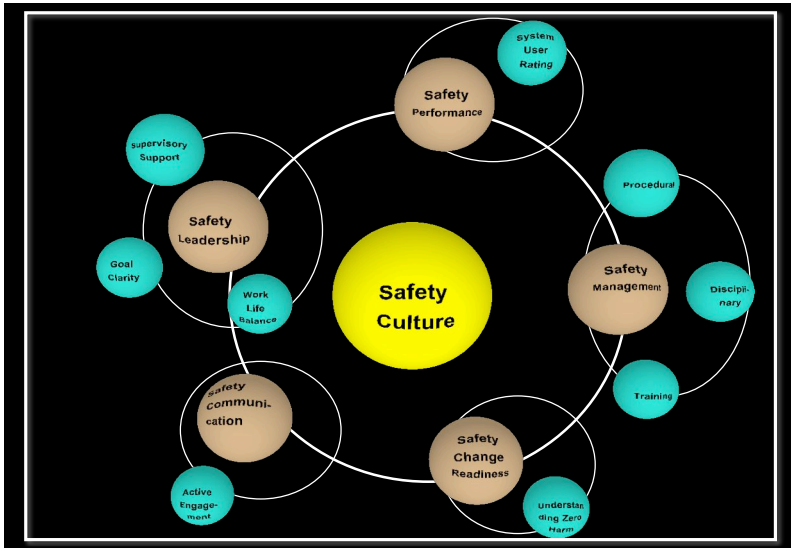
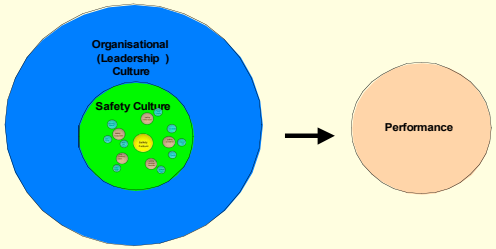
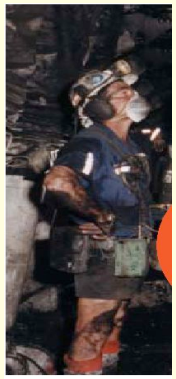


A five factor measure of safety culture

Peter Smith and Craig Garret (Faculty of Science, Engineering & Health, Cental Queensland University)
and Daryl Calvert (BHP Billiton Mitsubishi Alliance)



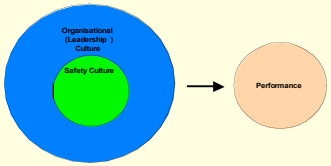


Safety Culture

- Is often described as:

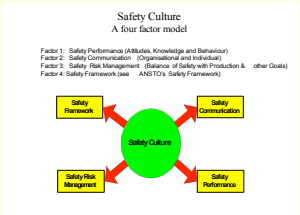
  "the way we do things around here"

- It lies within the wider organisational culture and it underpins performance.



- It came to prominence following the 1986 Chernobyl disaster but lacks a clear theoretical framework around which measures may be constructed.

  We conducted a secondary analysis of survey data collected as part of an INSAG supported survey of nuclear facilities (INSAG, 1991; Smith and Garrett, 2004)



The analysis indicated that in the nuclear industry safety culture reflected 4 broad factors:

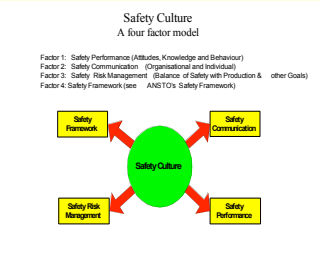
These four factors provide an empirical starting point for measurement.

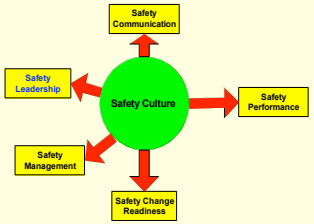
Safety Culture

- To capture the way safety is approached in the mining industry we workshopped the 4 factor INSAG derived model with several BMA safety managers

- They highlighted that in the mining industry safety leadership, safety management, and safety change readiness were key features of "the way we do things around here"

- Together we developed 60 questions to cover 5 safety culture factors:
  Leadership **Management**
  Communication **Change Readiness**
  Performance





These questions were tested with two BMA samples.

Sample 1 (N = 546) completed the Safety Culture questions along with the Organisational Culture Inventory

human synergistics

Sample 2 (N = 525) completed the Safety Culture questions along with the Organisational Effectiveness Inventory.

human synergistics

Total BMA Safety Culture Respondents N= 1071

Data	Frequency	Percentage
Organisational Role		
Executive member/Mine/Port Manager	9	.9
Manager	41	4.1
Superintendent	34	3.4
Supervisor	121	12.2
Engineer	71	7.1
Operating/Maintenance	470	47.3
Other	197	19.8
Prefer not to respond	51	5.1
Age		
under 20	16	1.6
20-29	162	16.1
30-39	270	26.8
40-49	299	29.7
50-59	198	19.7
60 or over	19	1.9
prefer not to respond	43	4.3
Gender		
Female	74	7.5
Male	889	89.6
prefer not to respond	29	2.9
Years With Organisation		
less than 6 months	78	7.7
6 months to 1 year	103	10.2
1 to 2 years	94	9.3
2 to 4 years	121	11.9
4 to 6 years	61	6.0
6 to 10 years	91	9.0
10 to 15 years	83	8.2
more than 15 years	330	32.5
Prefer not to respond	53	5.2

Using factor analysis we identified stable and reliable scales on sample 1 and confirmed these on sample 2.

For example, safety leadership was measured using three scales:

Supervisory support

Goal clarity

Work-life balance

1.9

Safety Leadership
Outcomes of Confirmatory Factor Analysis (First Sample)

#	Standard Regression Weights	Error Variance	Squared multiple correlation R^2	Critical ratios	Composite reliability	Variance extracted
Supervisory Support					(B) 0.92	0.61
Q37	0.726	.439	0.527	11.627	(A) 0.91	0.63
Q45	0.765	.479	0.586	11.945		
Q56	0.834	.253	0.695	12.454		
Q60	0.841	.266	0.707	12.507		
Q46	0.777	.309	0.603	12.034		
Q54	0.772	.388	0.596	12.012		
Q47	0.525	.395	0.276	11.627		
Goal Clarity					0.86	0.62
Q19	0.805	.371	0.648	13.491		
Q20	0.778	.202	0.606	16.659		
Q22	0.719	.346	0.517	15.651		
Q23	0.620	.396	0.385	13.491		
Work Life Balance					0.76	0.54
Q25	0.722	.513	0.521	8.653		
Q26	0.994	.015	0.989	8.953		
Q48	0.378	.840	0.143	8.653		

Deleted Item: Q47 I am clear about my safety responsibilities

1.10

Safety Leadership
Outcomes of Confirmatory Factor Analysis (Second Sample)

#	Standard Regression Weights	Error Variance	Squared multiple correlation R^2	Critical ratios	Composite reliability	Variance extracted
Supervisory Support						
Q37	0.771	0.369	0.594	12.627	0.90	0.61
Q45	0.811	0.430	0.658	13.945		
Q56	0.794	0.344	0.630	13.454		
Q60	0.852	0.250	0.725	14.507		
Q46	0.676	0.428	0.457	15.034		
Q54	0.751	0.467	0.565	11.012		
Goal Clarity					(B) 0.85	(B) 0.53
Q19	0.772	0.187	0.596	13.491	(A) 0.83	(A) 0.56
Q20	0.705	0.371	0.497	16.659		
Q47	0.496	0.350	0.246	11.757		
Q22	0.668	0.373	0.446	15.651		
Q23	0.509	0.499	0.270	13.491		
Work Life Balance					0.75	0.52
Q25	0.668	0.581	0.446	8.653		
Q26	0.984	0.041	0.968	8.953		
Q48	0.448	0.864	0.201	8.653		

Deleted Item: Q47 I am clear about my safety responsibilities

The result was five factors measured with 9 reliable scales:

FACTORS (5)	SCALES (9)
Safety Leadership	Supervisory Support, Goal Clarity & Work Life Balance
Safety Communication	Active Engagement
Safety Management	Procedures, Disciplinary Process & Training
Safety Change Readiness	Safety Change Readiness
Safety Performance	Safety System Rating

5 factors and 9 scales developed from an INSAG-CQU framework with the assistance of BMA Safety Managers.
All factors and scales developed on BMA sample 1 and confirmed on BMA sample 2 - Total N = 1071.

Safety Leadership
(Supervisor Support, Goal Clarity &Work Life Balance)

6 items	Supervisory Support (alpha reliability 0.894)
Q1	My supervisor helps me find ways to achieve my safety objectives
Q2	My supervisors help me grow and develop on the job
Q3	My supervisors structure things so that there goals and my goals can be safely achieved
Q4	My supervisors help me do a safe job
Q5	I am actively encouraged and supported to work safely
Q6	My supervisors lead by example

4 items	Goal Clarity (alpha reliability 0.766)
Q1	I know and understand the company's safety goals
Q2	My supervisors make clear how the company's safety goals apply to me
Q4	The company and I have shared safety goals
Q4	I am always clear about what others at work expect of me

3 items	Work Life Balance (alpha reliability 0.725)
Q1	The company considers safety is not just about work, it is about family too
Q2	The company is a family friendly employer
Q3	Work allows me to balance my work and personal life

Safety Management
(Procedures, Disciplinary Process & Training)

6 items	**Procedures** (alpha reliability 0.784)
*Q1	Our safety procedures are too over the top
Q2	Our safety procedures are worth the effort
*Q3	Our safety procedures are too complex to be understood
*Q4	Our safety procedures are too strict
*Q5	In general, too much attention is paid to safety in our job
*Q6	If I worried about safety all the time, I will not get my job done

4 items	**Disciplinary Process** (alpha reliability 0.70)
Q1	My supervisor handles safety discipline constructively
Q2	The company's safety disciplinary process on-site is fair and reasonable
Q3	The company's safety disciplinary process on-site is consistently applied
Q4	Disciplinary procedures are critical for safety

5 items	**Training** (alpha reliability 0.816)
Q1	I receive adequate training to enable me to work safely
Q2	The company's safety training is well done at BMA
Q3	I am satisfied with the safety training I get
Q4	The company's safety training explains both the how and why of safety rules
Q5	The company's safety training makes clear who is responsible for what

Safety Communication
(Active Engagement)

8 items	**Active Engagement** (alpha reliability 0.859)
Q1	We are encouraged to suggest safer ways to do things
Q2	It is simple to report breaches in safety practices
Q3	Management gives a consistent message about safety
Q4	Management considers our safety suggestions
Q5	The safety feedback I receive from my supervisor is useful
Q6	There is a very effective process for participating in safety improvements
Q7	There is good support for reporting breaches in safety practices
Q8	I am satisfied with the recognition I get for doing my job safely

ACTIVE ENGAGEMENT:
The safety message is consistent.
It enables all participants to both listen and inform.
It is supported by user friendly company systems.

Safety Change Readiness

5 items	**Safety Change Readiness** (alpha reliability 0.726)
Q33	Woking safely means that my ideas for change play an important part in shaping the future of my work
Q59	Working safely means that I get more say in how things are done
Q34	Working safely means we are ready to accept new ways of doing things more safely
Q35	Working safely gives me the chance to learn and use new skills
Q16	Zero injury is realistic

Continuous improvement sees change as an opportunity.

Safety Performance
(Safety System Rating)

7 items	**Safety System Rating** (alpha reliability 0.881)
Q1	In general, there's a good safety attitude in my work group
Q12	The safety rules in my workplace make sense
Q7	Our safety committees are very effective
Q8	In general my working conditions enable me to do my job safely
Q9	Compliance with safety rules is always very high
Q2	Equipment is generally well designed to support safety
Q10	I would recommend the companyas a safe place to work

Q10 is the most highly weighted of the seven-item safety performance scale

We have completed three of four stages of testing the validity and utility of the Safety Culture Measure.

Stage 1

Is safety system rating linked to organisational culture (OCI)?

Stage 2

Is safety culture measurement better statistically linked to safety system rating?

Stage 3

Is the safety culture measure a useful diagnostic tool?

Stage 4

Is the safety culture measure a useful lead indicator and benchmark tool?

1. Demonstrating the link between organisational culture and safety culture

OCI Predicting Safety Performance (Safety System Rating)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Constructive	.467[a]	.218	.217	.59112
Passive Devensive	.485[b]	.235	.232	.58527

a. Predictors: (Constant), ConstructiveStyles

b. Predictors: (Constant), ConstructiveStyles, PassiveDevensiveStyles

Constructive leadership culture predicts **22%** of the variance in Safety System Rating.

The OCI CONSTRUCTIVE styles reflect a healthy balance of people and task relationshi ps leading to the attainment of organisational goals through the de velopment of people. The OCI PASSIVE/DEFENSIVE styles (excluding avoidance) emphasise predictability and security at the cost of learning and adaptability.

Together with Constructive styles, Passive/Defensive styles pred ict **23%** of the variance in Safety System Rating (Safety Performance)

2. Safety Culture Measurement validated against Safety Performance (stage 1)

Safety Culture Predicting Safety Performance (Safety System Rating)

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
Safety Leadership	.683[a]	.466	.466	.13309
Safety Communication	.756[b]	.571	.570	.11936
Safety Management	.768[c]	.589	.588	.11687
Safety Change Readiness	.770[d]	.594	.592	.11629

a. Predictors: (Constant), SafetyLeadership

b. Predictors: (Constant), SafetyLeadership, Safety Communication

c. Predictors: (Constant), SafetyLeadership, Safety Communication, SafetyManagement

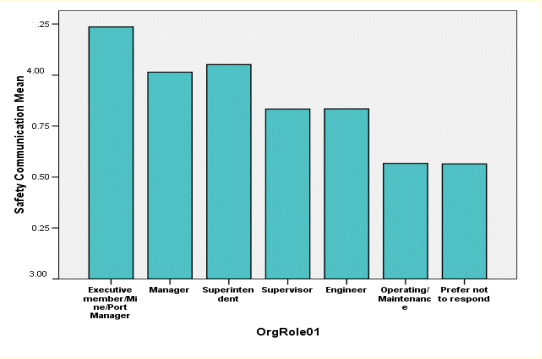
d. Predictors: (Constant), Safety Communication, SafetyManagement, Safety Change Readiness

Safety Leadership predicts **47%** of the variance in Safety System Rating.

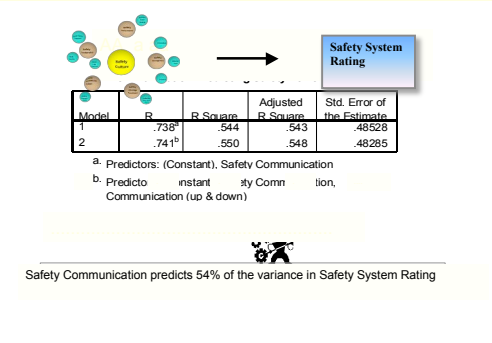
Overall the four Safety Culture variables predict **59%** of the variance in Safety System Rating (Safety Performance)

3. Safety Culture measurement as a diagnostic tool

Safety communication and organizational role



3. Safety Culture measurement as a diagnostic tool



Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
1	.738[a]	.544	.543	.48528
2	.741[b]	.550	.548	.48285

a. Predictors: (Constant), Safety Communication

b. Predicto nstant ty Comn tion, Communication (up & down)

Safety Communication predicts 54% of the variance in Safety System Rating

3. Safety Culture measurement as a diagnostic tool

Safety Culture predicting Safety Change Readiness

	R			
	a			
				0

a P

b P

c P

Safety Leadership predicts **49%** of the variance in Safety Change Readiness.

Overall three Safety Culture variables predict **53%** of the variance in Safety Change Readiness

In conclusion:

Three practical advantages of understanding safety culture empirically within a rigorous psychometric paradigm are illustrated by this research.

1. Rigorous measurement provides a clear operational definition of safety culture – this is essential if results are to be meaningfully interpreted in order to inform safety management practice.
2. Rigorous measurement provides an opportunity to test the utility of safety culture measurement as an additional lead indicator.
3. Rigorous measurement of safety culture provides a potential for improving organisational performance through the use of a standardised benchmark measure.

Dr Peter Smith (Professor of Organizational Systems)
Faculty of Science, Engineering and Health
Central Queensland University
Rockhampton, Qld, Australia 4702
tel: 07 4930 9907
email: p.b.smith@cqu.edu.au