Human Capital Evaluation: What your Company paid for its Human Capital and what it got for its Money[1]

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Introduction

Many times, the phrase "our people are our most important asset" is used by company CEO's. Yet personnel are not included on the balance sheet of any company. There are several reasons for this, including the fact that the personnel are not owned by the company. This paper is informed by a literature survey spanning two hundred years, from the early comments of Joseph Whitworth in the Nineteenth Century till the present and by the writer's 50 years of experience in industry and academia.

What this paper attempts to do is put people onto the balance sheet, and to do it in two ways: what the company paid for the asset (that is, what the people cost) and secondly what the company got for its money (that is, what is the value of the personnel asset).

The cost of the asset is determined by using Discounted Cash Flow calculations for every current employee, using their current Cost to Company, their years to retirement and the company's current Cost of Capital. These costs are then aggregated for all personnel to achieve the cost of the asset. Such a calculation fulfils all the necessary accounting conventions.

A conventional balance sheet is in effect a snapshot in time – what the value and structure of a company's assets were on the date signified on the balance sheet

The fact remains that for our human capital example, the ***commitment*** of the company to the individuals involved is the governing factor, and therefore the calculation is the correct assessment of the human capital value when the calculation is made. If there are changes, for example if personnel are to be made redundant, then the commitment ceases and a new DCF calculation is made.

This proposed method of Human Capital evaluation is simple, easy to perform using a company's standard accounts, and does not, in principle, violate any established accounting conventions. The main objections to the practice centre on the fact that the employees are not owned by the company. Nevertheless, a balance sheet may be developed for management accounting purposes

[1] How to cite this paper: Bradley, E.A.; Wichers, J.H. (2020). Human Capital Evaluation: What your Company paid for its Human Capital and what it got for its Money; *PM World Journal*, Vol. IX, Issue VI, June.

which includes a value for Human Capital. The normal balance sheet, to adhere to legal and shareholder requirements, may still be prepared and used until legal requirements change.

This particular technique for human capital evaluation, has, as far as the writer's research has been able to show, not been implemented or proposed before.

In a recent field test of the index, taken at a South African water supply company, the value of the Human Resource was calculated at UK£7 million. This compared with the traditional hardware asset base of UK£97 million, leading to a ratio of 7.2%. That is, it requires a human asset of about 7% of the hardware asset to maintain the latter.

The spreadsheet detailing the calculation is given below in Table 1

This ratio can be compared with similar companies both locally and oversees to see how they compare. Do similar companies invest more or less on this particular human asset? Is there an optimum ratio for this type of work in this sort of company? Further research and access to the relevant companies' files is necessary to answer this question.

What is envisioned is a database linking human capital to various industries. For a steel mill or other heavy engineering effort, the percentage of human capital compared to traditional hardware capital is probably very low. For an information technology firm on the other hand, the human capital percentage would be much higher, perhaps reaching into the 90's. Nevertheless, there would be a certain range of human capital in each case that would typify the industry involved. If such a data base was developed, it could be used by company management to determine, for example, whether the company was under- or over-invested in human capital.

Staff No	Trade	Years of Relevant	5,6*Log H	Qualification	Health Index	IQ/14	Mech Test	Overall Index
		Experience		NQF/SAQA Years				
		2 to 40	2 to 9	1 to 10	3 to 9	5 to 9	1 to 100	~3 to 9
19	TOOL STORE ATT							
42	MAINT SUPER							
56	CERT MAINT WORK							
132	HEAVY DUTY DRIV							
134	TRASF PS SUPERV							
157	MILLWRIGHT							
184	MAINT PLANNER	12	6	6	9	6,5	37	6,9
228	FITTER							
234	FITTER							
254	WELDER							
271	MILLWRIGHT							
306	MAINTENANCE ADM							

348	MILLWRIGHT	22	8	6	9	6,5	47	7,3
409	ARTISAN HELPER							
411	ELECTRICIAN	18	7	6	9	6,6		7,2
413	ARTISAN HELPER							
423	JUNIOR ARTISAN	13	6	4	9	5,9		6,3
453	A & I SPEC MECH	15	7	6	9	6,9	44	7,1
454	INSTR &SCADA SP							
471	JUNIOR ARTISAN							
564	ARTISAN HELPER							
578	ARTISAN HELPER							
632	CIVIL MAIN TECH							
687	PIPE PLUMBER	11	6	6	9	6,4	52	6,8
699	FITTER	11	6	6	9	6,6	48	6,9
713	HEAVY DUTY DRIV							
719	BOILER MAKER							
790	ARTISAN HELPER							
796	GEN ASSIST							
755	MECH TRAINEE	2	2	6	9	7,6	54	6,1
		104	47	46	72	53	282	54,4
		13	6	6	9	6,6	47	**6,8**
		Years of Relevant		**Qualifications**				**Overall Index**
Staff No	**Trade**	**Experience**	**5,6*Log H**	**SAQA Years**	**Health Index**	**IQ/14**	**Mech Test/10**	**(D+E+F+G)/4**

Table 1: Human Capital Calculation for the Maintenance Department of a Water Supply Utility

The Other Side of the Equation: What is the Value inherent in the Investment in Human Capital?

To determine the balance sheet cost of the human asset is simple. This however is only half the story. One may invest a lot or a little in the company's human capital, but what is the ***value*** of the asset? Has it been a good investment? In other words, we can also look at this in terms of the demand side and the supply side in economic theory. The company demanded a certain human asset, and paid for it. What was supplied for money? A proposal is made here to use four indices of human performance: Intelligence (hereafter referred to as IQ), Qualifications, Experience and Health. The author's experience and research to date has shown that these four are the only reliable measures which may be used in developing individual and combined indices of the value of the human capital investment. This conclusion is based on the seminal work of Schmidt and Hunter (1998). The title of their paper is significant: *The Validity and Utility of Selection Methods in Personnel Psychology: Practical and Theoretical Implications of 85 Years of Research Findings.*

85 years' worth of data has to be significant. As far as the writer has been able to ascertain, no more recent research surpasses the magisterial effort of Schmidt and Hunter. These authors continue to be referenced in papers to this day as authorities on personnel selection. What their research shows is the validity of 19 factors used in personnel selection, from the highest, with a validity of 0.51 to the lowest, with a validity of -0.02. Their findings are shown in Table 2 below.

From our point of view, we need measures that are:

1. Of high validity
2. But also, that are hard measures, not falsifiable by the person being tested, so that they are acceptable to accounting, or at least to management accounting, persons
3. Are acceptable across a range of industries. In other words, measures that can be standardised so comparisons can be made across companies and across industries'

There are only three measures in the Schmidt and Hunter list that meet these criteria:

- Intelligence
- Experience
- Qualifications

These are items 1, 12 and 16 on the list. Fortunately, Intelligence is the highest scorer, with a validity of 0.51. In other words, the intelligence test represented by the GMA or General Mental Alertness test predicts over half of the attributes needed for effective job performance. In the development of our model of the value of human capital, we will substitute the Ravens Progressive Matrices for the GMA test as it is simpler to administer and is not in any way culturally biased. We will now discuss the three factors we have identified in more detail.

Intelligence

Intelligence, as a measure of human performance, has both its champions and its detractors. It is perhaps the case that among the detractors are those who are sensitive about their own level of intelligence. Be that as it may, the history of intelligence testing is a long and respected one.

Intelligence, as measured in IQ tests, has been adequately demonstrated to be accurate and reproducible. What is significant for the present study is that IQ tests are not self-administered in the sense that one can answer questions in a way that can skew the result. This is not true for personality measures, where questions such as ranking of preferences, as only one example, can be manipulated by the candidate to give answers that he or she thinks are required.

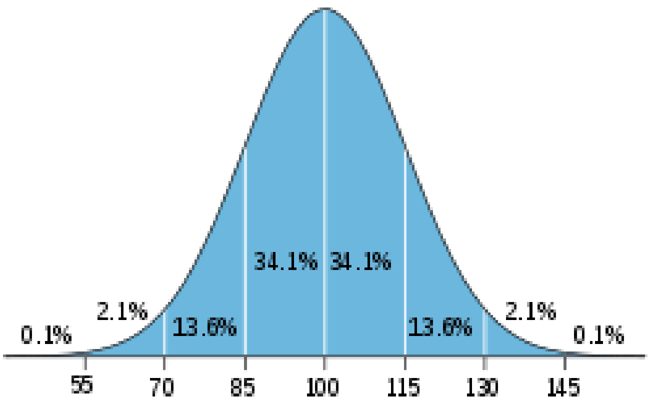

Figure 1: Normalized IQ distribution with mean 100 and standard deviation 15.

One valid criticism of IQ tests is that some of the tests are culturally biased and also biased against foreign language speakers. This is not true however of the test known as Raven's Progressive Matrices, an example of which is shown in the figure below. Such tests are proven to be completely bias free, including possible culture bias.

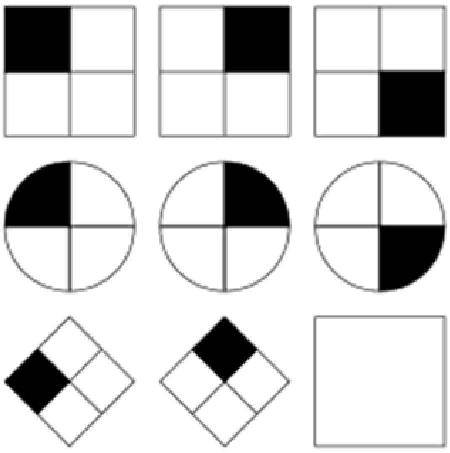

Figure 2: An Example of a Test Question from Raven's Progressive Matrices: What Figure Should go in the vacant square? (a selection of possible alternatives is usually given)

So, intelligence, as measured by tests such as the Raven's Progressive Matrices, becomes the first measure of human capital in our system. To emphasise the fact again: Intelligence is a hard measure, reproducible, non-falsifiable and the best predictor of job performance, bar none.

General Mental Alertness, or GMA, is also used as a measure of intelligence. GMA tests are not identical to the Ravens matrices, but for our purposes they both measure intelligence, or IQ

Correlations with IQ

What settles the argument for or against IQ as a predictor of job performance is the previously mentioned work of Schmidt and Hunter. Their research is from the 1990's and has not been improved upon or superseded. It demonstrates conclusively the value of IQ as a valid predictor of job success.

Theories of intelligence have been developed and tested by psychologists for over 90 years (Brody, 1992; Carroll, 1993; Jensen, 1998). As a result of this massive related research literature, the meaning of the construct of intelligence is much clearer than, for example, the meaning of what is measured by interviews or assessment centres (Brody, 1992; Hunter, 1986; Jensen, 1998). The value of .51 in Table 1 for the validity of General Mental Alertness, or GMA, is from a very large meta-analytic study conducted for the U.S. Department of Labor (Hunter, 1980; Hunter & Hunter, 1984). The database for this unique meta-analysis included over 32,000 employees in 515 widely diverse civilian jobs. This meta-analysis examined both performance on the job and performance in job training programs. This meta-analysis found that the validity of Intelligence for predicting job performance was even higher than that given in the table as far as ***professional-managerial jobs*** are concerned, at 0.58. The figure is 0.56 for high level complex technical jobs, 0.51 for medium complexity jobs, 0.40 for semi-skilled jobs, and 0.23 for completely unskilled jobs. So, it is true to say that to a great extent, when one employs a person, one is buying, or renting, that person's intelligence.

Furthermore, Schmidt and Hunter provide another reason for including IQ in the human capital portfolio. The reason is that it is also a remarkable predictor of other positive human characteristics, which are not so easily measurable. IQ is therefore not only a hard measure, consistent, reproducible and not self-administered, but it also correlates with other, less hard but well-established measures. These include:

- Leadership
- Lifespan
- Workplace performance
- Work-related learning
- Creativity
- Musical creativity
- Patents
- Inventiveness

Serial Number	Measure	Validity r
1	GMA tests	0.51
2	Work sample tests	0.54
3	Integrity tests	0.41
4	Conscientiousness tests	0.31
5	Employment interviews (structured)	0.51
6	Employment interviews (unstructured)	0.38
7	Job knowledge tests	0.48
8	Job try-out procedure	0.44
9	Peer ratings	0.49
10	T & E behavioural consistency method	0.45
11	Reference checks	0.26
12	Job experience (years)	0.18
13	Biographical data measures	0.35
14	Assessment centres	0.37
15	T & E point method	0.11
16	Years of Education	0.10
17	Interests	0.10
18	Graphology	0.02
19	Age	-0.01

Table 2: 19 Predictors of Job Performance

Experience

Compared to Intelligence, the validity of Experience as a predictor of job performance is much lower at 0.18. It is nevertheless a hard, unfalsified measure which can add value to management accountant's evaluation of human capital. In fact, Human Resource Professionals will always tell you that the most reliable predictor of success in an advertised position that they have been tasked to fill is how well the candidate has performed in that position before. From the point of view of the company making use of a recruitment consultant, there is both an upside and a downside to this approach. There is a high probability that the consultant's recommendation will be suitable in the required position, but any person who might have been suitable but does not fit the template will never be recommended. For example, any person who was placed into a career by following his father's example or recommendation, but is unsuitable and unhappy in their job, will find recruitment consultants unsympathetic when such a person attempts to change his career mid-stream. Sometimes the distinctions are fairly subtle – a late friend of mine became a civil engineer because that is what his father was. He spent the rest of his life wishing he had chosen mechanical engineering.

Nevertheless, experience is important and fits our criterion as a parameter that is reliable and unfalsifiable (provided checks have been made as to the candidate's honesty in supplying information on his experience).

When used on our assessment of Human Capital Value, however, we must also recognise that the function of experience versus value is not linear. Initial experience is more valuable than subsequent experience. Once the basics are learned, new concepts come up less and less frequently. Hence, we need some sort of scale that will recognise this fact. As a first bet, a logarithmic time scale is a good, practical and well-understood choice. For example, depending on the technology to be mastered, four years' worth of experience might be a good minimum requirement. But eight years' worth of experience might not be twice as valuable as four years.

If we adopted a Log scale, four years might be represented in our index as Log (4) = 0.60 approximately. Log (8) on the other hand would be approximately 0.90. That is only half as much again, rather than twice as much. If we chose a natural log scale, then Ln (4) = 1.38 and Ln (8) =2.08 where we see the decline in value is slower. More research needs to be done on how on average, across various technologies, the value of experience declines over time. There is probably a good PhD in there somewhere. We will return to this discussion on experience below when we discuss the composite index.

Qualifications

The need to be adequately qualified for the job on hand goes without saying. One does not entrust brain surgery to a barber or electrical installations to an accountant, however useful, efficient, experienced and productive the barbers and accountants are in their respective fields. To some extent, however, experience can serve as a proxy for qualifications. Because of this we sometimes see persons being accepted into professional organisations on the basis of their experience without the requisite qualifications. An apprentice mechanic gets transferred into the company's design office as a trainee CAD operator, then back onto the factory floor as a maintenance technician, eventually becoming, perhaps maintenance manager. And then, perhaps being accepted into some professional engineering organisation because of his experience.

In several fields where this phenomenon occurs, I find a degree of resentment on the part of the non-qualified and yet successful persons. Architectural technicians resent architects. Self-made men in engineering or commerce resent graduates, always emphasising the extra experience they have, having both left school together, the one getting a head start (and income) by going straight into industry or commerce while the other spends at least four years getting academically qualified. This experience gap can never be eliminated, and those non-academically qualified tend to rub it in whenever they can. This is to over-emphasise the importance of experience. Both factors must appear in our index of the value of human capital, suitably weighted as necessary.

The simplest initial measure of Qualifications is simply the years spent in achieving them, or some non-linear factor indicating this. For example, a Doctoral Degree might rank as a 9, a Master's Degree an 8 and a Batchelor's as a 7.

Health

The final factor in our index of Human Capital Value is one that was not investigated by Schmidt and Hunter. It is some measure of employee health, individually and collectively. An unhealthy workforce is obviously a less-than-optimal workforce. Employee illnesses affect the company by reducing productivity. Absenteeism increases in direct proportion to employee illness. Mistakes in production, errors in recording, abuse of customers through irritability and lack of attention to necessary details are a few of the other ways that employee illness can affect the company.

Several measures of employee health are available, some developed by companies in-house and some developed by insurance companies and medical aid societies. One such system is explained below, in Tables 3, 4 and 5. The health index covers what medical science and medical aid societies consider the most important and prevalent threats to health and therefor to good work performance.

Metric	Blood Glucose	Blood Pressure	Cholesterol Level	Body Mass Index	Smoker Status
In Range	Less than 7.8mmol/Liter	Less than 130/80mmHg	Less than 5mmol/L	BMI between 18.5 and 25	Never a Smoker
Intermediate Risk	Less than 11mmol/Liter	Less than 160/100mmHg	Less than 7.5mmol/L	BMI between 25 and 30	Non-smoker for the last 12 months
High Risk	Greater than 11mmol/Liter	Greater than 160/100mmHg	Greater than 7.5 mmol/L	BMI greater than 30	Smoker

Table 3: Typical Health Check Ranges Chart

To understand this table, we also need to understand the column headed Body Mass Index.

This is explained in the table below:

Body Mass Index	Nutritional Status
Below 18.5	Underweight
18.5 – 24.9	Normal Weight
25.0 – 29.9	Overweight
30 or greater	Obese

Table 4: Body Mass Index Chart

BMI (Body Mass Index) is a measure of one's nutritional status and also an indicator of the possible risk that one's mass may have on one's future health. It is defined as a person's mass in kilograms divided by the square of the person's height in metres (kg/m^2)

Using the Health Check Ranges Chart

The chart uses an inverse scale. That is, the lower any value in the chart is, the higher the points scored. For example, if one has never been a smoker, the score for that block in the table is nine. All in-range values score 9, intermediate risks score 6 and high risks score 3. An individual's score is the sum of five values, divided by five. For the example given in the table below, the value is (9 + 6 + 3 +6 +9)/5 = 33/5 = 6.6

Metric	**Blood Glucose**	**Blood Pressure**	**Cholesterol Level**	**Body Mass Index**	**Smoker Status**
In Range	9				9
Intermediate Risk		6		6	
High Risk			3		

Table 5: Example of using the Health Table

Developing the Index

It is now necessary to develop a practical index using the four factors of Experience, Qualifications, Health and Intelligence. In this regard, the following questions must be answered:

- Should the four factors have equal weight?
- Should the factors stand alone?
- Should they be combined arithmetically or multiplicatively?
- What should the range of the factors and the resulting index be?

The simplest method would be to simply present the four factors as averages for the workforce.

The information might then look as follows in Table 6 below:

IQ	Experience	Qualifications	Health
97	8 years	6	9

Table 6: The Simplest Presentation of the Four Factors, expressed as an Average for the Workforce

Such a simple presentation might suffice in some instances. For example, this table indicates that the workforce has an IQ on average of just below the mean for a school-leaving certificate in Western societies. This might well be good enough, depending on the nature of the company.
For an information technology firm, however it is almost certainly much too low.

Secondly, the average experience of eight years may be good or it may not be, once again depending on the industry, the competition in the market etc. For example, in a maintenance engineering firm, experience counts a lot. The "Old Hands" have learned through long experience how to maintain complex machinery, with certain failures that may only occur once or twice in anyone's working lifetime. As a contrary example, a courier company may not need much experience from its drivers or warehouse staff, in which case the eight years average experience might not be an advantage.

Thirdly, a Qualification level of 6, depending on the system used, may indicate an average qualification equivalent to a high school diploma. This may or may not be acceptable, once again depending on the industry that the company is in.

Finally, the company in this example has a clean bill of health with and index of 9.

Where such analysis of the four factors may prove especially useful is in company takeovers. The prospective buyers will naturally study the conventional accounts, the market conditions, etc, but the extra information obtained from this, what is effectually, a human capital audit, may better inform the decision to buy or not to buy.

Having said the above, that is to present and analyse the four indices in their basic form, perhaps a company should attempt to combine the four indices in some way to provide a Key Performance Indicator, or KPI, of company performance. This approach is common in many industries. For example, in manufacturing, a high-level indicator initially developed by the Japanese, is entitled Overall Equipment Effectiveness, or OEE. The formula may vary from industry to industry but in one case, reads as follows:

$$\text{OEE} = \text{Availability} \times \text{Production} \times \text{Quality}$$

All three parameters are expressed as percentages or as numbers less than unity. For example, the result could read as OEE = 97% x 90% x 95% = 82.935%. This indicates that the plant was running at 97% Availability, that the Production rate was 90% of what it should be and that quality was at

95%, indicating that five out of every hundred items produced were defective. The OEE figure gives the management a snapshot of the company's performance. Perhaps the result of just under 83% is acceptable, depending on the age of the equipment and other factors. But on the other hand, perhaps not. In which case the management should intervene to improve the situation.

A question immediately comes to mind: Should the three indices be multiplied together or should they be added? If the additive model is used the answer is

$$(0.97 + 0.90 + 0.95)/3 = 0.94$$

The difference in the two methods is how the factors influence each other. One very low factor, compared to the other two, will drag the overall index down more in the multiplicative (geometric) model than in the additive (arithmetic) model. There are pros and cons to both models. In the case of OEE, the multiplicative model is universally accepted.

Having experimented with various alternatives, the writer proposes the following: First modify the readings for each the four factors so that they fall into the same approximate range, viz from one to nine as far as possible. Then combine the values by adding them together. Then divide the product by four to arrive at the final result. (Arithmetic average). This is demonstrated in the table below:

Factor	**Range**	**Range Adjustment**	**Approximate Adjusted Range**	**Notes**
IQ	70 - 130	Divide IQ by 14	5 - 9	
Experience in Years	2 - 40	5.6*Log (Experience)	2 – 9	Top of range rarely achieved
Qualifications	1 - 9	No Adjustment	1 - 9	
Health Index	3 - 9	No Adjustment	3 - 9	

Table 7: Suggested Ranges for the Four Factors in the Human Capital Index

In Table 7, all four factors are equally weighted. But according to Schmidt and Hunter, IQ is of greater importance than Experience or Qualifications, by a large amount. However, the ingrained practice in Human Resource departments is to place high regard on both experience and qualifications, even to the exclusion of any direct measure of intelligence, so as a first pass it is proposed to keep all four factors at equal weight. This certainly makes sense in the case of Health, the factor neglected by Schmidt and Hunter. Health is intuitively of equal importance to IQ, as sick persons, even with high IQ, cannot perform properly. We could then plot a table as shown in Table 5 below, which is a field test of the Index, conducted at the maintenance department of the South African water supply company previously mentioned. The average values of the four factors were found to be: IQ: 93; Experience: 12 years; Qualifications measured by the SAQA system: 6 years; Health: 9.

Factor	Value	Adjusted Range	Value of Asset	Cost of Asset
IQ	93	Divide IQ by 14	6.6	
Experience in Years	12	5.6*Log (Experience)	6.0	
Qualifications (SAQA Index)	6	No Adjustment	6	
Health Index	9	May vary from 3 to 9	9	
Arithmetic Average			6.9	£7m

Table 8: Development of the Index for the Maintenance Resource of the Water Company

The resultant average and adjusted value is 6.9 on a roughly 3 to 9 scale. This value can be used to compare this company with others in the same industry, nationally and internationally. It is also used to define the ratio Index/Cost of Asset, which in the case in question was 6.9/£7million.
A data base could now be constructed for various companies in various industries, to see how representative this value of 6.9 is, as a representation of the worth of the company's human resource. It would serve in much the same way as the OEE formula does when used in a production context.

In Conclusion

What this present research has done is to provide a simple and practical tool for the assessment of the two sides of any Human Resource, what the company paid for the resource and what it got for its money. It is then up to management to optimally manage and motivate this resource. The writer has not been able to find any similar initiative having ever been attempted and therefore hopes that his model will be accepted in industry in the future.

Abbreviations

GMA General Mental Alertness. A series of tests used to determine intelligence
IQ Intelligence Quotient, used today as a general name for measured intelligence
OEE Overall Equipment Effectiveness
SAQA South African Qualifications Authority

Main References

This article is informed by the writer's 50 + years in industry and academia, some of which is recorded in his book referred to below. It is also informed by over 90 references in relevant literature. Only the main ones are included here:

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About the Authors

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Edgar A. Bradley is a Consultant, specializing in Benchmarking, Human Capital Evaluation and RAM work (Reliability, Availability, and Maintainability). His qualifications include a Bachelor's degree in Mechanical Engineering from the University of the Witwatersrand, Johannesburg, South Africa (1964) and a Master's degree in Mechanical Engineering from the University of Akron, Ohio, USA (1969) aswell as an MBA from Cranfield University, in the UK (1975). He has the South African Government Certificate of Competency (Factories, Mechanical) and has completed the course in Advanced System Reliability Engineering by JBS Associates, Knoxville, Tennessee, USA. He also has completed the course in Repairable Systems Reliability and Failure Analysis by the Finn Jensen Reliability Consultancy, Denmark.

For the past ten years he has worked as a Mechanical Consulting Engineer, giving consulting and training to the petroleum and other industries in the Middle East and in Southern Africa. He was formerly employed by Eskom, the South African power utility, in the position of Chief Consultant (RAM) in the Generation Group. His 31 years with Eskom included 18 years' experience as a Reliability and Maintenance specialist as well as, before that, 11 years as a Project Engineer and two as a Boiler Plant Specialist. He has also worked for mechanical contracting firms as a project and design engineer, and has 50 years of industrial experience in Benchmarking, RAM engineering, power plant, pipework engineering, cryogenics and plant maintenance.

In 1999 he received Eskom's Chairman's Award for his work in developing the Operators' Challenge, a simulator-based competition to improve power station operators' performance and reliability. In 2002 he developed the concept further with the Cyberthon, an international version of the challenge, held between power station operators in South Africa and Russia. For the several years he served on one of Eskom's tender boards

For over 40 years he has also served as a lecturer in the Faculty of Industrial Engineering at the University of the Witwatersrand, lecturing and developing courses on the MSc programme on inter alia, Reliability Engineering, Maintenance Engineering, Project Management, Industrial Marketing and Systems Engineering. He has also lectured in Reliability Engineering at the University of Pretoria. In 2013 he was appointed as lecturer in Quality at the Namibian University of Science and Technology. He has lectured in Reliability Engineering and Systems Engineering at North West University as well.

He has consulted to many firms in the electronics, defence, petrochemical, electricity, mining, manufacturing and chemical industries. He has also presented many industrial training programmes, both in-house and open to industry. He is a Registered Professional Engineer and a Member of the South African Institute of Industrial Engineers. He was also twice President of the Southern African Maintenance Association (SAMA – now SAAMA). In 1999 he had the major input into the design of the SAMA Audit and Award process, which was successfully applied in 1999 for the first time in South African industry. In 2001 he was accepted as a member of Mensa South Africa and in 2004 as a member of the Society of Maintenance and Reliability Professionals, USA.

He has had papers presented on reliability, maintenance and related subjects at conferences in South Africa, the USA, Australia, China, Hong Kong, Israel, Korea, Zimbabwe, the UK and Egypt. He has published papers in journals in South Africa and the UK. In both 2003 and 2004 he was invited to speak on the Eminent Speaker Tour of various chapters of the Maintenance Engineering Society of Australia. He is a regular trainer on various courses in various countries in the Middle East. He was a conscripted member of the South African Defence Force for ten years, retiring with the rank of Major from the Technical Services Corps. In 2016 he authored the book Reliability Engineering – A Life Cycle Approach, published by CRC/Taylor and Francis in the USA.

Edgar has been married to Peggy since 1968. They have four children: Guy, Vanessa, Susan and Samantha, and five grandchildren, Josh, Zara, Cassy, James and Jensen. Edgar's non-work-related interests include church work, classic motorcycle restoration, birding, conservation and travel, especially by 4x4. He can be contacted at edgar.bradley@telkomsa.net

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Prof. Harry Wichers has been a part-time lecturer at the North West University (NWU), former Potchefstroom University for CHE, on pre- and postgraduate levels in Systems Engineering and Reliability Engineering from 1986 - 2000. He continued to lecture on pre and postgraduate level at the same university in various Engineering Management subjects from 2003 to 2010. These subjects included Creative Entrepreneurship, Maintenance Management and Entrepreneurial Career Skills. He has also lectured at the Vaal University of Technology (VUT), Vanderbijlpark, in the subjects Maintenance Engineering. He was instrumental in 2004 in the establishment of the Centre for Research and Continued Engineering Development in the Vaal Triangle, (CRCED Vaal), focusing on delivering Master and Doctoral degrees in Engineering Management to Industry. Prof. Wichers is a registered Professional Engineer with ECSA, member of the Institutes of Business Management and Mechanical Engineers (SAIME) and founder member and ex-president of the Southern African Maintenance Association (SAMA).