the process. Line management audits our efforts on a weekly basis, and we respond directly to their changing needs.
• Gap analysis - discrepancy in performance.
• Constantly revise method of instruction. Evaluate initial GAP analysis. Revise Training
Planning
Top Down
• Safety and production drivers direct our training planning.
• We look at accident statistics, and production figures to guide us in this process.
• Accident investigation and other ad-hoc investigations also help to determine needs. Gap analysis, using competency models, which identify skill requirements.

Design
Bottom Up
• Task analysis, Task Procedure, Task Observation. MQA looking for the answer.
• In-house method - Skills Application Modules. Resources - Unit Standard, Learning Material, Assessment.
• Live show script for Industrial Theatre. Telling the story of work in its full context.
• Clusters of skills are dealt with at a time, then the learner goes to work with them.
Design
Top Down
• Need to Know basis design.
• Criterion Referenced Instruction

Delivery
Bottom Up
• Theoretical and Practical Coaching with a hands on approach.
• Stope Training (In context).
• Classroom, simulated work, real work.

• Referenced Instruction Underground instruction, and practice.
• Industrial Theatre with lively audience participation. Then Experiential learning in a mock-up stope (Simulator). Then the actors accompany the learners into the workplace for demonstration and evaluation.
Delivery
Top Down
• Class room teaching primarily • We are starting to use computer based training for Miners and up.

Evaluation
Bottom Up
- Show how you can do the work. Observed by the specialists who mentored from the start.   - Observe the performance - MQA wise.   - Verbal Q&A from Evaluation Sheets. Practical demonstration of competence.   - By training personnel while performing simulated work.
Evaluation
Top Down
- Testing following learning. Attempts to measure application of learning in the workplace exist, but rely on feedback from supervision - not always given   - Tests   - Practical assessment and an oral criterion test   - Weeks later a follow up visit measures, assess, and evaluates.

Feedback
Bottom Up
- Assessment in the workplace. Performance output.   - Team where trained together and line have the ability to assess and feedback.   - Observed by specialist trainers and feedback by line management.   - Constant monitoring looks at the changes in environment and performance yields immediate info, act on that to correct.
Feedback
Top Down
- Resource limitations require line feedback - not always given   - Follow-up visits.   - Regular Performance appraisal interview.

Remedial
Bottom Up
- Back to formal training if serious enough, otherwise supervisory or peer correction   - Revise method of instruction. Evaluate initial GAP analysis. Revise Training.   - Constant monitoring. Then retraining same method.   - Observer feedback sends the worker back to the UG Training. If still no success the worker continues to work in current competent area.
Remedial
Top Down
- Repeat Training Modules if necessary.   - Ideally feedback - develop new material / methods. In reality feedback is not effective or non existent.   - Feedback from line management is acted on in custom training events.

Reinforcement
Bottom Up
- Re-enforcement of learning happens by doing the work correctly.   - By doing.
Reinforcement
Top Down
- Annual refresher – formal   - Set clear and realistic objectives. Stick to set objectives. Regular Follow-ups.   - By on going training.   - Re-fresher - if pre-assessment from leave fails. If changes in the work place re-training on return from leave.   - Participating in an induction course of 3 days after returning from leave.   10 Day re-training on return from leave.

Where (Where do they learn?)
Bottom Up
- Underground training centre, Designated training team leaders take the new trainees in underground training stope until ready to be deployed in other teams. The training team is split after completing the program. Class room training also on surface. Underground training section has normal hierarchy, Mine Overseer, Shift Boss, Trainee Miner, Trainee Worker.   - Stope.   - The last 6 months we have a new system. It uses underground theory instruction, practice model work, but not in teams.
Where (Where do they learn?)
Top Down
- In a training centre, and later on the job.   - Underground classrooms and practical venue.   - In a training centre, and simulated work environment.   - Previously surface - theory and practice.   - Managerial instructions are taught on surface.

What (What are they exposed to?)
Bottom Up
• Coach, allow the normal work to proceed under guidance of the training team.   • Lectures, practical working in the stope, work as a trainee.   • Lectures - Converting to facilitation method of lecturing. Practical - hands on approach.   • Lectures and hands on training in the workplace.   • Theory, Practice, Work with observation.
What (What are they exposed to?)
Top Down
• Lectures, some practical, work in the simulated stope.   • Clusters of skills are dealt with at a time, then the learner goes to work with them.

Delays (Do delays exist between learning, and application in the workplace?)
Bottom Up
• No it is the same thing.   • Cluster of skills are dealt with at a time, then the learner goes to work with them. No delay.
Delays (Do delays exist between learning, and application in the workplace?)
Top Down
• Not usually, but in the case of special skills e.g. pump operators, Yes, normally 4 to 8 months.   • Don't know, but 10 Day re-training on return.   • Two day learning process.   • Day 1 Theoretical, Day 2 Practical evaluation.

Time (How long does it take to have a new worker become competent?)
Bottom Up
• It varies from employee to employee.
• 3 weeks team leader, varies about 1 week per skill.
Time (How long does it take to have a new worker become competent?)
Top Down
• Focussing on 'workers' only, usually a matter of months only. • Don't know. • The time is dependent on the target population, when exposed to one task only 6 months and needs to be divided into 2 categories. 1. Days theoretical. 2. Regular application of the task. • One month. • Don't know now, but NQF methods will focus on this.

Evaluate Performance
Bottom Up
• Observation and analysis. • Line supervision feedback. • Observer and line management monitors performance.
Evaluate Performance (How do you assess the competence of the worker?)
Top Down
• Verbal Exam for Category A workers. Written Exam for Category B workers. Both A and B are assessed through performance output, and structured assessment sheets. • Performance appraisal. • Show and tell during training phase.

Problems (What problems do you have now?)
• Diversity in the learner population, attitudes.
• Unionisation, leads to group think, happy family syndrome.
• Very politicised work force created huge rifts between the workers and management.
• Re-evaluation and follow-up, concept is not always understood by all parties.
• Some cases the needs analysis was not properly done, which has a negative effect on the training cycle.
• Diversity in the learner population, lack of practical application.
• MQA - Skills based changes to deal with.
• Re-structuring.
• Line involvement and assessment of the worker not working.
• High quality people leaving due to uncertainty and change.
• MQA units standards implementation is a high priority, but a huge job. It is going to take some time to get in line.
• A general lack of Training Specialists in our industry.
• Motivational problems are often misread as training problems.
• We don't have good managers in the mining industry. In this hard industry we lack discipline. Lack of Soft Skills like cross cultural communication.
• Assessment started in certain categories of work, but assistance regarding task observations is needed with regards to discrepancies or deviations.

Solutions (Which problems have you found solutions to?)
• Training is skills and outcome based.
• Our solution for the gap between training and the work place is to train line management in mentoring, and assessment skills. In the hope that the quality of feedback will improve. Very EXPENSIVE! Don't know how effective, yet?
• An observer, who is there to help and correct the performance of the workers, provides underground training help.
• Shiftboss, Miners, Teams participate in teamwork and problem solving training on the surface.
• Working teams are learning together.
• Experiential learning is the most valuable part of the process.
• Industrial Theatre is a valuable component, which gets learners involved and enthusiastic.

History (How was it done in the old days?)
• Performance output was the only measurement tool.
• One on one apprenticeship.
• On going in house training from manager to employee.
• We learned from our peers. I went to an expert doing the same job as me whenever I had a problem to solve in my area. For advancement I talked to my line manager who facilitated my progress, and was my mentor for life long learning.
• Done better 30 years ago. Longer time spent training in training stopes. Government Mine Training centre, Chamber of Mines Training Centre, Decentralised Mining Training Centres.
• Workers didn't come back, so a lot of new training was done. Much time spent in training.

5 Findings

5.1 Introduction

There is strong theoretical evidence that a systems approach to learning support (training) has great value. Some of the respondents in the mining and industrial training community have a very clear vision of this approach, and are actively striving to change their current reality to an integrated, system focussed on the quality of human performance.

Prof. Mbigi and Dr. Mandela not only see the systems picture clearly, but also relate it to indigenous traditions and proven learning systems, which have survived culturally. This is an avenue which combined with the Cognitive Apprenticeship Model described by Sue Berryman are worthy of detailed exploration. (Appendix A.4 and A.8)

Findings are derived from analysis of the questionnaire assessment (section 4.5) and the study of the literature survey (section 3). These are categorised as, new guiding ideas, innovations in infrastructure, theories, methods, and tools.

Certain findings under each category were as anticipated. Others were, however, unexpected and these are highlighted for study.

5.2   Guiding ideas

- Humans learn naturally though modelling others behaviour (called modelling level 1 in this report), despite training and education.
- Working is learning.
- Thinking, "Bottom Up" like gardeners, not "Top Down" like Mechanics will lead us to the understanding of the organic nature of living, learning and working together.
- *Systemic thinking* reveals the *unexpected* notion that there are no iron clad answers to these issues of learning, and that any approach followed has to be defined as a process of change, which is local in space and time. In other words, the best way forward, is to let the people involved in the focus area, define their future vision, assisted by the valuable guiding ideas, but formulating their own dynamic way of living, learning and working together as a result. (see appendix C)

5.3   Innovations in the infrastructure

- Learning is best supported in the workplace, or the context of work.
- Have the expert supporting the learning in the context of work in a one on one interaction. Mentoring, coaching, guidance, etc., where expert input is available at the moment of performance will always have the greatest impact on the learning and performance of the individual receiving the support.
- The infrastructure required is a workplace, which houses an expert community of practice, which inducts novices into it through, a learning support system. Supporting learning means at least to, set an expert example of performance, observe, evaluate, and give meaningful immediate feedback on performance to the learner. Leading and managing change in local space and time, are the guiding principles of the effective learning process.
- Teams need to learn and work together.

5.4 Theories

- Neuro Linguistic Programming does not have solutions for all the learning answers we seek, but, Combining an expanded Clare Graves "value systems" or "world views" which deals with *the deep structural patterns of preferences*, and the meta-programs of the NLP world which deals with the *patterns or habits of perception and behaviour*, gives the change agent the maximum leverage to understanding and producing change in human behaviour.

- The *learning levels model* defined by Bateson is very informative:

    - Unconscious incompetence – We don't know we don't know.

    - Conscious incompetence – We know we don't know.

    - Conscious competence – We know we know.

    - Unconscious competence – We don't know we know (We don't have to think about it).

- Through a process of formalised modelling (called modelling 2 in this report) it is possible to recognise specific sets of beliefs, values, meta-program filters, physiology's, representational system facilities, and strategies that are used to generate the distinctions, patterns, processes, procedures and tools used at level1.

- Modelling 1 explicates "what" an expert does and modelling 2 explicates "how" they do it. Modelling is like giving someone a fishing rod and a can of worms. Modelling 2 is teaching someone how to make a fishing rod and find worms, as well as how to use them to catch fish. There is a big difference between these two levels (which correlates with Bateson's levels of learning above).

5.5 Methods

- Asking the expert to explain or demonstrate is often not enough because many elements used in his strategy are unconsciously recalled and applied. How then do we solve this problem? By formalised modelling called modelling 2 in Appendix B.2.

- Supporting learning means at least to, set an expert example of performance, observe, evaluate, and give meaningful immediate feedback on performance to the learner. Leading and managing change in local space and time, are the guiding principles of the effective learning process.

5.6   Tools

The tools and media used to support the learning process are dependent on the knowledge involved, as well as the localised conditions of the environment. The syntheses will always be a local process that will be informed by principles and guidelines summarised in Appendix B.

B.1   GENERAL PRINCIPLES AND GUIDELINES FOR ACCELERATED LEARNING

B.2   MODELLING

B.3   CORE SKILLS

B.4   LEARNING STRATEGIES

B.5   TRAINING METHODS

B.6   TRAINING DESIGN

B.7   TRAINING NEEDS ASSESSMENT

B.8   ADULT LEARNING THEORY

B.9   THE VALUE OF EFFECTIVE PERSONNEL SELECTION USING PROFILING

5.7   Unexpected or anomalous questionnaire results

- It was evident that systemic analysis leads to an entirely new viewpoint on training efforts and performance of workers. The concept of the learning organisation changed the point of view of change management as well. The idea that it is possible to have meaningful learning driving the change process in organisations from the bottom-up was not expected. Consult Appendix C for more details.

5.8 Additional topics

Media in use.

What media do you use to support the communication process? (Manuals, Slides/Overheads, Audio Tapes, Video Tapes, Models, Computer Based Training).

The answer to this question was that most training centres use all of the above except that some are starting to dabble in computer based training for level 3-4. The problem is that the training is a digital version of the old way of training.

Is it produced in-house or externally? In-house mostly, some training centres still have some old video material produced by the Chamber of Mines.

What media do learners take with them to the workplace? Not many training centres have handouts for worker training, due to the practical nature of the training.

5.9 Quotable quotes

Several contributors made notable comments. These are:

"Sometimes motivational issues are diagnosed incorrectly as training issues". The statement was also made that motivation is increased through participation in training on this specific mine.

"In the old days:

- Performance output was the only measurement tool.
- We learned through one on one apprenticeship.
- On going in house training from manager to employee.
- We learned from our peers. I went to an expert doing the same job as me whenever I had a problem to solve in my area. For advancement I talked to my line manager who facilitated my progress, and was my mentor for life long learning.
- Better done 30 years ago. Longer time spent training in training stopes. Government Mine Training centre, Chamber of Mines Training Centre, Decentralised Mining Training Centres.
- Workers didn't come back, so a lot of new training was done. Much time spent in training."

"A very politicised work force created huge rifts between the workers and management."

"Line involvement and assessment of the worker not working."

"High quality people leaving due to uncertainty and change."

"There is a general lack of Training Specialists in our industry."

"We don't have good managers in the mining industry. In this hard industry we lack discipline. Lack of Soft Skills like cross cultural communication."

"There is a major lack of communication between workers and management. People are not being told the reason for doing things, they are just being ordered."

"The senior staff (management) do not respect those on a lower level."

"The workers are not aware of the important aspects such as mine standards."

"The workers push production to achieve the bonus payment, sometimes compromising safety. This practice, in turn results in a lot of accidents and even fatalities."

"We suggest the use of underground training centres so that workers can practice what they learn in the proper working environment."

6   Application of findings

6.1   Introduction

The findings of this project are of use to personnel involved in mine training and management, MQA and SAQA, unions and the DME.

Personnel in each of these categories of activity will have differing uses for these findings and it is pertinent to describe what this anticipated usage is for each category.

6.2   Mine training usage

Mine training will be able to use outputs from this report to achieve several goals:

- Use Appendix A to sensitise to training issues current discussions around them, also some case studies on new ways of working and learning together.
- Use Appendix B as checklists for best practice in training.
- Use appendix C as a methodology to manage change in the "Learning Organisation"

6.3   Mine management usage

Mine management will be able to use outputs from this report to achieve several goals:

- Use Appendix A to sensitise to training issues current discussions around them, also some case studies on new ways of working and learning together. This may affect their guiding ideas about learning support, and have wide ranging policy implications.

- Use Appendix B as checklists for best practice in training.
- Use appendix C as a methodology to manage change in the "Learning Organisation"

6.4 Unions

It is envisaged that the unions will use these findings to:

- obtain general background information and learning issues

- interact more meaningfully and effectively with mine management

- be more involved and pro-active in addressing training requirements and shortcomings

6.5 DME

The findings of the report can also be used as background knowledge during accident investigations and when auditing or reviewing the content and implementation of Codes of Practice.

7 Technology transfer

The researcher hopes to define a pilot project on a Platinum or Gold Mine in South Africa, to demonstrate how these principles work in practice. An 18 to 24 month period is envisaged for a pilot implementation.

8 Conclusions

Concerning underground safety the most important learning outcome is to have workers with appropriate safety habits or strategies ingrained in their daily expert behaviour. To approach this ideal it is necessary to institutionalise many of the principles and characteristics related to human learning and performance, which are summarised in this report.

In the *Methods and Creative Learning Experiences* area, we learned the following:
- People learn naturally through a process called modeling. Formal modeling can enhance this.
- Learning is a constant body wide process.
- Learning is best done in the context of work.

- Cognitive apprenticeship seems a valid model.
- Combining the above mentioned with African Collective Learning Systems suggests the best practice for learning in the mining industry.

In the *Organisational Structure and learning Culture* area, we learned the following:
- Teams should work and learn together.
- The workplace is in most cases the best place to learn.
- The "bottom up" approach for change is compatible with the organisation of people working and learning together.

Do not forget the other components in the system, which are:
- *Performance and competency definitions and models*
- *Learning paths*
- *Learning support systems*
- *Assessment and evaluation systems*

To arrive at a sustainable learning organisation, it will require the patience and attitudes of the gardener, guided by guiding ideas informed by the nature of human behaviour and interaction.

"The Dance of Change" (Peter Senge) and the earlier publication "The Fifth Discipline Fieldbook" (Peter Senge), are most informative for any reader embarking on the road to understanding meaningful learning in organisations.