

THE ALCHEMIST AND THE MAGICIAN:
QUALITY IMPROVEMENT THROUGH EMPATHY AND LEARNING
IN
COMPLEX SYSTEMS

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to the Faculty of

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Master of Science

in

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by

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THESIS: THE ALCHEMIST AND THE MAGICIAN: QUALITY IMPROVEMENT
THROUGH EMPATHY AND LEARNING IN COMPLEX SYSTEMS

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This thesis is dedicated to every person I have learned from.
The experience of magic comes through seeing, learning and revelation.

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TABLE OF CONTENTS

	PAGE
COPYRIGHT PAGE	ii
APPROVAL PAGE	iii
DEDICATION	iv
ACKNOWLEDGEMENTS	v
TABLE OF CONTENTS	vi
LIST OF TABLES	viii
LIST OF FIGURES	ix
ABSTRACT	x
 CHAPTER	
1. INTRODUCTION	1
Background	1
Understanding the Medical Laboratory Workforce	1
Asperger’s Syndrome and Autism Spectrum Disorders	3
Machiavellianism and Change Management	5
The Machiavellian Change Agent versus the Autistic Process Controller	9
Statement of the Problem	14
Purpose of Study	14
Theoretical Bases and Organization	16
Limitations of the Study	17
Definition of Terms	22
2. REVIEW OF THE LITERATURE	23
Dr. Kurt Lewin’s theories on Group Dynamics and Social Change	23
Dr. Donella Meadows and System Dynamics	26
Dr. Albert Bandura and Social Cognitive Learning Theory	28
Dr. Robin Dunbar, Primate Behaviour, Language and Social Evolution	30
The Human Brain, Qualia and Consciousness	31
Qualia, Empathy and fMRI Studies	35
Mirror Neuron Systems and Action Learning	38

CHAPTER	PAGE
The Triadic Adaptive Learning System: <i>An Evolutionary Learning System</i>	43
The Quality Leadership Learning System	58
3. METHODOLOGY	62
Design of the Investigation	62
Ethical Approval	63
Sample.....	64
Treatment	64
4. RESULTS AND DISCUSSION	65
Results Tables	65
Results Discussion	73
Medical Laboratory Workforce Psychometric Results and Literature Sources.....	76
Relationship between Psychometric Scores and Community Size.....	84
Introduction to the Clinical and Laboratory Standards Institute.....	86
Quality Leadership in Complex Systems.....	87
Organizational Commitment to Quality Improvement	107
Organizational Learning and Profound Knowledge	133
Happy and Healthy Workplace Environments.....	149
Ethical Leadership and Integral Permaculture	155
5. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS	162
Summary of Research and Areas for Future Investigation	162
Symphony of Mind and the Mozart Effect	164
REFERENCES	168
APPENDICIES	
A. TALiS, Learning Spaces and Change Management	194
B. ASQ Quality Tools and TALiS	196
C. Design for Six Sigma (DMADV).....	198
D. ISO 9001:2008 Quality Management System and Knowledge Transfer.....	200
E. CSUDH IRB Study Approval April, 2014	202
F. NIH Research Ethics Certificate.....	204
G. Change Management Survey	207
H. Pheromone Image Approval	232
ENDNOTES	234

LIST OF TABLES

	PAGE
1. Studies of the Medical Laboratory Workforce (1983-2009)	2
2. Google Scholar Search Hits (April 18 th , 2015).....	10
3. Selected Psychometric Questionnaire Cut-Off (Discriminator) Values	21
4. Frequency Counts for Selected Variables (n=32).....	65
5. Psychometric Characteristics for the Aggregated Scale Scores (n=32)	69
6. Frequency Counts for Criteria Variables (n=32)	70
7. Spearman Intercorrelations among the Aggregated Scale Scores (n=32)	71
8. Spearman Correlations for Selected Variables with AQ and EQ Scales (n=32)	71
9. Spearman Correlations for Selected Variables with SQ and Mach-IV (n=32).....	72
10. Medical Laboratory Workforce versus Normal, ASD and Occupational Groups	77
11. Medical Laboratory Workforce Mach-IV Values versus Normative Values	78
12. Google Scholar Word Search May 29 th , 2015	95
13. System Traps and Laboratory Examples	99
14. ASD Research Evidence and Opportunities for Training Supports	139
15. CLSI Laboratory Design, Ergonomics and HFE Countermeasures	150

LIST OF FIGURES

	PAGE
1. Autistic and Machiavellian vantage points of a Complex System	12
2. Customer Experience, Field Theory and Phase Spaces	24
3. Bandura's Triadic Reciprocal Causation Model	28
4. Qualia, Mirror Neuron Activation, Empathy and Action learning	40
5. Mirror Neurons, Action Learning and Group Conformity	42
6. The Triadic Adaptive Learning System – <i>A Human Evolutionary System</i>	44
7. "The Canadians Arrive" - <i>The Devil's Brigade</i> (Adleman, 1968)	53
8. "The Dream" – TALiS, Integral Permaculture and the <i>Vision of Goodness</i>	61
9. Linear Structural Relationship Model, Spearman Intercorrelations and TALiS	79
10. Psychometric Scores of Medical Laboratory Workforce and Community Size.....	84
11. TALiS, the Juran Trilogy and Six Sigma Methodologies	88
12. House of Quality (HOQ) for Healthcare and Social Services Planning	91
13. TALiS, ISO 9001 QMS and "Knowledge Qubit" Feedback Loops	102
14. ISO QMS "Mirroring", Supplier-Service Chains and Value Stream Mapping	105
15. TALiS, the Deming PDSA Cycle and the <i>System of Profound Knowledge</i>	114
16. TALiS, Knowledge Transfer and the QPMP Sigmoid Function Curve	120
17. Dr. Albert Bandura's Reciprocal Determinism Model of Social Learning.....	135
18. The Pharos of Quality - TALiS and the <i>Quality System of Goodness</i>	158
19. The Goal of Goodness - Effective Customer Care and Community	166

ABSTRACT

At the heart of Quality Assurance is *Qualia*; Man's ability to understand one other as a species. Understanding the customer requirements of a product or service requires empathy. This thesis will explain how quality assurance activities permit laboratory professionals to work together as a community within complex healthcare systems, understand the voice of the customer and through knowledge, meet customer requirements.

A questionnaire was utilized to obtain information from medical laboratory professionals employed in Canada. The survey utilized four psychometric instruments to determine if: (a) Autistic personality types are prevalent; (b) Machiavellian personality types are prevalent, and; (c) Determine the cultural characteristics of the laboratory workforce.

Different personality styles point to learning system archetypes in the human brain. A neurocognitive model called the *Triadic Adaptive Learning System* (TALiS) is proposed. A new vision called *The Quality System of Goodness* is presented. This cybernetic system is supported by Integral Permaculture. Opportunities for further research are discussed.

CHAPTER 1

INTRODUCTION

Background

Laboratory medicine in Canada is undergoing unprecedented changes, due to internal and external forces influencing the organization, economics and quality of all medical laboratories. Personnel who are employed in medical laboratories are experiencing increasing operational pressures to reduce cost and improve productivity, while maintaining compliancy with new regulations and quality standards (Li & Adeli, 2009). These changes are occurring in the face of a looming human resources shortage of laboratory technologists across Canada (Davis, 2002). Due to economic pressures, the laboratory system has evolved over time into a regional service model, resulting in complex social structures (Plsek & Greenhalgh, 2001). Therefore, during quality improvement initiatives, resistance to change and social complexity is of ethical concern for quality assurance professionals when managing people with different personality types and meeting customer needs.

Understanding the Medical Laboratory Workforce

Several studies have brought to surface some personality traits of the medical laboratory technologist. As an introduction, Table 1 offers the reader some historical evidence relating to the workforce characteristics. The evidence published to date is thought provoking:

Table 1: Studies of the Medical Laboratory Workforce (1983-2009)

STUDY DETAILS	RESULTS	SOURCE
US Study (Houston, TX) <ul style="list-style-type: none"> ➤ Eysenck Personality Test (EPI) used ➤ 83 MTs, 57 Science Teachers 	<ul style="list-style-type: none"> ➤ Study found that there was a significant difference between the two groups with medical technologists showing higher score for neuroticism 	(Kazi & Piper, 1983)
U.S. Study <ul style="list-style-type: none"> ➤ 9 groups were studied using the Multivariate Personality Inventory (MPI), ➤ included MTs (3 males, 28 females) 	<ul style="list-style-type: none"> ➤ Compulsive scale most endorsed by MTs ➤ Technologists are drawn to the occupation for its technical qualities such as clear, concrete direction on tasks. 	(Magaro & Ashbrook, 1985)
ASCP US longitudinal Study <ul style="list-style-type: none"> ➤ 101 Male MTs ➤ 303 Female MTs 	<ul style="list-style-type: none"> ➤ Study investigated perceived gender discrimination in a female-dominated occupation, medical technology. ➤ Study found that Female MTs perceived higher gender discrimination than male MTs. 	(Tatum & Bleau, 2000)
Study done in Finland <ul style="list-style-type: none"> ➤ 674 Males, 4981 Female ➤ Data on sickness absence collected ➤ Bullying and predictors of health measured 	<ul style="list-style-type: none"> ➤ Workplace bullying is associated with an increase in the sickness absenteeism ➤ Targets of bullying seem not to belong to any distinct group when results were interpreted by researchers. ➤ Laboratory technologists included 	(Kiyimaki, Elovainio, & Vahtera, 2000)
US Study, Georgia <ul style="list-style-type: none"> ➤ Investigated moral reasoning among med lab professionals ➤ 47 participated in the study. ➤ The study used the Defining Issues Test, version 2 (DIT-2) 	<ul style="list-style-type: none"> ➤ Study found that moral reasoning was lower than that of other health care professionals. ➤ no relationship between moral reasoning, Age, and gender, 	(Kukoyi, 2007)
Study conducted in Taiwan <ul style="list-style-type: none"> ➤ 38 Males, 107 Females ➤ Brief Symptom Rating Scale (BSRS-5) ➤ Job Satisfaction Questionnaire (JSQ-40) 	<ul style="list-style-type: none"> ➤ Prevalence of psychiatric morbidity defined by BSRS-5 was 34.33% with: <ul style="list-style-type: none"> a) Insomnia ranking highest at 28.36%; b) Depression 25.37%,; c) Hostility (24.63%); d) Anxiety (23.13%), and; e) Inferiority (20.15%). 	(Lee, Lee, Liao, & Chiang, 2009)

Noteworthy are the lack of Canadian psychology research studies on the medical laboratory workforce. However, this lack of evidence should not be surprising, when the research on the workforce to date, is seen in a greater context with respect to workplace psychology in Canada. Industrial-Organizational Psychology as a profession has a greater presence in the United States compared to Canada. In addition to a smaller profile in Canada, research productivity measured in terms of published journal articles, seem to suggest possible resource challenges and a need for greater research funding (Beiler, Zimmerman, & Clark, 2014). It is this author's opinion is that caution should be taken with the evidence in Table 1, due to the instruments used for the study, their limitations, sample sizes and sampling methods. However, the 2009 study from Taiwan (Lee, Lee, Liao, & Chiang, 2009) is troubling. Employee health has a direct impact on productivity, quality and customer perceptions of care. Therefore, medical laboratories can have greatly improved working environments, if more is known about the employee, their social dynamics within the laboratory environment, the nature of their relationships with their employers and also most importantly, their relationship with their customers.

Asperger's Syndrome and Autism Spectrum Disorders

Asperger's Syndrome (AS) is an autism spectrum disorder (ASD), that affects approximately 1 in 88 people based on the DSM-IV criteria, with as many as 1 in 54 males affected (Centers for Disease Control and Prevention, 2013). It is a neurobiological condition characterized by rigid, restricted, and repetitive patterns of behaviour and interests, atypical use of spoken language, significant difficulties with social interactions,

and distinct cognitive differences (Alvarez, 2012). In addition to social and behavioural abnormalities that are characteristic of AS, individuals with the condition often have sensory issues, those being highly sensitive and possibly intolerant to certain sounds, light, and other sensory stimuli (Tavassoli, Miller, Schoen, Nielsen, & Baron-Cohen, 2013). It is important to note that AS falls within a spectrum of symptoms that are described as autistic in nature. Not all individuals with AS present the same clinical symptoms or severity (Alvarez, 2012).

There has been an increase with the level of publicity about Asperger's Syndrome in recent years. One reason for this increase in awareness, is that it is believed that many affected by Asperger's Syndrome have special *savant* skills (Pring, Hermelin, & Heavey, 1995) or possess a gift of "genius" in them (Fitzgerald, 2002). Famous people speculated to have been affected by AS include Albert Einstein, Sir Isaac Newton, Michelangelo, and Amadeus Mozart (Fitzgerald & O'Brien, 2007). Individuals with AS, who can overcome the symptoms of Autism, have been found by researchers to be employed in the physical sciences, computer science, healthcare, and engineering occupational groups (Grandin, 2008). However, statistics supporting the *prevalence* of high-functioning autism and Asperger's Syndrome in specific industries are not well documented, through large-scale studies of highly specialized occupational groups such as medical laboratory technologists. As well, generations such as the "Baby Boomers"¹ and "Generation X" group² who were born before 1980 are largely undiagnosed (Baron-Cohen, 2007).

Cognitive strengths of individuals affected with Asperger's Syndrome, as "candidate laboratory employees" will include: 1) strong systems thinking; 2) excellent eye for detail; 3) perfectionists, and; 4) rigid adherence to process and routine. These behaviours which are demonstrated by individuals with AS can be reasoned to be "cognitive gifts" and required for analytic quality in laboratory medicine. For these reasons, technologists who may have AS are reasoned by this author to be effective "process controllers" as a system *personality archetype*.

Machiavellianism and Change Management

The personality profile of a *Machiavellian* is credited to the literary work of Niccolo Machiavelli, a political advisor to the Medici Family in Florence, Italy in his book *Il Principe* (The Prince, 1513). In popular culture, a number of traits and behaviours paint the Machiavellian personality type in a dark light. This may be due to a misunderstanding of literature and media sources. Machiavellianism, psychopathy, and narcissism is seen by clinical psychologists as part of a triad of subclinical personality traits known as the "Dark Triad". For this reason, Machiavellianism carries a socially negative stigma (Rayburn & Rayburn, 1996). Many literature sources have referenced the book *Studies in Machiavellianism* by psychologist researchers Richard Christie and Florence L. Geiss, published in 1970. However, there is a great discrepancy between the evidence published in this book and what is understood today. Therefore, it is questioned by this author, if research since 1970, has revealed new clues about the true nature of the Machiavellian.

There has been great concern expressed by scholars about the “misrepresentation” of Machiavellianism within management. Researchers Grace and Jackson published an article in the journal *Philosophy of Management* stating this concern:

“In the name of intellectual honesty and sound scholarship, we urge management scholars to take note of this distortion of Machiavelli, and where possible address it, and that the users of the Mach-IV scale distinguish the man, Machiavelli, and his works from this instrument” (Grace & Jackson, 2014).

Researchers Grace and Jackson urged that individuals, who use Mach-IV test in education, training, consulting, and research, ensure that they make the distinction between the real Niccolo Machiavelli, his works, the Mach-IV test and the distorted misconception of him. For the reader, it should be noted that Christie and Geiss discussed this same issue in their book and admitted that the term “Machiavellianism” might be seen as inappropriate. However, Christie and Geiss stated that the research ideas came from *The Prince* (1532) and *The Discourses* (1531). Therefore, they reasoned that credit should be given to these literature sources (Christie & Geis, 1970, p. 339).

The reader should note that *Studies in Machiavellianism* is a significant body of work by Christie and Geiss, which spanned from 1954 to 1970. These researchers investigated Machiavellianism from a psychological perspective, leading to the development of two personality questionnaires, called the Mach-IV and Mach-V tests (Christie & Geis, 1970). Both psychometric instruments still hold validity, with high

predictive value today. Christie and Geiss found the following behavioural characteristics, with respect to individuals who had high Machiavellian scores, called “High Machs”:

- 1) High Machs were successful manipulators, through coalitions and their structures, not individuals (pp. 146-147);
- 2) High Machs do not bend to social pressures, unlike low Machs (pp. 295-296);
- 3) No relationship was found between High Mach scores and race relations (p. 41);
- 4) High Mach behaviour is purely objective in nature and not linked to high or low achievement goals, rather more their *manner* to achieve them (p. 43), and;
- 5) Researchers stated that “Machiavelli was the realist par excellence” (p. 18).

Machiavellianism is not a clinical condition; it is a merely a personality type. Researchers Christie and Geiss carefully screened out individuals with clinical conditions, prior to their studies (Christie & Geis, 1970, p. 45). The researchers did discover that there was a minor correlation between anxiety and the Mach-IV test (Christie & Geis, 1970, p. 44). Also noted, was a correlation between the Mach-IV test and Siegel’s Hostility Scale. However, the researchers admitted that this relationship should be treated with careful scrutiny. High Machs are not more hostile than Low Machs, but rather can more readily recognize and admit their hostile impulses (Christie & Geis, 1970, p. 47).

The researchers found that Machiavellianism is not necessarily linked to any personal drive to climb the corporate ladder or to seek absolute power (Christie & Geis, 1970, pp. 39-44). High Mach personality types were found to be apolitical in their behaviour. To support this argument, researchers conducted studies to determine if there

was a relationship between Machiavellianism and Authoritarianism. Christie and Geiss found no statistically significant evidence to support this notion, when investigating political preferences and Mach-IV scores. They clarified the differences between an Authoritarian personality type and a Machiavellian personality type:

“...both contain an unflattering view of man and this might lead to the expectation of a slight correlation. There is a subtle but important difference in the consequences of this unflattering view. A high-authoritarian view might be paraphrased, “People are no damn good, but they ought to be”. A high Machiavellian might well agree with the premise about people but would give a twist to the implications of such a view. “People are no damn good. So what? Take advantage of it”. (Christie & Geis, 1970, p. 38)

High Mach personality types were found to be flexible, opportunistic, adaptable, with an ability to take advantage of moments of general confusion within a group and test their limits (Christie & Geis, 1970, p. 159). High Mach personality types were found to be excellent at coalition forming and breaking within groups. However, no evidence was found by the researchers, to support the notion that High Machs were insensitive to emotional involvements (Christie & Geis, 1970, p. 311). Therefore, based on this extensive body of work and taking an amoral, third-person perspective of the personality style, this author reasons Machiavellian personality attributes and cognitive strengths represent an effective “Change Agent” as another system personality archetype.

The Machiavellian Change Agent versus the Autistic Process Controller

Both Machiavellianism and Autism may have social implications, from the perspective of industrial psychology and human resources. This is likely due to the fact that the personality styles share a common behaviour; both are thought to have social cognitive deficits with empathy. With respect to this workforce study, this author emphasizes that it should be made clear to the reader, that “social cognitive deficits with empathy” does not mean *lack* of empathy or care. All medical laboratory personnel do care about the patient and the quality of their work. The problem reasoned by this author is that the word “empathy” and its demonstration have a different meaning to different people. The concept of “empathy” will be clarified later in this thesis. A google scholar word search was performed on April 18th, 2015, using key-words to scan the database and obtain the number of search engine hits. This data is presented in Table 2. The reader will note that in Table 2, there appear to be two very large bodies of published material where Autism and Machiavellianism have been studied in relation to *social cognition*. What about the relationship between Autism and Machiavellianism? The body of knowledge to date, based on the number of google hits, is small in relation to the other published sources. There appears to be a great opportunity for future research based on this evidence.

Table 2: Google Scholar Search Hits (April 18th, 2015)

KEYWORDS	GOOGLE SCHOLAR HITS
“Asperger” + “Empathy”	16500
“Autism” + “Empathy”	36300
“Asperger” + “Social”	560000
“Machiavellian” + “Empathy”	14400
“Machiavellian” + “Social”	44100
“Asperger” + “Machiavellian”	507
“Autism” + “Machiavellian”	3220

It is reasoned by this author, that if any new ground is to be gained in understanding the relationship between Autism and Machiavellianism, “empathy” and “conventional morality” must be placed aside briefly, but both concepts will be discussed later in this thesis. This author questions if there has been a misunderstanding of the two personality types, simply because both personality types are reasoned to think in the *third person*. Empathy requires thinking in the *second person*. However, ethics considers *all vantage points*. Thinking in the third person means that the individual is not considered in either mindset.

This author proposes that there are three ways of conceptualizing the relationship between the Autistic and Machiavellian personality types: 1) the two personality types can

be looked at as distinct antagonists; 2) all personalities can be viewed as a spectrum of behaviours between the two, and; 3) they can be visualized as perfectly rational agent types, game pieces, or; 4) *automata* within a *clockwork system*. Christie and Geiss explored Machiavellianism in experiments, where it applied to *Game Theory* (Christie & Geis, 1970, pp. 173-189). Expanding on this idea, this author proposes that a two agent cooperative model can be conceptualized, using “Autistic Process Controller” and “Machiavellian Change Agent” game pieces. Using perfect logic, the two agent types must work together to deliver the greatest payout within a production system. However, their actions must both use the least amount of resources (time, personnel, equipment and inventories) to maximize utility as *Homo economicus*. When a hospital or healthcare authority is visualized as a cross functional map, it becomes a “chessboard”. Therefore, the system, when changed will produce different payouts of increasing value.

Autistics look at a system, as a series of inputs and outputs and focus on details, numbers, objects and patterns (Baron-Cohen, 2008). This suggests that a narrow cognitive lens is used, with a mindset that is conscientious of *variation* in a process, as a *process controller*. However, Machiavellians as change agents, look at the *functional group* structures within the system as a “game of chess” (Hallinan, 2005). Machiavellian perception also suggests that a distant vantage point is used, with a “big picture” mindset. Machiavellians as change agents are adapted to “gaming” the system (Nelson & Gilbertson, 2010), seeking “moments of truth”, with respect to a greater operational goal. The operational goal can be a product, service or with respect to six sigma methodology and optimization, the *Transfer Value* [$Y=f(X_n)$] (iSixSigma, 2015). Therefore, it is reasoned by

this author, that both personality archetypes interact with one another as opposing forces, permitting change to occur efficiently and safely, to produce new knowledge and value within a complex system.

For this heuristic model, this author proposes that process controllers and change agents see the laboratory as a system from different vantage points, illustrated in Figure 1. For changes to be made within a complex system, both agent types cannot work as well without the other. It is reasoned by this author, that two distinct cognitive lenses are being used to study the opportunity for improvement.

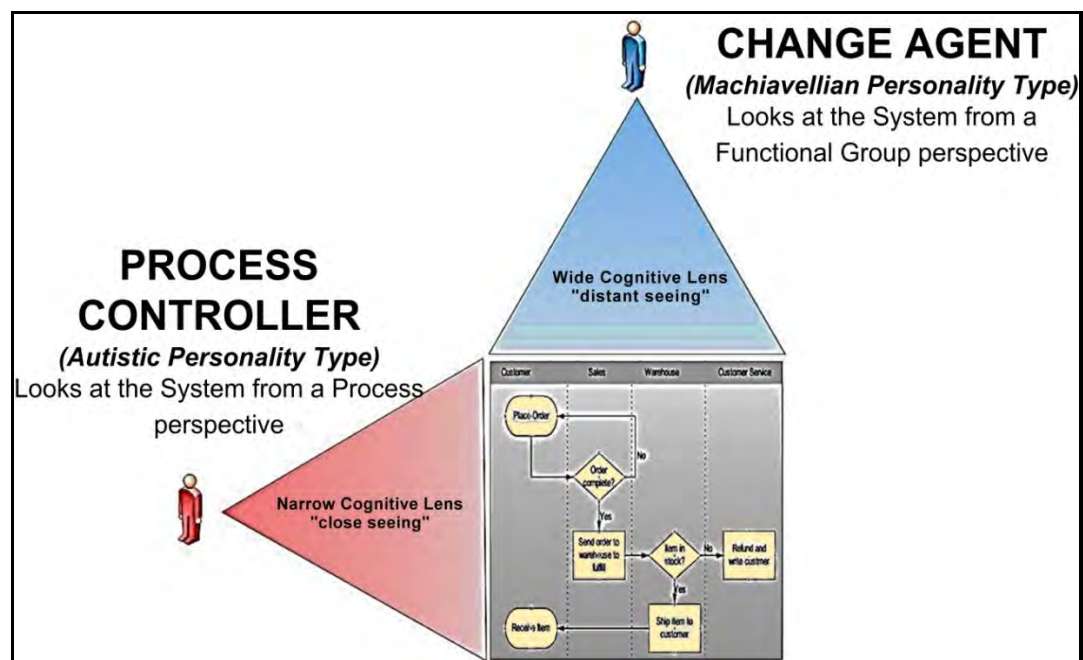


Figure 1: Autistic and Machiavellian vantage points of a Complex System

To promote understanding and correctly frame the opportunity for improvement as a lens and entry point into a system, *perception* by its nature comes at a cost of an *inability to see other things*. Therefore, both agents are reasoned suffer from a type of “blindness”

due to their personality archetypes. For change to occur that benefits both parties within a production system, both agent types require an information exchange. This process called *learning*, results in *new knowledge* as a *stock*. This new knowledge is the *end product* of two different types of “seeing”. Therefore, both agents, as personality types, are two *learning system archetypes* which interact with one another to produce new knowledge through *Variation of Mind*. This conceptual model in system dynamics will be expanded upon by this author in the Literature Review, Chapter Two.

Statement of the Problem

Medical laboratory technologists who may have Asperger's Syndrome (AS), a form of high functioning Autism, are thought to be employed in the medical laboratory industry. However, little is known regarding the prevalence of those employed with the condition. Individuals affected by AS, may have workplace challenges when dealing with social complexity. These difficulties are of concern to the quality assurance professional, where effective social relations are critical to the success of change management initiatives and customer needs. Quality improvement plans may span multiple functional groups within a complex system. This could lead to *Lewin Social Space* project team sizes that exceed the *Dunbar's Number*, which may result in obstacles or challenges with new knowledge transfer. Therefore, a new conceptual model for quality, with improved planning methodologies and tools for learning, are required to overcome the difficulties during change management initiatives, as a knowledge-based learning system.

Purpose of Study

This thesis will investigate both the pervasiveness and population distribution patterns of high-functioning Autism and Machiavellianism, within the medical laboratory workforces employed in Canada. The purpose of this population study is to determine the characteristics of the medical laboratory workforce, within a regional service model, based on the two personality types, using the four psychometric questionnaires.

The study will propose a new conceptual model for quality assurance, based on Qualia and its relationship to Social Cognition, Autism and Machiavellianism. This model, called the “Triadic Adaptive Learning System” (TALiS), will be used to explain the dynamics within the Juran Trilogy and the Deming PDSA Cycle, illustrating how the learning system archetypes work together to share and transfer knowledge. Expanding upon this model, the concept of the *Learning Space* and new knowledge transfer during a change initiative will be discussed, along with several opportunities for future research.

Using evidence from the literature review and the laboratory workforce study, this author will critique four quality guidelines published by the CLSI and recommend:

- 1) Laboratory facility design improvements, using the latest research published on autism, to improve working conditions and quality;
- 2) New approaches promoting empathy and understanding between technologists, their healthcare peers and the patient;
- 3) New approaches to accommodate different learning styles of the technologists who are on the autistic spectrum, through improved training programs, competency verification, and;
- 4) A new vision of “goodness” for quality, based on the ethics, philosophy and science, of *Integral Permaculture* in Quality Assurance.

It is the aim of this author, to produce new knowledge which will benefit the medical laboratory workforce and the broader healthcare communities. Through this new knowledge, it is believed that better understanding will arise, thus promoting the “quality culture of goodness”.

Theoretical Bases and Organization

The laboratory workforce study, which was undertaken as part of this thesis, was based upon prior studies by researchers who have investigated Asperger Syndrome and Machiavellianism. There are many journal articles published on the two personality types. Upon review of these journal articles, it was found by this author that:

- 1) Limited research has been done which investigates the prevalence Asperger's Syndrome and Machiavellianism in a highly specialized *occupational* group;
- 2) The questionnaires used in this study, to detect AS in conjunction with Machiavellianism, has never been performed before in a prior study;
- 3) Neither Asperger's Syndrome or Machiavellianism has been investigated in a *large-scale* study of an occupational group, and;
- 4) The *distribution patterns* of Asperger's Syndrome and Machiavellianism, within a regional service governance model, have not been investigated.

This research is reasoned by this author to be novel, in that all four gaps in knowledge will be satisfied through this study.

Limitations of the Study

It is reasoned by this author, that the medical laboratory workforce study should be seen as a preliminary investigation. The psychometric instruments used for *detecting* high functioning Autism (AQ, SQ-R and EQ) and Machiavellianism (Mach-IV), are *self-reports*. In addition, the questionnaires are designed to pick up *personality traits*. To be clear to the reader, the questionnaires are *not diagnostic instruments*. There was a relatively small sample size of males who participated in this study. However, this should not be surprising, since the predominant gender in the medical laboratory workforce is female (CIHI, 2011). It is also important to note that the Empathy Quotient questionnaire (EQ) cannot differentiate between *affective empathy* and *cognitive empathy* (Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007). Lastly, the EQ, AQ, SQ-R and Mach-IV questionnaires have not been widely used in assessing personality traits within the healthcare community.

It is recommended by this author, that future studies should aim to verify the results from this study within a regional health services model. Also, these studies should aim to compare the results within multiple healthcare occupational groups. It is possible that if similar studies are performed in the future, could verify the results in this workforce study. Therefore, what remains to be answered, is evidence to support the hypothesis that the psychometric scores are *relatively consistent* within the medical laboratory workforce, even if these populations are separated by great geographical distances and employed within different regional health authorities.

Self-Report

The four psychometric instruments (AQ, EQ, SQ-R and Mach-IV) used for this study, through historical evidence, been demonstrated to have high predictive value in psychology. However, the reader is cautioned that the questionnaires are *self-reports*. It is possible, that participants can both *under-report* and *over-report*, in response to the questions in the four psychometric instruments.

Generalizability

The generalizability of the study findings, in relation to the broader workforce populations, should be done so with caution. Due to the small sample size (n=32), the results may not be reproducible with respect to other workforce occupational groups, laboratory personnel employed in different geographical areas and those employed within different regional healthcare authorities. Therefore, this author recommends that the findings should be considered thought-provoking, but not conclusive.

Evidence based on Reliability

The four questionnaires, utilized multiple choice format questions, which were scored using *Likert-Type* scales, which have the following characteristics (Gliem & Gliem, 2003):

- 1) The scales must contain multiple items that can be combined or summed;
- 2) The items in each scale have a continuum of values that can be quantified;
- 3) Each item has no correct answer;

- 4) Each item does not test for any particular knowledge, skills, or ability, and;
- 5) Each item is a statement from which the participant must provide a rating.

The Cronbach's Alpha reliability coefficient was calculated from the data sets generated by the participant responses. The Cronbach's Alpha value is a measure of internal consistency of a test or scale; the alpha value is based on the response data sets.

Survey results with "acceptable" Cronbach's alpha values may range from 0.70 to 0.95 (Tavakol & Dennick, 2011). However, low alpha values can be due to a low number of questions in the instrument, poor interrelatedness between items or heterogeneous constructs (Tavakol & Dennick, 2011). Psychometric tests which produce alpha values greater than 0.90, might suggest that the questionnaire lengths should be shortened and that there are possible redundancies in survey questions (Tavakol & Dennick, 2011). It has been recommended that when a coefficient alpha value has been reported, the confidence interval for the alpha should accompany the alpha estimate (Iacobucci & Duhachek, 2003).

Evidence based on Normative Population Values

Normative population values were obtained using published data from prior studies that investigated Asperger's Syndrome and Machiavellianism. It should be noted in the literature review that this author was unsuccessful in finding large scale "standardization" studies with "universally agreed values" for the questionnaires. Data gathered from the four psychometric questionnaires, was then compared against several published literature sources. Several population groups were used for comparison, which included: 1) general population *normative* values; 2) population groups categorized by *academic discipline*, and; 3) the *nursing* workforce. The goal is to provide the reader with some sort of vantage point, from which to compare the medical laboratory workforce characteristics, against other populations, based on the four psychometric questionnaires.

Determination of Cut-off Values

This author was unsuccessful in obtaining "standardized" cut-off values for all four psychometric questionnaires, which were based on normative population values in the literature review. However, for the *Empathy Quotient* (EQ), the cut-off value of 30 or lower was recommended by researchers at the University of Manitoba (Stoesz, Montgomery, Smart, & Hellsten, 2011). The rationale behind the selection of cut-off values is to provide the reader some sense of the percentage of the workforce, which met requirements for each questionnaire (see results and discussions section, Table 6). Information regarding the cut-off values and the rationale behind their selection is presented in Table 3.

Table 3: Selected Psychometric Questionnaire Cut-Off (Discriminator) Values

SELECTED CUT-OFF VALUE	COMMENT	SOURCE
Autistic Quotient AQ = 21 or greater	<ul style="list-style-type: none"> ➤ ASC Group Mean (36.5) – 2SD (16.0) = 20.5 ➤ Value selected to avoid false negatives 	(Wheelwright, et al., 2006)
Empathy Quotient EQ = 29 or lower	<ul style="list-style-type: none"> ➤ EQ score of 30 is recommended as a useful cut score ➤ EQ score of 29 or lower selected 	(Stoesz, Montgomery, Smart, & Hellsten, 2011)
Systemizing Quotient SQ-R = 101 or greater	<ul style="list-style-type: none"> ➤ People with ASDs have “Extreme S” Brain types based on <i>EMB Theory</i> ➤ ASC Group Mean (77.2) +1 SD (23.8) = 101 selected ➤ Value selected to avoid false positives 	(Wheelwright, et al., 2006)
Machiavellianism Mach-IV = 60 or greater	<ul style="list-style-type: none"> ➤ Individuals who score 60 or higher are classified as “High Machs” 	(Christie & Geis, 1970)

Definition of Terms

Archetype: is an ideal example, or model, after which other things are patterned. An ISO 9001:2008 Quality Management System would be an example of an archetype. ISO 15189 is based on the ISO 9001 QMS. Therefore, ISO 9001 is an archetype of a quality management system, from which all variations are patterned (ISO 15189 and others).

Personality Archetype: An over simplified but well-understood personality type. Examples would be the “the absent-minded professor”, the “rock star”, “the philosopher”, etc. It may be a stereotype, or used as an *epitome* of an example. Personality Archetypes are easily visualized.

System Archetype: A system with feedback loops, which cause characteristic patterns of behaviour. Feedback loops may be regulating or reinforcing. Well known System Archetypes, which produce undesirable behaviours, are called “System Traps”.

AS: Asperger’s Syndrome

HFA: High Functioning Autism. The DSM-V reclassified Asperger’s Syndrome as High Functioning Autism in 2013.

Cognitive Empathy: Is the ability to understand another person’s perspective and predict what they might do in a social context.

Affective Empathy: Can also be called “emotional empathy”. It is the ability to respond with a socially appropriate emotion to another person’s mental state.

CHAPTER 2

REVIEW OF THE LITERATURE

Dr. Kurt Lewin's theories on Group Dynamics and Social Change

Dr. Kurt Lewin was a pioneering researcher in the early 1900's, who developed several theories in the area of social psychology, which was related to group dynamics, culture and social change. Kurt Lewin is seen as the father of modern social psychology. Three of his theories include: 1) Field Theory; 2) Change Process, and; 3) Action Research (Social Engineering). It would not be surprising, if Kurt Lewin and other social psychology researchers were inspired by the work of Albert Einstein, in addition to the work of Niels Bohr in quantum mechanics. Both Kurt Lewin and Albert Einstein fled from Germany in 1933, to escape from the Nazis. Both Lewin and Einstein immigrated to the United States in approximately the same time frame. Kurt Lewin's work on Field Theory built upon Gestalt Theory and cognition. Lewin's models provide a basic conceptual framework, which has applications in quality assurance. Therefore, Kurt Lewin's work applies to customer experiences with a product or service and organizational group behaviours during a change initiative.

Kurt Lewin explained that Field Theory is a “method of analyzing causal relations and of building scientific constructs”; not a theory where there are special laws, or formulas that are used in scientific disciplines such as physics (Lewin K. , 1997, p. 201). Kurt Lewin's model proposed that the behaviour of an individual, at any given point of time, is a

function of the person and their environment. Environmental stimuli affecting the person's behaviour, valence state and future actions, describes a type of "space" called a "phase space". Phase spaces are not three-dimensional physical spaces but they are instead, constructs of variables in the environment, that collectively describe a field around the person that shapes their behaviour, which could have five, twenty, or more dimensions if necessary to model and predict the behaviour (Lewin K. , 1997).

This author reasons that Lewin's "phase spaces" can also be described as "cognitive spheres of knowledge and awareness", at any given moment of time through a time-space. A simple diagram to explain the Lewin's model and its application to quality assurance is shown below in Figure 2.

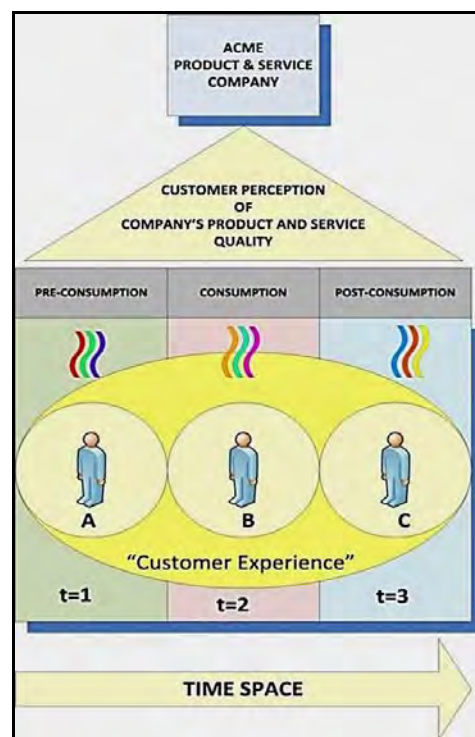


Figure 2: Customer Experience, Field Theory and Phase Spaces

Expanding upon Figure 2 as a conceptual model, the “ACME Product and Service Company” may be a restaurant chain, where the customer intends to purchase a meal.

Prior to ordering the meal, the customer will note the advertising, the cleanliness of the eating establishment and general atmosphere in the pre-consumption phase (See Figure 2, Phase “A”), represented by different coloured waves, which for the purposes of this paper shall be called qualia. The customer, during the consumption phase (See Figure 2, Phase “B”), will then experience the meal, which will affect their perception of the quality of the meal through its taste, texture and aroma. In the final phase, known as the post-consumption phase (See Figure 2, Phase “C”), the customer will then receive the bill. The customer will reflect on the overall experience, the friendliness of the servers and any distinctive features of the restaurant. If the restaurant chain is successful in delivering satisfaction and its distinctive quality features are remembered by the customer, the customer’s experience will result in a change in behaviour, leading to brand loyalty. Therefore, the customer’s perception has been shaped by all phases and their experience of qualia through the three fields within the “time-space”.

Another theory developed by Kurt Lewin called *Change Process Theory*, described social change as a three step process:

- 1) “Unfreeze” – the current system is opened from a steady state phase or equilibrium;
- 2) “Change” – the system once opened, is modified or improved, and;
- 3) “Refreeze” – the social system is then closed.

To unfreeze a human-based system, Kurt Lewin's model required that there was a process of "unlearning" in addition to learning that a social system must go through for change to occur. Within this change process, Lewin's theory stated that the behaviour of the social group was impacted by dynamic forces, affecting the learning "fields" during each phase of the change. These opposing forces were called driving and restraining forces and it was theorized that they impact the equilibrium point of the social group. Kurt Lewin's Change Process Theory led to the development of a quality planning tool, called a "Force Field Analysis", which is still used today (ASQ, 2015). Kurt Lewin's conceptual models can be described as "Learning Spaces", which will be addressed in the subsequent chapters in this thesis.

Dr. Donella Meadows and System Dynamics

Dr. Donella Meadows was an environmental and systems scientist, who is best known for the book, *The Limits to Growth*, (Meadows, Meadows, Randers, & Behrens, 1972). She is viewed by environmental movement communities, as the "Mother of Integral Permaculture" for her research (Permaculture Science, 2015). For this thesis, *Thinking in Systems*, provides the reader a foundation for understanding complex systems and system dynamics (Meadows D. H., 2008). Five of her rules regarding complex systems are as follows:

- 1) "A system is an interconnected set of elements that is coherently organized in a way that achieves something. It may exhibit adaptive, dynamic, goal seeking, self-preserving, and sometimes evolutionary behaviour" (p. 12);

- 2) “Structures within systems that produce characteristic behaviour are called *Archetypes* or *System Traps*” (p. 6);
- 3) “Stocks are the elements of the system that can be seen, felt, counted, or measured at any given time. The accumulation of information is a type of stock” (p. 16);
- 4) “A system is in a state of dynamic equilibrium when the stock stays constant. The inflows become equal to the outflows” (p. 21);
- 5) “A feedback loop is a closed chain of causal connections from a stock through a set of decisions, rules, physical laws, or actions that are dependent on the level on the stock and back again through a flow to change the stock” (p. 27), and;
- 6) “Balancing feedback loops are equilibrating or goal-seeking structures in systems and are both sources of stability and sources of resistance to change” (p. 30).

Expanding upon Lewin’s theories in social change, while using Donella Meadow’s rules in system dynamics, a simple conceptual model can be constructed to describe a quality system as a type of *learning system*. A quality system can then be defined as a:

- 1) Man-made closed system consisting of structural archetypes engineered with feedback loops that are self-regulating and equilibrating, with the goal to control variation in an output of a product or service, and;
- 2) A man-made learning system that has structural archetypes built in that exhibit adaptive, dynamic and evolutionary behaviour through new knowledge, to deliver increasing value and satisfaction to the customer.

A human-based quality system, which is in a state of dynamic equilibrium, has a *knowledge stock* that is *constant*. This means there is no *new knowledge* accumulating if the quality characteristics of the output are constant. Knowledge is not the same as information. Therefore, if new knowledge is not accumulating, then learning is not occurring (Deming, 2013, p. 200).

Dr. Albert Bandura and Social Cognitive Learning Theory

Dr. Albert Bandura is a Canadian Psychologist, who is best known for his work in cognitive psychology, behaviourism and social cognitive theory. Dr. Bandura's *Social Cognition Learning Theory*, states that a portion of an individual's knowledge is acquired by observing the behaviours of others and cultural norms within an organization (Wood & Bandura, 1989). Bandura's *reciprocal causation model* is shown below:

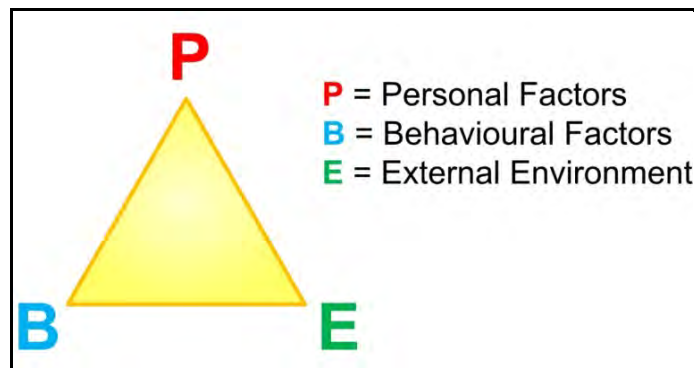


Figure 3: Bandura's Triadic Reciprocal Causation Model

Bandura's model is similar to Kurt Lewin's Field Theory but proposes that there are two key mechanisms involved with social learning:

- 1) *Self-Efficacy*: It is the central core and measure of an individual's personality and ability to complete tasks, motivation to achieve goals and environmental adaptations. This means that internal motivations affect the individual's actions (Bandura, 1989), and;
- 2) *Vicarious Learning*: It is the process of learning from other people in social groups and involves mechanisms of reward and punishment for perceived mistakes made through an individual's behaviour (Bandura, 1989). It allows Individuals to avoid making mistakes by observing others if they see them completed successfully.

Building upon the reciprocal causation model, Dr. Bandura proposed that a person's behaviour involves *feedback mechanisms*, called "reciprocal determinisms". Bandura's Social Cognitive Learning Model is known as the *Triadic Reciprocal Determinism* model of social learning (Bandura, 1989).

It is known that 50% of an individual's personality type is due to their genetic predisposition (Plowman, 2006). This connection between human biology and personality type is an important consideration for an employer to keep in mind, when understanding an employee's behaviour, their learning requirements and determining the support systems that they may require to meet quality goals. Other influences also shape the person's behaviour, such as their upbringing, educational level and their prior work experience (Levy, 2010). An employer therefore, should be aware of the personal and the behavioural determinants of a new employee and possible learning requirements, with regards to customer service at the time they are being oriented and trained in their new job. An employer should consider how it is aligned with their organizational goals (Wood & Bandura, 1989). Therefore, employers should consider in the *design* of their orientation

training program, feedback systems which recognizes these differences in employee personality and learning styles. With the appropriate learning supports and feedback systems, organizations can align their employees' talents with respect to customer service performance and the strategic goals of the organization. (Wood & Bandura, 1989).

Dr. Robin Dunbar, Primate Behaviour, Language and Social Evolution

There is a greater relationship between Kurt Lewin's Field Theory, Dr. Bandura's model of social learning and social group size in within organizations. Dr. Robin Dunbar, an anthropologist and evolutionary psychologist, proposed that there is a social cognitive limit to the number of individuals that any one person can have, to maintain a stable relationship (Dunbar, 2010). Dr. Dunbar studied the differences in primate brain morphology and compared them to social group sizes. Dr. Dunbar found a close relationship between the brain size and social group size. This discovery led to a model proposed by Dr. Dunbar, that there was an evolutionary need for large groups, which led to the sudden and rapid development of language (Aiello & Dunbar, 1993).

Dr. Dunbar proposed that language developed as a bonding mechanism, to reduce the amount of time for social grooming among non-human primates. Language permitted social time to be used more efficiently and permitted humans to exchange information about individuals who were *not immediately present*. Dunbar predicted that the social limit for anatomically modern humans to be a group size of 148 [95% confidence limits = 101-231] (Aiello & Dunbar, 1993). Dr. Dunbar stated that there was considerable evidence to support population groupings of the size, predicted in modern and historical human

societies. More recently, studies of social networks (Leskovec, Lang, & Mahoney, 2009) and user activity twitter networks have validated “Dunbar’s number”³ (Goncalves, Perra, & Vespignani, 2011).

To overcome Dunbar’s limit in social group size, there had to be an overwhelming need for the social groups to do so. This basic human need, required a change in population groups from egalitarian organizational constructs (*Gemeinschaft* social system), into highly stratified societies of people with specialized social and functional roles (Aiello & Dunbar, 1993). This social transition led to modern organizational systems of today (*Gesellschaft* social system). Dunbar’s number may be important with respect to employees who are on the Autistic spectrum. It has been found that individuals, who are on the Autistic spectrum, have differences in neural connections in their neocortex (Chomiak & Hu, 2013), which may result in social difficulties in large groups. If there are, in fact, a high number of medical laboratory personnel who are on the autistic spectrum, laboratory leaders should consider the Dunbar’s number, within in a regional health services model. Therefore, this evidence leads this author to question if there are in fact, differences in the “Dunbar number” for social group size within occupational groups, which may impact the dynamics of social-functional holarchies⁴ and knowledge transfer within complex systems.

The Human Brain, Qualia and Consciousness

What is Quality and how does it relate to Qualia? The word “quality” can be traced to the Latin word *qualitas*, meaning “a property” or a “distinguishing characteristic” (Merriam-Webster Dictionary, 2015). When speaking of a particular product or service,

quality is a characteristic or set of characteristics that sets it apart from other similar products. However, the word “qualia” has a different meaning, though it is closely related to quality. Qualia, the plural form of “quale” refers to a product or service characteristics that must be *experienced* by the customer through consumption in the *first person* for its distinctiveness to be clearly understood. Qualia are characteristics of a product that must be experienced by the customer as a *learning system*. In this light, the “eye of quality” assesses a product or service characteristics from all vantage points, including the eye of the customer, which is accomplished through *empathy*. Therefore, empathy is the key to product or service distinctiveness.

Qualia have been the source of considerable research and debate among philosophers, cognitive neuroscientists, psychologists and physicists (Crane, 2001). This has led to many theories which relate to human consciousness and cognition, including theories which suggest that qualia are real phenomena. Philosophy has failed to explain the human experience of qualia, such as the colour red, or the distinctiveness of the taste of a fine wine. However, physicists have proposed that the experience of qualia and consciousness can be explained at the *quantum level* if the human brain is modeled as a quantum learning system (Rapparini, 2008). Dr. Roger Penrose, a theoretical physicist and Dr. Stuart Hameroff proposed a model in the 1994 called the *Orchestrated Objective Reduction* (Orch-OR) model of consciousness, which suggests that quantum information processing occurs in the microtubules of neurons, within the human brain (Hameroff & Marcer, 1998).

The Orch-OR model of consciousness has been harshly criticized by critics over the years. However, in 2014 evidence was found to support six predictions of the Orch-OR theory (Hameroff & Penrose, 2014). More recently, evidence of “wireless communication” of axons via “vibration synchronization”, can occur between neurons across the entire brain (Ghosh, Sahu, & Bandyopadhyay, 2014). The Orch-OR model implies that the experience of and transfer of Qualia, as quantum information, is *instantaneous* within biological systems. Qualia as knowledge are not bound by the speed of light, once within the human brain. This insight then raises a very important question in quality assurance if there is a “biological superiority” of this mode of information transfer, over man-made information systems. However, qualia transferred through neuron microtubules, based on the Orch-OR model, are reasoned by this author to be limited to very small distances. Therefore, it is reasoned that the mechanisms of knowledge transfer through mirror neuron systems and the Orch-OR model may be very important in quality assurance.

Is the recent work of Hameroff and Penrose useable in quality assurance today? This author proposes that the concept of qualia as an *object* can be used in quality assurance as a model if qualia are visualized as a “quantum waves”. For use in developing new heuristic models in quality assurance, this author submits that a product or service can be easily visualized as emitting “quantum waves of quality”. In this light, the “aura of distinctiveness” through qualia is detected and shaped by the customer’s perception. The first person experience during consumption, leads to satisfaction, thus shaping the customer’s behaviour. What is very important, is that information transfer and perception is occurring instantaneously, based on the Orch-OR model. Dr. Penrose and Dr. Hameroff

gave this quantum information a name; they called them “qubits” (Hameroff & Penrose, 2014, p. 47). Integrating the Orch-OR model into the theories proposed by Lewin, Bandura and Dunbar, the customer’s gestalt sphere will detect distinct *quale types*, as they proceed through the three phases of a service discussed earlier (see Figure 2). Therefore, the human experience of qualia through all three phases, as well the customer’s emotional state, help make up the *learning space* of the customer and shape their behaviour through the new knowledge.

If the customer is satisfied with the product or service, the customer may share their experiences with others in their social space, thereby changing the behaviour of the whole social group as a community. Qualia as “qubits” of knowledge has thus been both transferred and understood, within the minds of the social group that the customer belongs to. In this light, a quality system is reasoned by this author to be “cybernetic”; an administrative neural extension of the TALiS and Orch-OR models. Through its methodologies and tools, a quality system captures qualia from the *voice of the customer*, translates them into qubits, called *customer requirements*. A quality system then replicates this new knowledge, to produce and improve the characteristics of a product or service. Therefore, if the design of the quality system is effective at the capture, codification, replication and transfer of these qubits of knowledge, the same first-person experiences of qualia are realized during consumption of a product or service, thus producing consistent customer satisfaction, resulting in a change in behaviour of the whole market as a community.

Qualia, Empathy and fMRI Studies

To be fully understood by a business or healthcare service, the subjective human experience of qualia by a customer, during the consumption of a product or service, requires empathy. Empathy is second person thinking, which closes the gap between the first and third person mindset of two or more individuals. Empathy is,

“...without question an important ability. It allows us to tune into how someone else is feeling, or what they might be thinking. Empathy allows us to understand the intentions of others predict their behaviour and experience an emotion triggered by their emotion. In short, empathy allows us to interact effectively in the social world, drawing us to help others and stopping us from hurting others.” (Baron-Cohen & Wheelwright, 2004)

Empathy can then be expanded upon and applied to healthcare service quality. Empathy closes the gap between the clinician and the patient, where a feedback loop occurs that not only benefits the patient but the caregiver as well. The patient's first person experience and emotional state of a service or product not only will create satisfaction for the patient but will create a sense of satisfaction for the caregiver. In addition to satisfaction, the care provider gains a sense of purpose and importance. If the patient is a routine patient, the learning space diminishes between the care provider and the patient, which can lead to bonding. Therefore, empathy can lead to a sense of community between the clinicians and their patients.

Empathy and social cognition have been investigated, using diagnostic imaging techniques. Advances in magnetic resonance imaging (MRI), have led to breakthroughs in the fields of neurology, providing investigators evidence of neural systems in the act of performing specific functions by direct observation. In particular, there have been numerous studies since the 1990s using functional MRI scans (fMRI)⁵. This research has revealed clues about the underlying neural systems, their functions in the human brain and how they work together to solve problems and achieve a goal. Looking at perception, studies have demonstrated that human vision is not handled by one general area of the brain. Neural systems which process vision are scattered across different regions in the human brain and work together, such as:

- 1) *Face processing* (Bystritsky, Pontillo, Powers, Sabb, Craske, & Bookheimer, 2001);
- 2) *Hand movements* (Prado, Clavagner, Otzenberger, Schelber, & Kennedy, 2005), and;
- 3) *Body movements* (Downing, Jiang, Shuman, & Kanwisher, 2001).

Studies have also found that there are neural systems, which can differentiate *biological motion* from *non-biological motion* (Grossman & Blake, 2002). Also, Autism and Asperger's Syndrome has been the subject of extensive research using fMRI studies as well, revealing clues about social perception.

Machiavellianism has also been investigated using fMRI imaging techniques. Studies have investigated brain functions related to **strategy, risk assessment, collaboration and competition** (Decety, Jackson, Sommerville, Chaminade, & Meltzoff, 2004).

Experiments using fMRI studies have provided evidence suggesting that Machiavellian thinking is “left-brained”⁶, with strongest activation in the left lateral orbital gyrus region (Nestor, et al., 2012). The ability of the brain to qualitatively compare relative measures (right hemisphere) and perform higher level arithmetical calculations (left hemisphere), has also been studied and verified using fMRI technology (Castelli, Glaser, & Butterworth, 2006). Therefore, cognitive processes associated with traits linked to Machiavellianism, appear to involve many neural systems, providing evidence that Machiavellianism is a high-level cognitive process, which is influenced by environment, genetics and most importantly, evolution.

Differences in personality types point to different perceptions, cognitive styles and learning needs. This includes both the customer and the care provider. However, empathy is reasoned to work only within shorter social distances and smaller numbers of people. How does the healthcare organization deliver quality and the perception of care, if both the community and organization exceeds the Dunbar’s number? What if the services for care are separated by large geographical distances? It is reasoned that quality assurance provides structural supports, tools, information, and systems, which permit the organization to overcome the limitations of the human brain. It then can be reasoned, that quality tools and supports act as “neurocognitive prosthetic devices”, permitting organizations to understand the requirements of the customer and transfer that knowledge to meet customer requirements across large distances. Therefore, a quality system can be reasoned to be an extension of the human brain, as a type of cybernetic “neural system”.

Mirror Neuron Systems and Action Learning

Empathy involves a feedback loop between two individuals, called “mirroring” which results in understanding. Mirror Neuron Systems were first discovered in Macaque monkeys by researchers in 1996 (Rizzolatti, Fadiga, Gallese, & Fogassi, 1996). Ever since the discovery of mirror neurons in 1996, their findings have been confirmed and widely published. However, growing evidence of mirror neuron systems through fMRI studies, suggest that a much wider mirror neuron network exists in the human brain (Matlin, 2005).

Mirror Neurons have been found linked to:

- 1) Face processing and empathy (Schnell, Bluschke, Konradt, & Walter, 2011);
- 2) Hand movements (Corina & Knapp, 2006);
- 3) Hearing and language (Corballis, 2010);
- 4) Body perception and motion (Peelen & Downing, 2007), and;
- 5) Music (Molnar-Szakacs & Overy, 2006).

It is thought by researchers, that there is a genetic and evolutionary basis for the development of these neuron systems, which implies that they evolved from very ancient and primitive learning systems (Heyes, 2010). Mirror Neuron systems are thought to have given primates, such as Homo sapiens, a survival advantage, through tool making and cooperation (Oberman, Pineda, & Ramachandran, 2007).

Mirror neurons are associated with *action based learning* (Rizzolatti & Craighero, 2004). If a person directly observes another person performing some task action, both

brains, in theory, will be seen using an fMRI scan to “activate” in the *same neural region(s)* as if *both* are doing the same task at the same time. This neural activity has been demonstrated in experiments (Buccino, Vogt, Fink, Zilles, Freund, & Rizzolatti, 2004). Mirror neurons facilitate altruistic behaviours between actors, permitting them to behave as one “closed system”. With this insight and considering the new evidence supporting the predictions of the Orch-OR model, it is questioned by this author if qualia “qubit knowledge transfer” may be occurring through mirror neuron system activation, thus leading to *instantaneous quantum knowledge transfer*. It is also questioned if the reciprocal feedback in the flow of information, through mirror neuron activation, can lead to *neural microtubule vibration synchronization* within the neural systems of two or more persons. If this is in fact true, then two or more individuals have become “one mind” through neural synchronization. Linking this mode of biological information transfer closely to quality, variation in the output of a process is controlled through action based reciprocal learning. Therefore, reduction and control of variation, is accomplished by regulatory feedback loops (Meadows D. H., 2008), if two or more individuals can directly see each other’s actions through reciprocal learning, visualized in Figure 4.

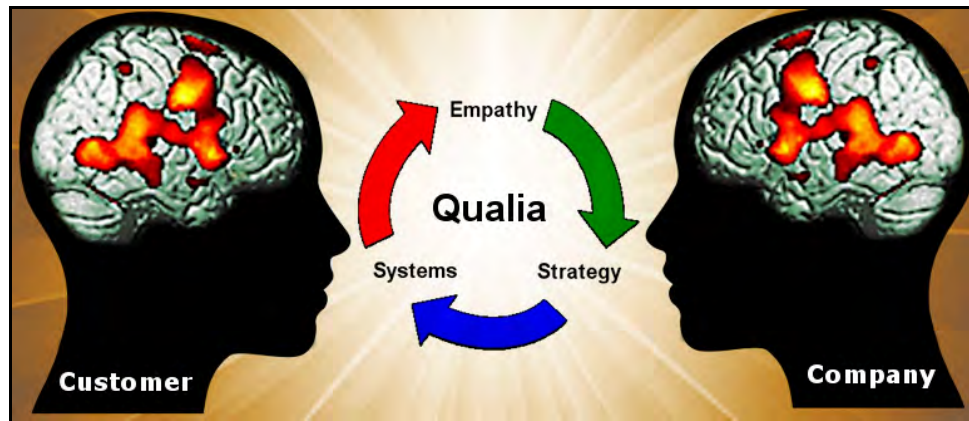


Figure 4: Qualia, Mirror Neuron Activation, Empathy and Action learning

The discovery of mirror neuron systems linked to hand movements has great significance in laboratory medicine, *knowledge transfer* and quality assurance. Control of variation in hand technique, in a laboratory testing process, can then therefore be achieved between two or more technologists hand movements through action based learning (Buccino, Vogt, Fink, Zilles, Freund, & Rizzolatti, 2004). To be completely assured that a laboratory testing procedure is being executed consistently among technologists within a health authority, all employees must *directly see* the technique performed by an expert trainer. Quantum knowledge necessary for analytic quality is then transferred by the trainer to other employees through mirror neuron activation. However, due to differences in mirror neuron systems among employees, several attempts with observation and feedback may be required, to ensure that the appropriate areas of the learners' brains have activated properly in the same neural regions. Therefore, knowledge transfer through hand movements and technique must be monitored closely.

Expounding upon this discussion of mirror neuron systems and hand movements, if one considers a regional health service model involving rural labs, versus a central regional laboratory, two common analytic quality-related issues may come to surface: 1) Precision differences between laboratories in IQC, external testing proficiency and; 2) Bias differences between laboratories in IQC and external testing proficiency. Differences in laboratory external proficiency testing results, when compared against peer groups that are using similar test methodologies, may suggest different cultural norms and practices between laboratories due to mirror neuron systems. However, there is no empirical evidence to support this notion. Rule-bound ISO regulated environments are reasoned to be a countermeasure to offset any differences. Good precision in analytic test quality may suggest that a laboratory has personnel that can work closely together as a team. However, if their results are compared to other groups in different communities, the technologist group may have an analytic test bias, simply because mirror neurons and quantum transfer of qualia as knowledge do not work across large geographic distances. Therefore, quality assurance tools in laboratory medicine provide *neurocognitive supports*, to help leaders and trainers overcome this distance barrier and transfer new knowledge to people within complex systems.

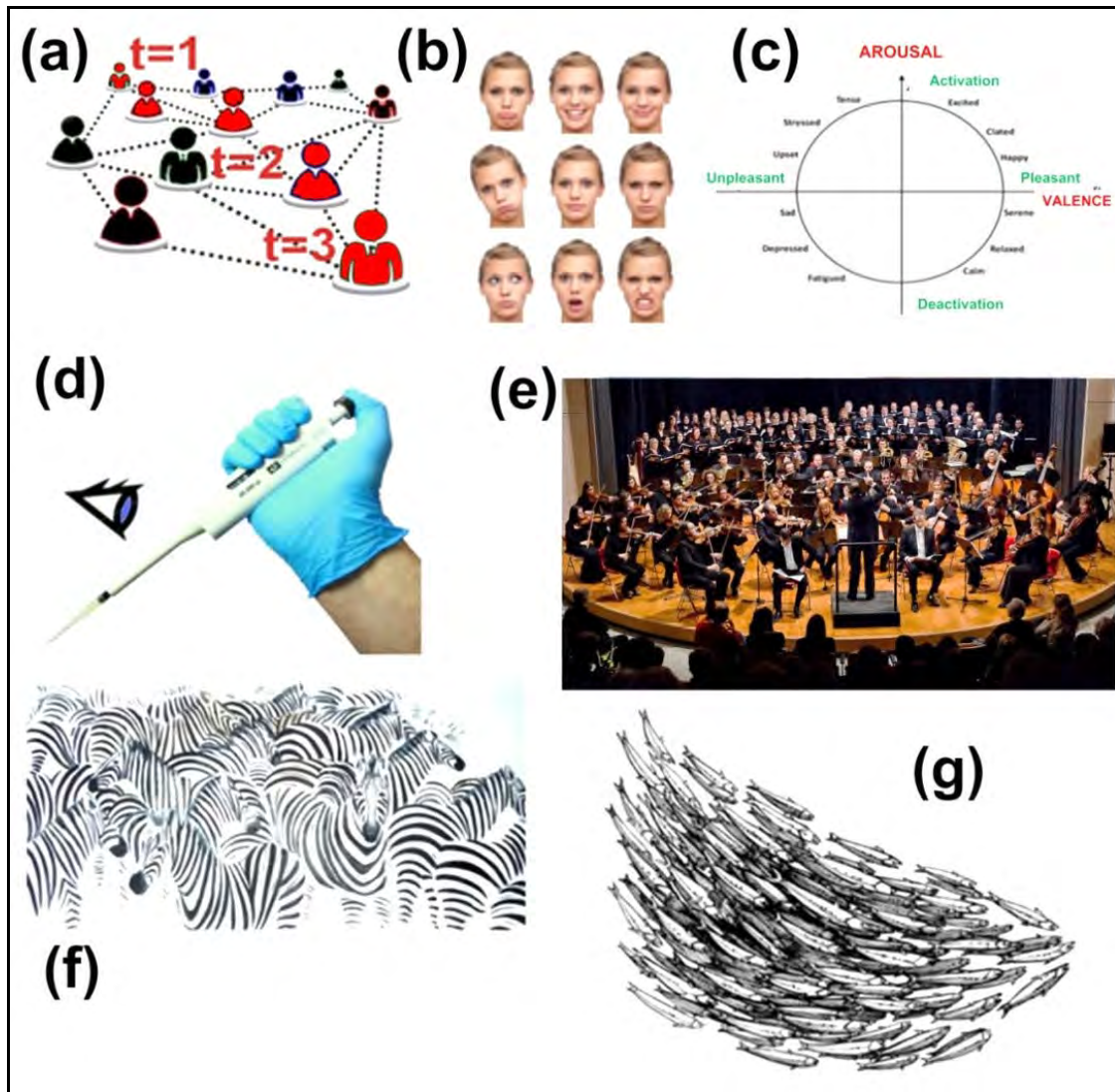


Figure 5: Mirror Neurons, Action Learning and Group Conformity

Mirror neuron systems are thought to have arisen within all vertebrates in nature through evolution (Oberman, Pineda, & Ramachandran, 2007). Mirror Neuron systems provide a fast and effective method for biological systems to remain together as a community, as illustrated by Figure 5. Looking at images in Figure 5, group conformity within the Lewin Social Space (Lewin, 1947) is maintained through effective mirror neuron

systems specialized in social cognition (Figure 5, see images “b” and “c”) and the handling of tools (Figure 5, see images “d” and “e”). Additionally, with this being a system, there is time delay with knowledge transfer (Figure 5, see image “a”), even if the mirror neuron systems are functioning perfectly, which is a characteristic of a closed system (Meadows D. H., 2008). From the perspective of evolutionary defence mechanisms, effective mirror neuron systems permit the group or “herd”, as a biological system to react to danger through panic effect (Heyes, 2010). With effective camouflage, they can use “stripe dazzle” (Figure 5, see image “g”), through their collective movements. This behaviour is a function of mind, to confuse any predators that trying to target and lock in on one individual within the group (Figure 5, see image “f”) (Stevens, Yule, & Ruxton, 2008). Therefore, mirror neuron systems, which have evolved over millions of years, have a mode of *knowledge transfer* within living systems; providing them with the capacity to *self-organize* into *complex structures*, with *hierarchies* (Meadows D. H., 2008, pp. 79-82).

The Triadic Adaptive Learning System: *An Evolutionary Learning System*

Up to this point in the literature review, field theory, social learning theory, Dunbar’s number, qualia and mirror neuron systems, have all been explored and discussed. Using this body of current knowledge and bringing it to a specific focus, a new conceptual model for learning is proposed by this author for Quality Assurance. A neurocognitive cybernetic model called the *Triadic Adaptive Learning System (TALiS)*⁷ is presented by this author as a human-based knowledge system for quality assurance and business excellence. An “infographic” to help the reader understand the model, has been provided by

Figure 6. This conceptual model will be used to produce new knowledge and a new vision for Quality Assurance, using the evidence presented in Results and Discussions section in Chapter 4.

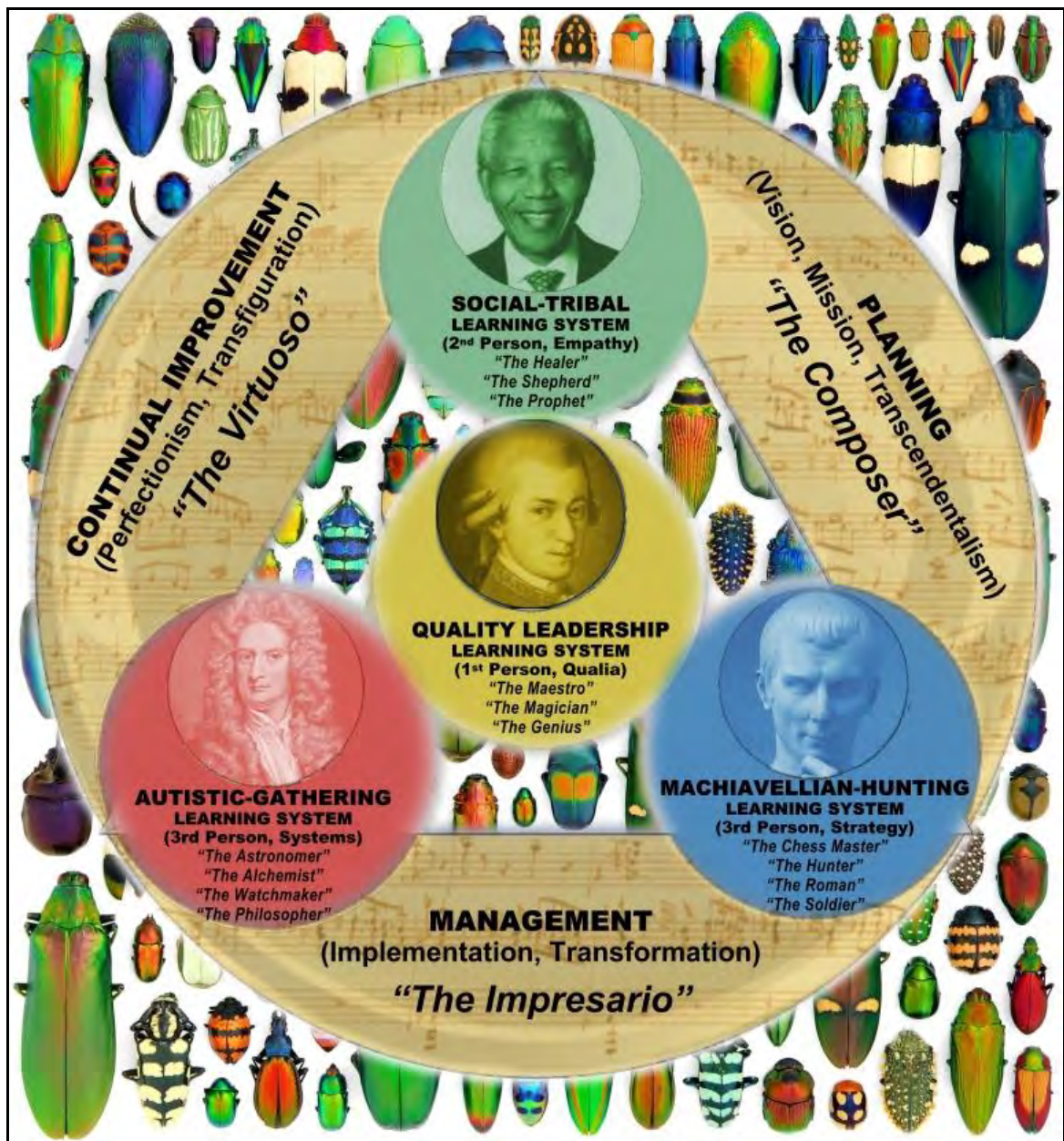


Figure 6: The Triadic Adaptive Learning System – A Human Evolutionary System⁸

All of humanity is recognized and symbolized in the TALiS conceptual model (Figure 6), with distinct personality types, cognitive styles and voices. This model proposes that within the human brain, three major *learning system archetypes* are present, which has led to the ascent of Man as a species. These learning systems are reasoned to have evolved within Homo sapiens, from simple hunter-gather societies in the distant past and today, are still essential for quality assurance in modern civilization. Collectively, the learning systems shape the person's gestalt sphere and their understanding of the world around them. The *personality archetypes* suggested within the triad, which make up the TALiS model, are “windows”, which are reasoned to point to underlying *neural learning system archetypes*, from which all variations are patterned. Therefore, each learning system archetype, as a “neurocognitive lens”, is reasoned by this author to have a distinct mindset which understands different types of knowledge.

The human brain is a conscious, reward seeking learning system. The three learning system archetypes within the TALiS, work together in the brain towards a payout, a reward, or a goal such as a quality objective. They are the foundation of the TALiS. The three learning system archetypes are as follows:

- 1) *The Social-Tribal Learning System (STLS)*;
- 2) *The Autistic-Gathering Learning System (AGLS)*, and;
- 3) *The Machiavellian-Hunting Learning System (MHLS)*.

As learning system archetypes, each neural system has a distinct mindset, with different functions and with them, specific aptitudes and limitations with the transfer of knowledge.

Therefore, variations in the neural systems which make up the archetypes within the TALiS result in characteristic behaviours and personality types.

Each learning system within the TALiS model produces a distinct payout or reward based on their different mindsets. The term “mind blindness” has been described by the psychology community to explain ASDs and other social cognition conditions (Synapse, 2015). However, the term “mind-blindness” may be misleading; meaning different things to different people. Also, there is a difference between *affective empathy* and *cognitive empathy* (Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007). Individuals with AS may not have “mind-blindness”, but may be reasoned instead to have a *type* of “neurocognitive social astigmatism”⁹, when using the TALiS model. As neurocognitive lenses, the triad within the TALiS model is all proposed to have distinct forms of perception, which by their nature, are reasoned to come at a cost of astigmatism. Keeping the model very simple for practical applications in quality assurance, it is proposed that the brain has “three eyes of quality”. Therefore, these neural system archetypes with their astigmatisms shape the customer’s mindset and perception of a product or service. Through qualia transfer, the customer’s experience during consumption thus influences their behaviour.

The *Social-Tribal Learning System* (STLS) is the first neural learning system archetype proposed by this author to exist within the human brain. This learning system thinks in the *second person*, using a narrow “close seeing” cognitive lens, with mirror neurons specialized in the processing of human faces and language. The STLS archetype hears and understands language and can detect the emotional state of another person

through the tone of voice. Using empathy, the learning system's reward is to understand another person's *first-person* emotional state, their point of view and to predict what the person will do within a social group or "tribe". It seeks to understand another person's experience of qualia in a product or service. However, the STLS is proposed to have impairments and limitations. The STLS by its nature as an archetype has a form of neurocognitive astigmatism:

- 1) The learning system only works at *physically close distances*;
- 2) It's effectiveness is limited to the Dunbar's Number in social group size;
- 3) It cannot see or hear the collective background sound and motions of the tribe;
- 4) It cannot see or hear *beyond the social boundary* of the tribe;
- 5) The learning system cannot see hands or silhouette, and;
- 6) The learning system can only detect qualia experienced by another person.

A person with an effective empathy system is reasoned by this author to have an ability to penetrate into the *centre* of the "tribe" and can overcome the "social cognitive stripe dazzle" of the collective social transactions occurring within the group. By doing so, the STLS can focus specifically on the needs of another individual and deliver quality service and care. These social transactions help shape the customer's perception in a manner, that the customer then perceives oneself to be "special" and positioned at the *centre of the group*. Therefore, these needs or wants can be reciprocal because mirror neurons provide a feedback loop of information and thus giving the healthcare employee satisfaction.

The STLS learning archetype seeks a reward of belonging, protection from outside forces and care within the tribe. For the TALiS model, empathy is reasoned to be a *type* of systemizing. Empathy provides social feedback loops, which permits the group to establish a *social hierarchy*. However, the STLS archetype and its behaviour are reasoned to be directly related to the *Selfish Herd Theory* (Hamilton, 1971). Transactions occurring between two individuals may not benefit the tribe. Their actions may, in fact, may go against the goals of the tribe and the larger organizational goals spanning multiple tribes. From an evolutionary perspective, empathy is related to deception and manipulation of others (Smith, 2006). Empathy is associated with *favoritism* (Harris, Herrmann, & Kontoleon, 2009), *nepotism* (Decety & Cowell, 2014) and in its darker form, *racial bias* (Forgianini, Gallucci, & Maravita, 2011). Empathy is also related to Authoritarianism, prejudice and social dominance (Backstrom & Bjorklund, 2007). Therefore, empathy can be counterproductive and lead to undesirable outcomes within an organization and its quality goals.

Empathy is a very complex topic in psychology, ethics, philosophy and group dynamics (Decety & Cowell, 2014). Also, it appears that *cognitive empathy*, *affective empathy* and how they are related to *Theory of Mind*, are not fully understood or entirely agreed upon by psychology researchers (Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007). However, it is reasoned that there is a relationship between social cognition and Machiavellianism based on the TALiS model. Empathy and Machiavellianism are two different types of *social learning systems*. Keeping the model simple for quality assurance, Machiavellianism is reasoned to offset tribal behaviour as an “opposing social force”,

bringing all employees to a common goal. Therefore, there is a relationship between social cognition and Machiavellianism within system dynamics that apply to knowledge transfer, change management and quality assurance.

The *Autistic-Gathering Learning System* (AGLS) is the second neural system archetype proposed by this author. This learning system is reasoned to think in the *third person*, using a narrow “close seeing” cognitive lens with mirror neurons specialized in the processing of hands, hand motion and gestures. The AGLS sees colours, small details and patterns. It is limited to vision, taste, touch and smell to detect qualia at *close distances*. To be clear to the reader, this author proposes that “taste”, “touch” and “smell” are different types of “close seeing”. It is reasoned that there are two types of neural learning networks within the AGLS: 1) A tool or product assembling learning system and; 2) A harvesting-measurement learning system. Through close seeing, tasting, touch and smell, the AGLS assesses an object for quality. Inspection, sampling, and measurement provide feedback information (“qualia” or “qubits”) as new knowledge within this learning system. Through organizing, counting, careful *hand technique* and timing, the inputs are brought into a sequence called a “process”, which leads to a “final product”. Through learning the system in the external environment (functional holon) is then “closed”, using feedback loops to regulate and control the inputs. A set of feedback loops is proposed by this author to flow between the two learning systems (inspection and control). Therefore, the payout is the *reduction of variation*, through *inspection* and *control* of a *process* within a *functional holarchy*, thus leading to *consistency* in the *output* of a final product.

The AGLS as an archetype has limitations like the STLS. As it is with the Social-Tribal Learning System, the AGLS as an archetype has a form of neurocognitive astigmatism:

- 1) It only sees hands; not human faces, the individual, or silhouette;
- 2) It can only see small targets and details *within* the social-functional holarchy;
- 3) It cannot see large targets or “the big picture” outside the social-functional holarchy;
- 4) It does not hear language, but can detect *harmonics* in sounds;
- 5) It understands numbers, symbols and letters, and;
- 6) Being cautious, it seeks safety in what is reproducible, consistent and predictable.

A person with an effective AGLS reasons with logic and seeks the truth through tangible empirical evidence, scientific and engineering reasoning. Therefore, an Autistic behaviour may be better described as “closed-systemizing”, through the lens of system dynamics.

The *Machiavellian-Hunting Learning System* (MHLS) is the third and last neural system archetype proposed within the TALiS model. This system thinks in the *third person*, using a wide “distant seeing” cognitive lens, with mirror neuron systems specialized in silhouette and motion detection. It hears only the collective voice of the tribe(s). The MHLS observes and maneuvers from a vantage point *outside* of the boundary line of the social space of a tribe (social-functional holarchy). This social learning is reasoned to occur within the *common space of the organization*. As a type of social learning system, the MHLS is effective at mimicking the *collective* motions and sounds within the common

space of the organization, better described as “organizational citizenship behaviour”

(Dietvorst, 2010). The MHLS by its behaviour:

- 1) Seeks to find entry and leverage points within social systems using “moments of truth” to make changes and produce bigger payouts;
- 2) Assesses risk, urgency and danger between a system and its external environment;
- 3) Does not see system parts as small pieces, but as “chunks” or *functional holarchies*, similar to playing chess or poker (Charness, Reingold, Pomplun, & Stampe, 2001);
- 4) Can detect *loopholes* as “shadows” within complex systems. It also sees rules and regulations as “trees”, “fences” and “gates” within complex systems, and;
- 5) Does not need to spread *misinformation* to gain leverage within a system and reach a payout. It *shares* or *withholds* knowledge if it is *prudent* and *objective* to do so.

The MHLS seeks to make changes in the functional structure within an organization through coalition forming and breaking. The MHLS’s reward is to bring the tribes together, through altruistic behaviour, to a common objective.

The MHLS as an archetype sees people and social groups as *objects*. This author is mindful, that the vantage point presented to the reader, is an unflattering view of Man as a species. However, to clearly illustrate the mindset of the MHLS to the reader, it is to be considered in the context of big business, large-scale healthcare systems and supplier chains. The evolutionary connections between hunting behaviour, herdsmanism, warfare and Machiavellianism can be expounded upon by proposing the “Rules of Herds” in quality assurance. These heuristics are reasoned to support Hamilton’s *Selfish Herd Theory* from a

distinct vantage point (Hamilton, 1971). It is thought that these rules can be verified by future studies investigating Machiavellianism using fMRI technology:

- a) If the *silhouette* of the *herd* is observed moving in a common direction over time, the group is behaving like a *system*. The herd is *organized* and *reward* seeking;
- b) If the *motions* and *sounds* within the silhouette of the herd are *periodic*, the group is behaving like a *closed* system;
- c) If the silhouette of the herd moves at a *constant speed* and in a common direction, with periodic motions observed to be at a *constant rate of speed* (neither *accelerating* or *decelerating*), the system is in *dynamic equilibrium* and *control*;
- d) Agents who walk with the herd, make motions and sounds like the herd, are *invisible* within the silhouette of the herd;
- e) An agent's *footprints* (not *handprints*), which are *different* than the herd, will be detected. Their *intentions* and *future actions* are better predicted over time, which does not follow a *defined sequence* of steps within a *process flow*;
- f) Motions and sounds within the common direction and collective sounds of the herd, point to *functional holarchies*, not *social hierarchies*;
- g) *Motion dazzle* observed within the silhouette of the herd, is a *motion cue*, which points to *entanglement* in process flows and *functional silos* within the *supplier-service chain*;
- h) If a *fire* breaks out, the herd will *panic*. Motion dazzle will be visible, with the risk of *stampede*. The system will open, with *runaway escalation*, and;
- i) If the *same type* of fire repeats itself, motion dazzle will not be seen, since the herd is a *learning system*. The herd will *evolve* into a different *cultural archetype*.

The silhouette of an army in parade, with “all eyes forward” and “quick marching” in perfect cadence, much like an arrow towards an objective, is an optimized social system that is in a state of dynamic equilibrium. Through *operational definitions* (Deming, 2013, p. 65), a business can better optimize its internal processes and align them with its greater aim (Deming, 2013, p. 58). Operational definitions permit businesses to leverage the strength of the MHLS into optimized *functional holons* and *supplier-service chains*, seen in Figure 7.



Figure 7: "The Canadians Arrive" - *The Devil's Brigade* (Adleman, 1968)

This author questions if the “Rules of Herds” heuristics proposed for cybernetics and system dynamics, could lead to new quality assurance practices¹⁰. Industries which could benefit from this insight, may apply to:

- 1) Supplier-service chain quality methodologies;¹¹
- 2) Patient workload or case management practices;¹²
- 3) Stock market behaviour;
- 4) Monitoring of regulated industries, such as banking;
- 5) Behaviours of competing industries and customer markets;
- 6) Evolutionary robotics with improvements to autonomous robot design, and;
- 7) Anti-terrorism surveillance technologies for public areas with high social traffic.

The MHLS archetype, supported by the “Rules of Herds” is reasoned by this author to be a type of *social-functional* learning system. However, the MHLS as an archetype also has a type of neurocognitive astigmatism, like the STLS and the AGLS. Through “distant seeing”, the MHLS only sees the silhouette of the system. This includes employees as *functional groupings* and the customer as a *market*. The MHLS is blind to social-hierarchies. It can only see functional-holarchies from its vantage point *outside* the social space, whereas the STLS from its vantage point in a “tree” (hierarchy) can better see the “power constellation” *within* the herd’s social space. The MHLS can only see a process as it flows within the work environment *from a distance*. Therefore, the MHLS by its behaviour and third person mindset may be better described as “open-systemizing”;

targeting loopholes, flows and functional holons within systems, when compared to the AGLS through the lens of system dynamics.

Machiavellian and Autistic behaviour, as two driving forces facilitating organizational change, are reasoned by this author to exist within the TALiS model. Both mindsets work together like two neurocognitive “pistons” within the “quality system engine” to produce change within complex systems. As dynamic learning systems, these changes improve process flows and lead to ever larger payouts. The Machiavellian mindset might view Autistic behaviour as “chasing one’s tail”, as well as being over preoccupied with details. Also, a High-Mach might think that the Autistic personality type is overly cautious and having tunnel vision. However, the cognitive strength and gift of the Autistic’s mindset in relation to the Machiavellian, is its sharp focus and high attention to details. Therefore, Autistic behaviour and actions results in tight controls to minimize variation within a process.

The Autistic’s opinion of the Machiavellian mindset would be quite different, especially through the lens of physics. Albert Einstein is famous for his quote in the *Born-Einstein Letters*¹³, regarding *quantum entanglement*, in his letter dated March 3rd, 1947 to Max Born. Einstein stated, “I cannot seriously believe in quantum theory because it cannot be reconciled with the idea that physics should represent a reality in time and space, free from spooky action at a distance” (Einstein, Born, & Born, 1971, p. 158). Einstein did not believe that two particles, separated by large distances, could have an influence on one another, otherwise known as “quantum entanglement”. He was found later to be wrong. It

is imagined by this author, that if Einstein were alive today, might offer words of advice regarding differences in cognitive styles and perceptiveness between people, if the TALiS and Orch-OR models are considered.

It is imagined that Einstein might advise the reader, that the movements of the Machiavellian could be perceived as “spooky actions at a distance” by an Autistic personality type, due to the Machiavellian’s relative vantage point *outside* the Lewin social space. These behaviours might lead an Autistic to believe, that a High-Mach’s possible motivation is to avoid “entanglements”. However, it is also possible that the Autistic might be lacking in *mindfulness*; not realizing it is detecting its *own shadow* in the distance, in the way *it sees other people*. An Autistic could also have a Machiavellian mindset at the same time. As a consequence, cultural obstacles to learning might arise within a group, due to the fact that when thinking in the third-person, the various *cognitive styles* of the team members can be very different. Also, the differences in the actors’ relative *vantage points* and their *perception of time* can be very different. Empathy, through second-person thinking, brings all mindsets together and facilitates understanding within the group.

Einstein however, might go one step further. Einstein might add that Machiavellian perception, from their third-person, vantage point, can also be reasoned to be a *type* of “spooky watching at a distance” as well. Looking at big-business, banking and other financial industries, actors within the hierarchy, who undermine quality goals of the organization through their own personal interests and privileged access to knowledge, need to be mindful that they are not entirely invisible. Detection and prediction of the future

movements of an agent, through effective monitoring controls of *procedures* (“Rules of Hands”, AGLS) and *processes* (“Rules of Feet”, MHLS) does not require *cognitive* or *affective empathy* (“Rules of Faces”, STLS). Therefore, it is then questioned if there are possible weaknesses with the *Theory of Mind*, if the TALiS and Orch-OR models are used and where they relate to Autism and Machiavellianism (Meltzoff, 1999).

Two or more actors in an organization, separated by large distances, can produce undesirable system archetypes, all the while, undermining quality goals within a closed system. Using the “lens of Einstein and Born”, *the behaviours of actors and the consequences of their actions, are not diminished by physical distances within closed systems.* The actions of all actors are interdependent, which through feedback controls, is a fundamental requirement to keep a system closed and in a state of *dynamic equilibrium*. As an extension of the TALiS, a quality system’s effectiveness at delivering quality is only as good as the actors’ understanding and respect of this knowledge. It is in this light, that wisdom of Dr. Deming can be better appreciated. Deming stated that a system “cannot understand itself” (Deming, 2013, p. 61). Quality Systems require *people to cooperate and share knowledge* to reach a goal.

It can also be reasoned that Quality systems are engineered to clear information entanglement, orchestrating flows of codified knowledge as qubits which are synchronized between actors, like programmable *automata* within a *clockwork system*. This knowledge transfer is accomplished through the use of rules and defined sequences within processes. Quality systems, being human-based knowledge systems, are not perfect. The “Voice of

Einstein and Born” is a quality warning. If the knowledge, processes and rules are not understood, respected and followed by the actors, a “panic within the herds” can arise, which can throw the system out of a state of dynamic equilibrium. To better illustrate the risks of information entanglement, panic and escalation, the *2007-2008 Global Financial Crisis* is a glaring example and warning (Helleiner, 2011). Dr. Donella Meadows dubbed this systems rule as the “eleventh commandment”, stating “thou shalt not distort, delay, or withhold information” and warned that actors can “drive a system crazy” by “muddying its information streams” (Meadows D. H., 2008, p. 173). Therefore, quality systems can overcome the physical distances between businesses and can clear information entanglement, if the employees appreciate and respect the value of knowledge.

The Quality Leadership Learning System

The Orchestrated Objective Reduction model, developed by Sir Roger Penrose and anesthesiologist Dr. Stuart Hameroff, to explain the biology of human consciousness, is stirring. The latest evidence that supports the Orch-OR model expands the human imagination and has profound implications within quality assurance. Dr. Penrose’s and Dr. Hameroff’s research seeks to find scientific evidence of human consciousness and evidence that all biological systems, which make up Earth’s biosphere, are part of a greater cosmological quantum consciousness. In this light, human consciousness and the subjective experience of qualia are reasoned by this author to be both shaped and constrained by the limitations of the three neural learning system archetypes which make up the TALiS. For ease of use within Quality Assurance, it is reasoned by this author that the TALiS can be

symbolized as the “Pharos of Quality”, whereas the Orch-OR model can be symbolized as the “candle” or “flame” of the person’s consciousness or spirit within the TALiS.

Therefore, these models can represent a lantern or beacon, to symbolize the collective consciousness of employees and their customer market as a *community*, when working together towards a higher goal.

The Orch-OR and TALiS models are reasoned by this author to provide important links between the: 1) empirical, rational mindset; 2) intuitive, imaginative thinking, and; 3) subjective human experience. These “dimensions of mind” suggest that quality leaders may have a greater importance within the organizations and the communities served. Human needs such as *hope* and *optimism* are important with respect to employee morale during periods of operational hardship, uncertainty and change. It is reasoned by this author, that Quality leaders are in a sense, *knowledge* and *spiritual* leaders. As “shepherds”, quality leaders could use a spiritual, holistic and ethical approach within quality assurance like a “magician” or a “shaman”, with the capacity to reach within the organization and facilitate social change. It is in this light, that quality leaders require *talismans*: quality systems, tools, methodologies and standards, to lift and transform organizations into a greater level of consciousness. Quality systems are reasoned to be extensions of the Orch-OR and TALiS models, which use information frameworks, tools, methodologies and standards to capture, codify and share knowledge. This knowledge results in product-service satisfaction for the customer. This altruistic behaviour, results in customer loyalty within the community. Therefore, it is reasoned by this author that quality assurance strongly supports a growing discipline called *Organizational Neuroscience* (Becker & Crepanzano, 2010).

It is thought by this author, that quality leaders should have an intrinsic dimension of *charisma*, possessing a special social talent to bring people together as a community. Using imagination and transcendental thinking, the quality leader can shape and project “the dream”, in order for the organization to understand its purpose as a community. This is accomplished by the use of a “talisman” called the *vision statement*. The vision statement plays an important role by shifting and projecting a cognitive lens to energize and expand the gestalt sphere of the organization into a higher state of mindfulness. This is accomplished through the careful use of language (Meadows D. H., 2008, p. 174). Transcendental thinking is the first step towards establishing a new purpose within the organizational community, leading to solidarity. Through collective engagement of all minds to the “cause” and fully understanding their identity and purpose, the organization can begin the process of transformation as a learning system. Through learning, discovery leads to *revelation*, resulting in a cultural transfiguration. Therefore, it is through revelation that the organization as a community evolves into a new cultural archetype.

The vision statement is closely linked with the *beliefs statement* and *values statement*. All three quality tools are “talismans” which bind the organization and its employees as a community. The vision, beliefs and values statements are linked to organization’s identity, purpose and the employees’ relationship with their customers as a community. As a *lodestar*, a consistent theme with all three statements should be the “goal of goodness”. Quality Assurance is reasoned by this author to support the philosophy, science and ethics of *Integral Permaculture* (Figure 8).

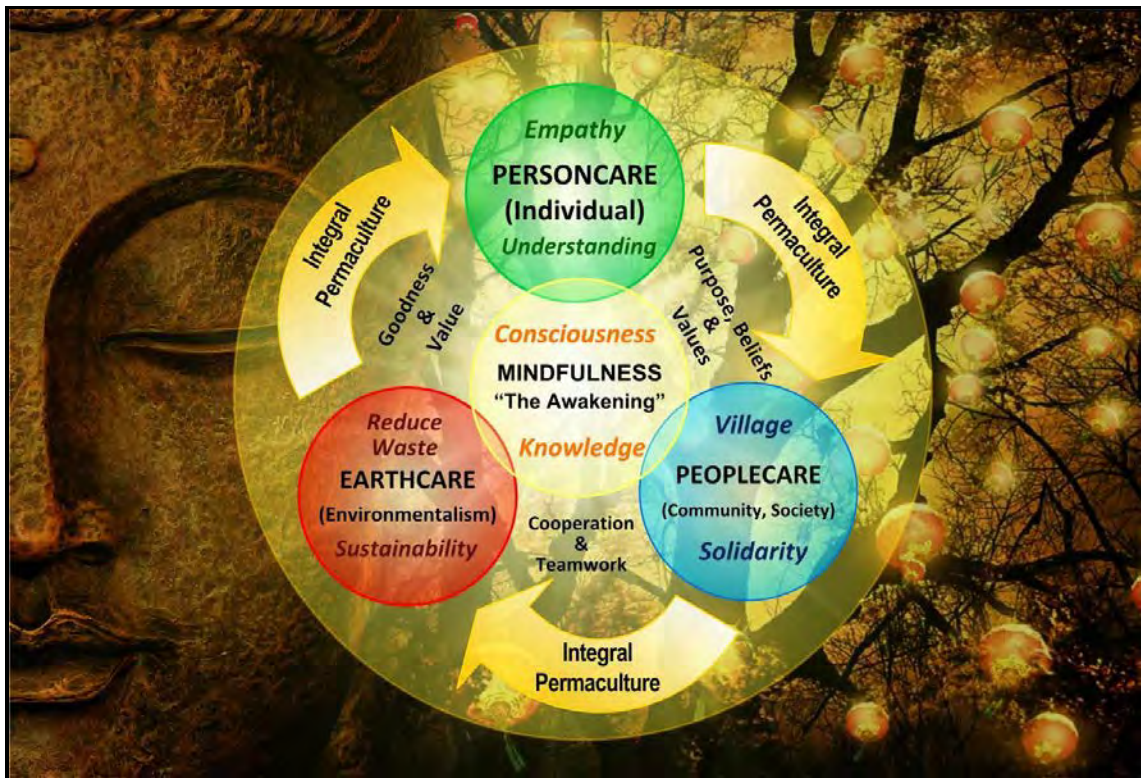


Figure 8: “The Dream” – TALiS, Integral Permaculture and the *Vision of Goodness*

Quality Assurance tools, frameworks, methodologies and standards, provide the means for organizations to nurture and expand the “culture of goodness”, through empathy, learning and mindfulness. Integral Permaculture can be applied within medical laboratory environments and integrated within current quality programs. In this light, four published guidelines by the *Clinical and Laboratory Standards Institute* will be examined. This critique will use the evidence and models presented in the literature review, the research findings and the wisdom and spirit of Dr. Donella Meadows, the Mother of Integral Permaculture.

CHAPTER 3

METHODOLOGY

Design of the Investigation

This exploratory cross-sectional study of the medical laboratory workforce utilized a descriptive correlative design. This study involved the collection of data using four psychometric questionnaires to determine cultural characteristics of the medical laboratory workforce. These four instruments are the:

- 1) *Autistic Quotient (AQ) Questionnaire* (Baron-Cohen, Wheelwright, Skinner, Martin, & Clubley, 2001);
- 2) *Empathy Quotient (EQ) Questionnaire* (Lawrence, Shaw, Baker, Baron-Cohen, & David, 2004);
- 3) *Systemizing Quotient-Revised (SQ-R) Questionnaire* (Wheelwright, et al., 2006), and;
- 4) *The Machiavellian Personality (Mach-IV) Questionnaire* (Christie & Geis, 1970).

The participants for this study were recruited online. The questionnaires were administered with the use of an internet survey tool (Qualtrics, LLC, 2015). In addition to the information gathered in the questionnaires, demographic data was collected from the participants.

The three-fold purpose of this study is to:

- a) Detect the presence of Autism spectrum disorders (ASDs) and Machiavellianism;
- b) Define the cultural characteristics within this occupational group based on the four psychometric instruments, and;
- c) Determine if there are relationships between psychometric scores and facility/laboratory size within a regional health service governance model.

All participants in this study were anonymous and completed the electronic consent form.

The participants were recruited through advertisements posted on the SSMLT website (SSMLT, 2015) and the fall 2014 *CMLTM Newsletter* (CMLTM, 2014).

Ethical Approval

Ethical approval was obtained from the Institutional Review Board at California State University, Dominguez Hills (See Appendix E). This author was required to complete the *National Institutes of Health*, Web-based course called “Protecting Human Research Participants” (see the certificate of completion in Appendix F). The participants in this study gave consent electronically through the Qualtrics website by entering a Captcha™ Code (See Appendix G) embedded within the Qualtrics online survey tool (Qualtrics, LLC, 2015). They were given the opportunity to read the terms and conditions of the survey, the disclaimer and how their data was to be used for this thesis.

Sample

Data from a total of 32 participants was obtained. There were 7 Males and 25 females, with an age range of 23 to 62 who completed the online questionnaire. Data was collected from the participants in the provinces of Manitoba and Saskatchewan. Data Analysis was completed using SPSS statistical software. Due to the small male population in the sample and to protect participant confidentiality, the data was aggregated in some instances, for further analysis.

Treatment

For this workforce study, demographics such as; age, gender, community and laboratory size were collected along with the questionnaire scores. This information was gathered to determine if there were any relationships between the test scores and:

- 1) population patterns within regional health service models;
- 2) Bring to surface opportunities for improvement within the quality systems in place, and;
- 3) Better understand the social dynamics within the workforce.

In some instances, data was aggregated to determine these relationships due to limited sample size and to protect participant confidentiality.

CHAPTER 4

RESULTS AND DISCUSSION

Results Tables

Table 4: Frequency Counts for Selected Variables (n=32)

Variable	Category	<i>n</i>	%
Sex	Male	7	21.9
	Female	25	78.1
Age ^a	23-31	8	25.0
	32-47	9	28.1
	48-56	9	28.2
	57-62	6	18.7

^a Age: $M = 44.16$, $SD = 12.55$.

Table 4 *Continued*

Table 4 *Continued*

Variable	Category	<i>n</i>	%
Size community live in ^b	Under 2,000	12	37.5
	2,001-5,000	7	21.9
	5,001-10,000	2	6.3
	10,001-25,000	3	9.4
	25,001-50,000	1	3.1
	50,001-100,000	2	6.3
	100,001+	5	15.6
Size community employed ^c	Under 2,000	11	34.4
	2,001-5,000	9	28.1
	5,001-10,000	2	6.3
	10,001-25,000	2	6.3
	25,001-50,000	1	3.1
	50,001-100,000	2	6.3
	100,001+	5	15.6

^b Size of Living Community: *Mdn* = 3,500.

^c Size of Employed Community: *Mdn* = 3,500.

Table 4 *Continued*

Table 4 *Continued*

Variable	Category	<i>n</i>	%
Laboratory size ^d	1-10	22	68.8
	11-20	3	9.4
	21-30	1	3.1
	51-60	2	6.3
	61-70	1	3.1
	71-80	1	3.1
	101+	2	6.3
Unionized	Yes	28	87.5
	No	4	12.5

^d Laboratory Size: *Mdn* = 5.50.

Table 4 *Continued*

Table 4 *Continued*

Variable	Category	<i>n</i>	%
Years in profession ^e	1-4	8	25.0
	5-18	8	50.0
	19-28	8	75.0
	29-41	8	100.0
Years with current employer ^f	1-3	8	25.0
	4-10	8	50.0
	11-26	8	75.0
	27-40	8	100.0
Number of employers over career ^g	1	9	28.1
	2	10	31.4
	3-5	9	28.1
	6-9	4	12.4

^e $M = 19.17$, $SD = 13.14$.

^f $M = 14.41$, $SD = 12.50$.

^g $M = 2.88$, $SD = 2.14$.

Table 5: Psychometric Characteristics for the Aggregated Scale Scores (n=32)

Score	Number of Items	M	SD	Low	High	α
Autistic Quotient	50	22.59	9.38	10.00	48.00	.90
Systemizing Quotient	75	67.88	24.51	26.00	134.00	.94
Empathy Quotient	40	39.03	13.34	8.00	69.00	.91
Machiavellianism	20	59.25	5.27	44.00	69.00	.26

Table 6: Frequency Counts for Criteria Variables (n=32)

Variable	Category	n	%
Autistic Quotient Criteria	No	15	46.9
	Yes	17	53.1
Systemizing Quotient Criteria	No	29	90.6
	Yes	3	9.4
Empathy Quotient Criteria	No	25	78.1
	Yes	7	21.9
Machiavellianism Criteria	No	17	53.1
	Yes	15	46.9
Total Criteria Met ^a	0	8	25.0
	1	11	34.4
	2	9	28.1
	3 - 4	4	12.5

^a Criteria Met: $M = 1.31$, $SD = 1.06$.

Table 7: Spearman Intercorrelations among the Aggregated Scale Scores (n=32)

SCORE	1	2	3	4
1. Autistic Quotient	1.00			
2. Empathy Quotient	-.59 *****	1.00		
3. Systemizing Quotient	.49 *****	-.24	1.00	
4. Machiavellianism	.28	-.22	0.08	1.00

* $p < .10$. ** $p < .05$. *** $p < .01$. ***** $p < .005$. ***** $p < .001$.

Table 8: Spearman Correlations for Selected Variables with AQ and EQ Scales (n=32)

Variable	Autism Quotient (AQ)	Empathy Quotient (EQ)
Sex ^a	-.09	.31*
Age	-.10	.10
Size community live in	.05	-.09
Size community employed	.21	-.13
Laboratory size	.25	-.11
Unionized ^b	.13	-.23
Years in profession	-.11	.10
Years with current employer	-.16	.13
Number of employers over career	-.15	.28

* $p < .10$. ** $p < .05$. *** $p < .01$. ***** $p < .005$. ***** $p < .001$.

^a Sex: 1 = *Male*, 2 = *Female*.

^b Unionized: 1 = *Yes*, 2 = *No*.

Table 9: Spearman Correlations for Selected Variables with SQ and Mach-IV (n=32)

Variable	Systemizing Quotient (SQ-R)	Machiavellianism (Mach-IV)
Sex ^a	-.35 **	.20
Age	-.25	-.06
Size community live in	.28	.02
Size community employed	.37 **	.27
Laboratory size	.34 *	.25
Unionized ^b	.51 ****	.10
Years in profession	-.15	-.01
Years with current employer	-.24	.03
Number of employers over career	.18	-.31 *

* $p < .10$. ** $p < .05$. *** $p < .01$. **** $p < .005$. ***** $p < .001$.

^a Sex: 1 = *Male*, 2 = *Female*.

^b Unionized: 1 = *Yes*, 2 = *No*.

Results Discussion

This study used an online survey questionnaire to detect the prevalence of high-functioning Autism and Machiavellianism in the medical laboratory industry. The three-fold purpose of this study was to determine if: (a) Autism spectrum disorders (ASDs) are prevalent; (b) Machiavellianism is present; and (c) Determine the cultural characteristics within this occupational group. Data from 32 respondents were used for this study.

Table 4 displays the frequency counts for selected variables. There were three times as more females in the sample (78.1%), than males (21.9%). The ages of the respondents ranged from 23 to 62 ($M = 44.16$, $SD = 12.55$). The population size of the communities where the respondents *lived* at the time of the survey, ranged from “under 2,000 (37.5%)” to “100,001+ (15.6%)”, with the median sized community being 3,500. The size of the communities where the respondents were *employed*, ranged from “under 2,000 (34.4%)” to “100,001+ (15.6%)”, with the median sized community being 3,500. Two-thirds of the respondents at the time of this survey (68.8%) were employed in labs with 1 to 10 technologists. Almost all of the respondents (87.5%) were unionized employees. The number years of professional activity reported by the respondents, ranged from 1 to 41 years ($M = 19.17$, $SD = 13.14$) and the number of years of employment for their current employer ranged from 1 to 40 years ($M = 14.41$, $SD = 12.50$). The number of employees that the respondents worked in their career ranged from 1 to 9 ($M = 2.88$, $SD = 2.14$) (see Table 4).

Table 5 displays the psychometric characteristics for the four aggregated scale scores. Three of the four scales had acceptable levels of internal reliability ($\alpha > .70$), while the Machiavellianism scale had poor internal reliability ($\alpha = .26$) (Saris & Gallhofer, 2007) (see Table 5).

Table 6 displays the frequency counts for the four criteria variables. The most prevalent criteria met in the sample were autistic quotient (53.1%) and Machiavellianism (46.9%). The total number of criteria met by each respondent ranged from 0 to 4 ($M = 1.31$, $SD = 1.06$) (see Table 6).

Table 7 displays the Spearman rank-ordered intercorrelations for the four primary scale scores. The alpha level for this analysis was set at $p < .10$, due to the sample size ($N = 32$). Two of the six correlations were significant at the $p < .10$ level. Specifically, the autistic quotient was shown to be negatively related to the empathy quotient ($r_s = -.59$, $p < .001$) and to be positively related to the systemizing quotient ($r_s = .49$, $p < .005$) (see Table 7).

Table 8 displays the Spearman correlations between nine demographic variables and the respondent's autism and empathy quotient scores. For the resulting 18 correlations, one was significant at the $p < .10$ level. Specifically, the female respondents had higher empathy quotient scores ($r_s = .31$, $p < .10$), in relation to males (see Table 8).

Table 9 displays the Spearman correlations between nine demographic variables and the respondent's systemizing quotient and Machiavellianism scores. For the resulting 18 correlations, there were five correlations were significant at the $p < .10$ level.

Specifically, systemizing quotient scores were higher for:

- (a) Respondents who were male ($r_s = -.35, p < .05$);
- (b) Respondents who worked in larger communities ($r_s = .37, p < .05$);
- (c) Respondents who worked in larger labs ($r_s = .34, p < .10$), and;
- (d) Respondents who were not employed as unionized employees ($r_s = .51, p < .005$).

In addition, Machiavellianism scores were higher for those respondents who had fewer employers in their career ($r_s = -.31, p < .10$) (see Table 9).

In summary, the data that was collected in this study in this study from the 32 respondents was used to detect the prevalence of high-functioning Autism and Machiavellianism in the medical laboratory industry. These findings in this study will be compared to population normative values, academic groups by discipline and the nursing population, from which conclusions and implications will be drawn and a series of recommendations will be suggested.

Medical Laboratory Workforce Psychometric Results and Literature Sources

The survey results from the AQ, SQ-R and EQ questionnaires and the mean scores of the medical laboratory workforce were then compared against collated data from several published studies. There were two questions that were addressed, those being: 1) the medical laboratory workforce mean values, compared to normal population means, and; 2) the medical laboratory workforce means, in relation to academic or other occupational groups. The published results of the “normal control” group (Baron-Cohen, et al., 2014) are shown in Table 10. The medical laboratory workforce scored higher on the Autistic Quotient and lower on the Empathy Quotient questionnaires, in comparison to the population normative values. The Empathy Quotient mean value of the medical laboratory workforce population, when compared to the nursing workforce is significantly lower.

Mentioned earlier in this thesis, the empathy quotient is limited. The EQ questionnaire cannot distinguish between *cognitive empathy* and *affective empathy*; therefore, the values need to be treated with careful scrutiny. The Systemizing Quotient is significantly higher when compared to the normal control values. Looking closer at the data, it appears as that the medical laboratory workforce characteristics, based on the three questionnaires, is most in agreement with the published figures of students in the “physical sciences” (Baron-Cohen, et al., 2014). The physical sciences group, studied by researchers at Cambridge University, included participants from disciplines such as: mathematics, physics, chemistry, computer science, geology, engineering, astronomy and astrophysics

(Baron-Cohen, et al., 2014). This statistical evidence is not surprising, considering the high degree of complex technology, which is used in medical laboratories today.

Table 10: Medical Laboratory Workforce versus Normal, ASD and Occupational Groups

GROUP		AQ			EQ			SQ-R			Reference Source
		n	M	SD	n	M	SD	n	M	SD	
NORMAL CONTROL	F	2562	17.1	7.6	2376	48.5	13.7	2261	55.1	21.1	(Baron-Cohen, et al., 2014)
	M	1344	20.3	7.8	1253	38	13.7	1197	68.1	21.6	
AS/HFA	F	454	32.9	11.5	419	26.4	17.2	397	71.7	25.7	
	M	357	34.8	9.1	307	20.4	12.4	295	78.4	24.3	
Physical Science	F	159	18	5.7	159	44.7	11.3	159	59.9	19.4	(Wheelwright, et al., 2006)
	M	294	19.4	6.4	294	35.9	11	294	65.4	17.5	
Biological Science	F	290	15.6	5.8	290	48.5	11.4	290	52	19.2	
	M	125	16.7	5.8	125	41.6	11.5	125	62	17.8	
Social Science	F	181	15	5.1	181	48.7	10.8	181	51.2	19.7	
	M	115	16.2	5	115	41.4	11	115	61.9	18.8	
Humanities	F	408	14.6	5.3	408	48.7	11.2	408	48.4	17.9	
	M	189	15.7	6	189	40.5	11.7	189	53.7	20.6	
Nursing	F	na	na	na	336	51.9	na	336	57.2	na	(Penprase, Oakley, Ternes, & Driscoll)
	M	na	na	na	54	45.2	na	54	65.1	na	
Med Lab Workforce	M & F	32	22.6	9.4	32	39	13.3	32	67.8	24.5	2014-2015 Study (Thesis)

The medical laboratory workforce Mach-IV mean was then compared with collated data from several published literature sources of other groups, shown in Table 11. The Mach-IV results showed poor internal reliability (see Table 5). Therefore, the medical laboratory workforce mean should be interpreted with caution. If the mean value of 59.25 is representative of the workforce, it seems to indicate that they are not significantly higher as a group when compared against the general population. However, the medical laboratory workforce mean of 59.25 is close the discriminator value of 60 (Christie & Geis, 1970), which differentiates “High Mach” personality types from “Low Mach” personality types.

Table 11: Medical Laboratory Workforce Mach-IV Values versus Normative Values

GROUP	SEX	Mach-IV			Reference Source
		n	MEAN	SD	
General Population	na	82	55.9	7.7	(Jakobwitz & Egan, 2006)
General Public & Students from two universities In England	F	125	49.31	5.45	(Andrew, Cooke, & Muncer, 2008)
	M	125	49.30	5.56	
UBC Psychology Students	F	349	54.58	7.05	(Sherry, Hewitt, Besser, Flett, & Klein, 2006)
	M	134	58.74	7.51	
Med Lab Workforce	M/F	32	59.25	5.27	2014-2015 Study (Thesis)

The evidence presented in Table 11 is very limited. It is not known is how the medical laboratory workforce values compare to occupations in finance, marketing, logistics or other professions within large scale businesses. It is quite possible that the medical laboratory workforce means are much lower than professionals employed in these occupational groups in business. Therefore, further research into Machiavellianism in the

laboratory medicine, in relation to other healthcare and non-healthcare occupational groups and their dynamics within quality assurance is required.

A linear structural model (Figure 9), was constructed using the Spearman rank-ordered intercorrelations from Table 7, along with proposed “mind maps” for each dimension in the TALiS model. For clarity to the reader, the AQ test is not at the “centre” of the model seen in Figure 9. The AQ test has been projected this way for its relationship to be seen more clearly with respect to the EQ, SQ-R and Mach-IV questionnaire results.

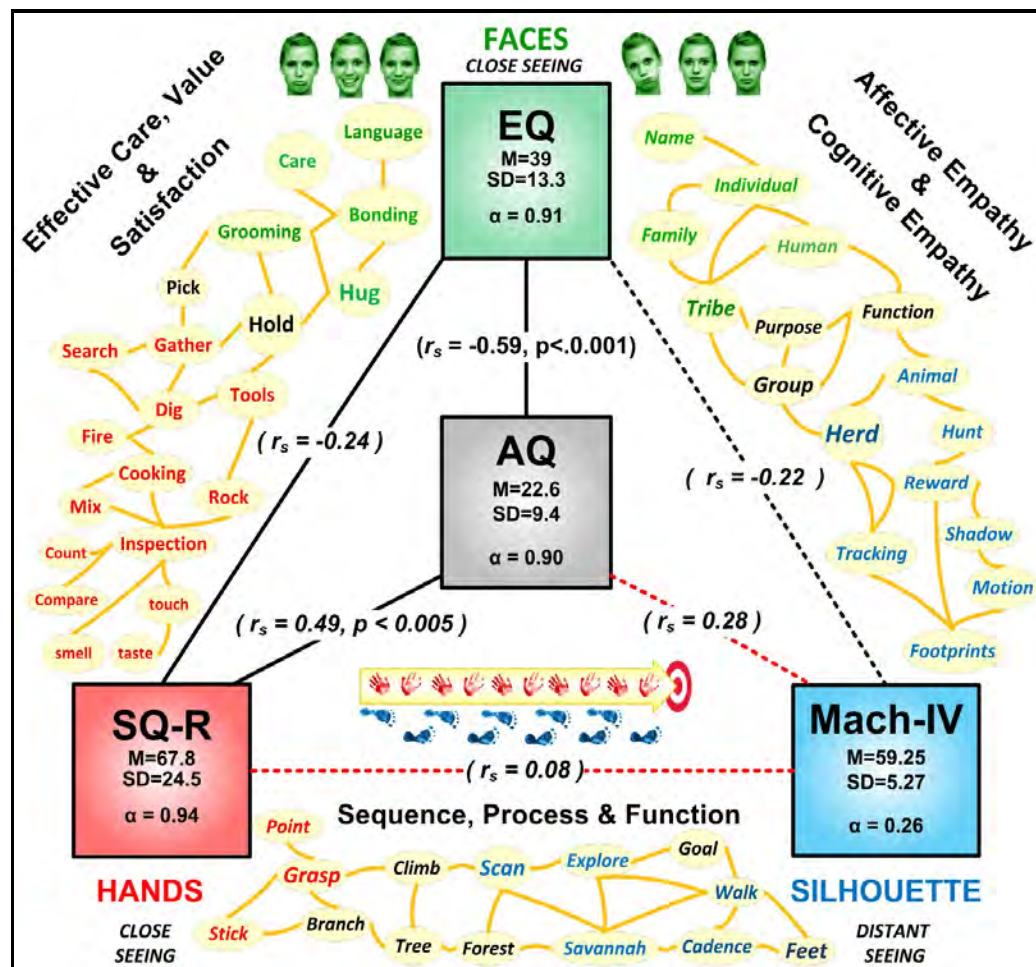


Figure 9: Linear Structural Relationship Model, Spearman Intercorrelations and TALiS

The reader should note that the Spearman rank-ordered intercorrelations of the EQ, SQ-R, AQ tests, versus the Mach-IV test, have not been entirely supported by prior studies. Intercorrelations not supported by prior studies have been highlighted using red dotted lines in Figure 9. Despite the small sample size, the intercorrelations between the EQ, SQ-R and AQ tests agreed with prior literature sources (Wheelwright, et al., 2006). The inverse relationship *detected* between the EQ and Mach-IV results (See Figure 9, $r_s = -0.22$), also agreed with earlier findings (Andrew, Cooke, & Muncer, 2008). However, this author was unsuccessful in finding any prior evidence to verify:

- 1) The relationship between the AQ and Mach-IV test, and;
- 2) The relationship between the SQ-R and the Mach-IV test.

Therefore, the Spearman intercorrelations presented in Figure 9 are to be interpreted with caution. These values should be further investigated and verified in future studies.

Discussed earlier in the literature review, it is well known that individuals with ASDs have deficits with cognitive empathy¹⁴. Therefore, the minor correlation *detected* between the AQ versus the Mach-IV ($r_s = 0.28$) and the minor inverse correlation *detected* between the EQ versus the Mach-IV ($r_s = -0.22$), appear to be make sense, when considering the nature of this workforce sample.

The absence of a relationship between the SQ-R and the Mach-IV ($r_s=0.08$) is thought-provoking. Stated earlier, this author was unsuccessful in finding prior published research that investigated the relationship between the SQ-R and the Mach-IV tests. Keeping in mind that the sample size was very small ($n=32$) and that the Mach-IV test had

poor internal reliability ($\alpha = 0.26$), it is plausible that there is *no relationship* between the SQ-R and Mach-IV. It is thought provoking that all other psychometric measures detected a correlation in Table 7, with the exception of the SQ-R and the Mach-IV. It is questioned by this author, if the lack of a correlation between the two instruments can be explained by the following:

- 1) *Different neural systems* are being detected by the two instruments;
- 2) There might be Neural system(s), which are *not detected* by *either* instrument;
- 3) There is/are neural system(s) present, that process information based on different *cognitive vantage points*, which are not the same for the two instruments;
- 4) The cognitive vantage point of the SQ-R is *within* the Lewin social space, whereas the Mach-IV vantage point is *outside* the Lewin social space;
- 5) The Mach-IV test deals with *human systems*, whereas the SQ-R test deals with *non-human* systems, or;
- 6) There is some sort of relationship between the SQ-R, hands, hand motion and technique (procedure), whereas the Mach-IV is related to feet, flows, pacing and cadence (process, function).

Although it is conjecture, it is plausible that the SQ-R and Mach-IV questionnaires, by their design, may not produce a correlation, based on the evidence presented in Table 7.

Therefore, the lack of a correlation between the SQ-R and Mach-IV needs to be further investigated and verified in a future study.

It was initially thought by this author prior to this study, that the SQ-R and Mach-IV tests might detect a correlation since both mindsets are reasoned to think in the *third person*. However, this author's notion appears to be unsupported by Table 7. Different neural systems appear to be involved. A third-person mindset may require different vantage points and thus "leans" on different neural systems to understand the quality goal. With respect to social systems, there is a clue through the research studies conducted by Christie and Geiss, which implies that third person thinking, can involve two or more vantage points, when analyzing a quality related issue. Discussed early in the literature review, the researchers studied the relationship between the Machiavellian and Authoritarian personality type (Christie & Geis, 1970, p. 38). The researchers found no relationship between the two personality types, suggesting that the personality types differ by the *height* of their *vantage points* relative to the social system.

It can be reasoned that the Authoritarian personality type sees the "social tribe" from a high vantage point in the "tree" and *looks down* at the social system as a *hierarchy*. This does not appear to be the vantage point of the Machiavellian personality type. It is reasoned that the "High-Mach" sees the tribe from a distance, as a "herd" (as chains or groups) on the *same social plane*. This notion is suggested by Christie and Geiss. There is evidence in Table 9, of a positive correlation between the SQ-R versus "laboratory Size" (SQ-R, $r_s = 0.34$, $p < 0.10$) and the "Size of community" employed (SQ-R, $r_s = 0.37$, $p < 0.05$). This also seems to be supported by very weak correlations *detected* between the Mach-IV versus *laboratory size* (Mach-IV, $r_s = 0.27$) and the *size of community employed* (Mach-IV, $r_s = 0.25$). These clues suggest that depending on the height of the actor's

vantage point within the system, when thinking in the third-person, there is a greater need to “lean” on these neural systems, which are detected by the SQ-R and Mach-IV tests. This may be required to better understand the quality goals within a highly stratified social system such as a health authority and the workflows that relate to these goals. Also, the evidence appears to support the notion that Machiavellianism is “left-brained” thinking, discussed early in the literature review (Nestor, et al., 2012). Therefore, it is questioned by this author, if the evidence presented in the literature review, the proposed “Rules of Herds” and this workforce study is sufficient to support the argument that the AGLS and MHLS archetypes within the TALiS model are not concerned with social-hierarchies, but rather workflows, functional holarchies¹⁵ and supplier-service chains.

Relationship between Psychometric Scores and Community Size

The survey results were then plotted against community sizes in Figure 10. The purpose of the graphs is to provide the reader a better sense of the spread of values and to see if there was a relationship between the results versus community size. It is also important to note that the cut-off values used in this study are not universally agreed upon by psychology researchers. Therefore, these graphs present the scores in a manner, which permits researchers to assess the workforce characteristics based on their requirements.

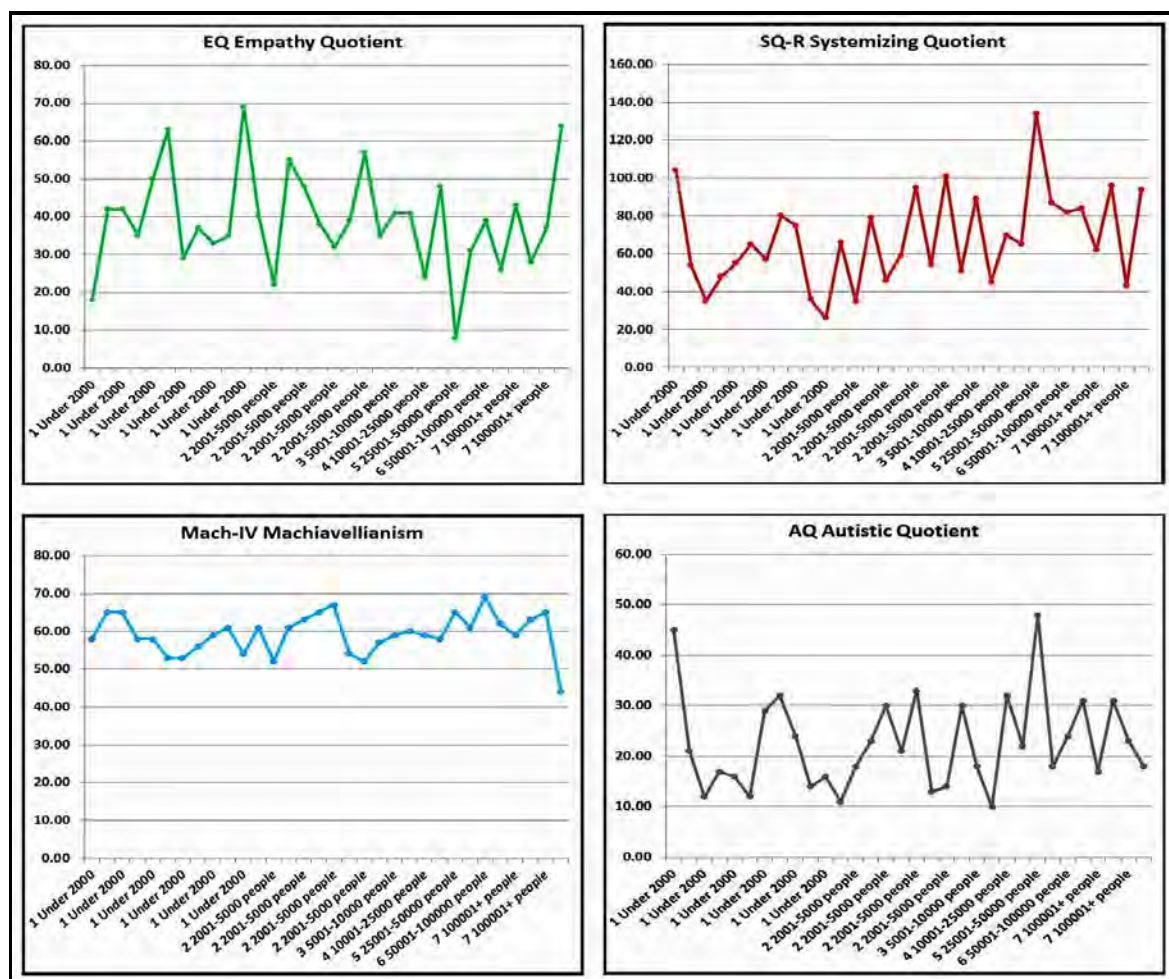


Figure 10: Survey Scores of the Medical Laboratory Workforce and Community Size

Upon closer inspection of the graphs in Figure 10, for the EQ, SQ-R, AQ and Mach-IV questionnaires, there are two graphs that are noteworthy. This includes the SQ-R and Mach-IV tests. For the Mach-IV test, there is a little spread of the values, despite the differences in community size. Mach-IV scores cluster around the discriminator of 60, which differentiates between a “High-Mach” and a “Low Mach” (Christie & Geis, 1970). The very weak correlations *detected* between the Mach-IV versus *laboratory size* (Mach-IV, $r_s = 0.27$) and the *size of community employed* (Mach-IV, $r_s = 0.25$), suggests that there is very little difference between rural laboratories versus large laboratories. Christie and Geiss discovered through “ball and spiral” experiments that High-Machs have a more *task-oriented* focus, whereas Low-Mach’s tended to get more carried away in *group maintenance* encounters. They stated “process is not generated *within* each of the participants separately; rather, it develops *between* them – it is an effect of the group as a unitary system” (Christie & Geis, 1970, pp. 269-273). Therefore, the Mach-IV values could be evidence that the workforce is thinks like a unitary system or as a supply-service chain.

For the SQ-R questionnaire, there is a clear upper trend with increasing population size in Figure 10. The graph is supported by correlations between the SQ-R versus “laboratory Size” (SQ-R, $r_s = 0.34$, $p < 0.10$) and the “Size of community” employed (SQ-R, $r_s = 0.37$, $p < 0.05$). Although all four questionnaires may be important in quality assurance, it appears that the SQ-R test is the most significant. It is important to consider all occupational groups. A similar pattern may be found with other occupational groups. Therefore, this evidence points to the importance of ISO regulated environments and other occupational groups might benefit within this type of quality system framework.

Introduction to the Clinical and Laboratory Standards Institute

The Clinical and Laboratory Standards Institute (CLSI), is a non-profit organization in the United States, which is committed to developing and improving laboratory practices within the healthcare community. The CLSI was first organized in 1968 and was formerly called the *National Committee for Clinical Laboratory Standards* (NCCLS). The organization uses a consensus-based process for standardization in laboratory medicine. This author has selected four standards published by the CLSI for critique using the literature review and research results on the medical laboratory workforce to build new knowledge. The CLSI standards are:

- 1) *QMS14-A: Quality Management System: Leadership and Management Roles and Responsibilities;*
- 2) *QMS06-A3: Quality Management System: Continual Improvement;*
- 3) *QMS03-A3: Training and Competence Assessment, and;*
- 4) *QMS04-A2: Laboratory Design.*

The body of knowledge and conceptual models developed in the literature review, along with the research findings on the workforce, will be used to as a lens to expand on selected themes within the mentioned CLSI published standards.

Quality Leadership in Complex Systems

What is a leader? Edwards Deming described a quality leader as a knowledge leader who has been “transformed” through new “knowledge”, suggesting some sort of personal revelation (Deming, 2013, p. 181). Deming proposed that a leader has the quality of *charisma*; with “personality” and “persuasive power”. Deming stated that the leader accomplishes transformation first with a *theory*; how it would bring gain to the organization and to its employees. Through a sense of obligation to the people, Deming stated that the leader is compelled to accomplish the transformation and does so through a practical and methodical approach (Deming, 2013, p. 181). This suggests that a quality leader has in some sense, a set of moral duties to the organization, its people as a community and this important role makes them accountable for the performance of the organization. This leadership role must touch all “dimensions of mind” which make up the culture of the organization. Therefore, being a quality leader in healthcare is more than a “job” or “profession”, but a “spiritual calling”, with a vision to support a *culture of goodness*.

Translating a vision into a business plan requires a methodology and quality tools to bring all people together and reach operational goals. Quality Assurance requires a basic conceptual framework; a simple structure that is simple and easy to understand. Joseph Juran, one of the fathers of quality assurance, proposed a well-known model called the “Juran Trilogy”. Juran stated that the trilogy itself was a very old model and had been a tried and true methodology, which has been used for centuries (Juran, 1988). Juran described three major processes making up the triad; called *Quality Planning*, *Quality*

Control, and *Quality Improvement*. The Juran Trilogy is reasoned by this author to be the most fundamental process framework within Quality Assurance. With regards to organizational change, a fitting semblance would imagine the phases as three movements within a great symphony. All three movements or processes within the Juran Trilogy are interconnected and designed to lead the organization to a goal. They form the basis of system dynamics within business and healthcare.



Figure 11: TALiS¹⁶, the Juran Trilogy and Six Sigma Methodologies

Using the Juran Trilogy as the structural model for a quality system, the TALiS can be incorporated. When the two models are combined, a greater pattern emerges. As a visual aid, Figure 11 has been provided for the reader to better understand the relationships. The Juran Trilogy, as the foundation of a quality system, provides the TALiS the means whereby, to root itself and reach within a complex system. Quality systems, tools, methodologies and standards are learning supports that permit organizations and people to “see” effectively, learn and transfer knowledge as “codified qubits” across large distances to meet customer requirements. Therefore, quality tools are instruments that act as extensions of the human brain, serving as “neurocognitive prosthetic devices”, thus providing qubits of knowledge for each user’s learning system in the TALiS (See Appendix B).

The flow of knowledge, using image Figure 10 requires a brief discussion. Beginning with the STLS, Figure 11 depicts a clock-wise flow of cognitive processes. The *voice of the customer* is captured through surveys, interviews and focus groups, where the *customer requirements* are understood by the STLS. This requires that the organization invests resources, to talk directly to customers and to discuss their needs within focus groups. Multiple focus groups may be required to hear “multiple voices” (community, organizational, high-level government and regulatory requirements). Since the STLS relies on *spoken language* for understanding the customer requirements, this learning process becomes important when the customer is part of a cultural group that does not speak in the common language of the organization. This is particularly true for the Francophone population, First Nations and Inuit cultures within Canada.

An excellent example of Canada's "good government" commitment to quality service is the *Government of the Northwest Territories*. Eleven official languages are recognized (GNWT, 2015). Quality requirements can be lost, when translating the Voice of the Customer into *Critical to Quality* requirements when using business improvement methodologies such as *Six Sigma* (ASQ, 2015). Focus groups and interviews offer the quality assurance department the ability to:

- 1) Understand the customer's point of view and mindset as a learning system with possible learning needs;
- 2) Understand the dynamics within the social spaces (hierarchies) in the communities;
- 3) Better map out the holistic quality requirements for the customer, and;
- 4) Identify system archetypes that might arise, from multiple providers offering services in the *same* community, which are linked to the customer's *total care*.

The customer requirements are then translated from qualia, using *Quality Function Deployment*, where qubits of knowledge are characterized into *technical requirements* (ASQ, 2015). Critical to quality requirements (CTQs) can then be prioritized and specified through tools, such as the *House of Quality* (ASQ, 2015), by the project committee members. For the reader, a simple example of the House of Quality has been provided in Figure 11. It is thought by this author that the TALiS model could lead to improvements in the HOQ, for easier use and greater utility in Healthcare and Social Services.

			<div> <div>+</div> <div>+</div> <div>-</div> <div>-</div> <div>+</div> </div>								
CUSTOMER REQUIREMENTS			Up	Up	Target	Down	REGIONAL HEALTH AUTHORITY, REGULATORY & GOVERNMENT				
S/No	Customer Need	Importance	PROCESSES	EQUIPMENT SPECS	TRAINING	ERGONOMICS, HFE	COMMUNITY HOSPITAL & CLINICS	HEALTH AUTHORITY	REGULATORY ACCREDITATION, & EQA	PROVINCIAL GOVERNMENT MANDATES	FEDERAL GOVERNMENT MANDATES
			CTQ 1	CTQ 2	CTQ 3	CTQ 4	Hosp.	Comp A	Comp B	Comp C	Comp D
1	Waiting Time	4	6	7	5	5	2	4	5	6	7
2	Accurate Testing	1	1	1	2	1	1	1	1	2	2
3	Language Serv.	2	4	6	6	4	3	2	1	2	5
4	Pleasant Staff	3	3	6	4	5	6	2	7	2	1
CTQ Importance Score			42	59	45	44					
CTQ Relative Rank			4	1	2	3					
How Much (Target, Spec Limits)			>3SIG	>4SIG	>90%	>75%					
Risk (Organizational Difficulty)			3	2	4	1					

Figure 12: House of Quality (HOQ) for Healthcare and Social Services Planning

The House of Quality (HOQ) is a powerful quality tool for planning in healthcare and social service. It is used for *Design for Six Sigma* (DFSS) and *Lean Six Sigma* (LSS). A roadmap outlining a DFSS QPMP has been provided in Appendix G to give the reader a sense where the HOQ as a learning tool fits within the bigger project picture. The HOQ is reasoned by this author to be the “opera house”; the collective “ensemble” of all actors’ voices. The HOQ is a tool used by quality leaders to compose and launch “the great

symphony”. As the “eye of providence”, the HOQ touches all learning requirements of the TALiS model to gather and codify new knowledge. Using Quality Function Deployment, the HOQ translates qualitative user needs (qualia) and quantitative requirements (qualitas), into quality parameters. This codified knowledge flows from the STLS to the MHLS, where the subsystems needed (functional holarchies) to meet customer requirements are determined as a set of targets. This method provides the key entry points to safely open the sub-systems. The MHLS then begins to work with the AGLS to open up the sub-systems, make changes and then control the new processes using qubit feedback loops, thus closing the system. Feedback loops through inspection and control are adjusted to improve the new processes to a satisfactory industrial level (symbolized as a zipper in Figure 9). Once this level of industrial control has been achieved, the Deming PDSA Cycle takes over, and through a dynamic control feedback loop, the processes are further tightened by the AGLS and brought to a higher sigma value. Therefore, the process sigma value is a measure of the organization’s ability to translate the VOC using QFD and its effectiveness in transferring that knowledge through the TALiS and optimize processes within functional holarchies as a “breakthrough system”.

Reaching great quality goals within complex systems can be an enormous challenge. The dynamics within a complex system may not be clearly seen and understood until it is constructed. Edwards Deming said that efforts by employees across multiple divisions are “not additive”, but “interdependent”. The efforts of employees, of one division, can undermine the quality goals of another division (Deming, 2013, p. 59). The Quality Leader and the project team must be mindful of load imbalances and inefficiencies,

which can lead to sub-optimization within a complex system during organizational change.

Quality tools provide the means to recognize the problems and fix them. Deming called this

“System Optimization” and explained this important concept, stating:

“An example of a system well-optimized is a good orchestra. The players are not there to play solos, like prima donnas, each one trying to catch the ear of the listener. Each of the 140 players in the Royal Philharmonic Orchestra, London, is there to support the other 139. An orchestra is judged by the listeners, not so much by illustrious players, but by the way they work together. That’s what counts” (Deming, 2013, p. 60).

System optimization is a very important concept. The quality leader acts as an organizational “maestro”, driving the three movements of the Juran Trilogy as a symphony.

Donella Meadows said that with respect to system optimization, the aim is to enhance the *total system’s* properties such as growth, diversity, resilience, stability and sustainability (Meadows D. H., 2008, p. 178). She stated that one should never maximize parts of systems or subsystems while ignoring the whole. Therefore, it is questioned if Dr. Deming and Dr. Meadows seem to support the argument that *Design for Six Sigma* (DFSS) might be the better approach when planning a new healthcare program.

System optimization and undesirable archetypes are however, a continual challenge for large scale systems. Quality Systems are man-made learning systems. Leaders, managers and medical personnel, with the best of intentions in the spirit of quality, from their vantage point and actions, can produce undesirable behaviours within systems that

impact product quality and service. Undesirable system archetypes can be a potentially serious quality issue. Quality assurance cannot stop undesirable archetypes from surfacing within complex systems such as healthcare or business, but it has the means to detect undesirable archetypes with quality tools, better understand their behaviours and dynamics within complex systems and provide effective monitoring systems within the organization. Therefore, a robust quality system permits actors to overcome the effects of undesirable system archetypes and promotes system optimization within an organization.

Some discussion is needed on system archetypes, since this is an important topic in system dynamics and quality assurance. An environmental scan of system archetypes was performed using the Google Scholar search engine on May 29th, 2015 as a starting point, to get a better sense of the industries' awareness on system archetypes. Key words were entered into the search engine and used to collect the number of published literature sources in Table 12. The key words "healthcare", "ISO 9000" and "ISO 15189", in Table 12, suggest that the body of knowledge in system archetypes in laboratory medicine appears to be very small. This raises the question if system dynamics, within highly regulated clinical laboratory environments have been studied in depth, since they are very much linked to Quality Assurance. Therefore, the evidence presented in Table 12 is very thought provoking.

Table 12: Google Scholar Word Search May 29th, 2015

KEYWORD	Google Scholar Hits
“archetype”	177,000
“system” + “archetype”	106,000
“business” + “archetype”	65,500
“quality” + “archetype”	81,300
“medicine” + “archetype”	37,900
“healthcare” + “archetype”	8,210
“ISO” + “archetype”	26,200
“ISO 9000” + “archetype”	1,470
“ISO 15189” + “archetype”	9

A second internet scan was then conducted by this author on May 29th, 2015 using the website search engines of regulatory and professional bodies that are related to laboratory medicine. A search for published literature on system archetypes was also made, on the following websites using the key words “archetype” and “optimization”:

- 1) College of American Pathologists (CAP, 2015);
- 2) Institute for Quality Management in Healthcare (IQMH, 2015);
- 3) Clinical and Laboratory Standards Institute (CLSI, 2015);
- 4) Health Council of Canada (HCC, 2015);
- 5) Canadian Institute for Health Information (CIHI, 2015);
- 6) Accreditation Canada (Accreditation Canada, 2015), and;
- 7) Health Canada (Health Canada, 2015).

It was discovered by this author that there was no evidence to be found in the website search engines for the terms “archetype” and “optimization”.

In addition to the first two environmental scans, this author went one step further and conducted a keyword search within the *Ontario Laboratory Accreditation (OLA) Requirements, Version 6.0*. It was found that the words “optimization” and “archetype” were nowhere to be found within the accreditation standards (IQMH, 2013). Joseph Juran, Dr. Edwards Deming, and Dr. Donella Meadows were all aware of the importance of system optimization. A basic understanding of undesirable system archetypes, especially the most common scenarios, is important in Quality Assurance. Therefore, the potential payouts in terms of quality, service delivery, and cost savings within healthcare, could be significant if system dynamics and undesirable system archetypes are better understood by all healthcare personnel and put into practice.

Dr. Donella Meadows discussed the problems of undesirable system archetypes in her book, *Thinking in Systems* (Meadows D. H., 2008). The most well-known, undesirable system archetypes within system dynamics are called “System Traps” (Meadows D. H., 2008, p. 112). These common system traps are as follows:

- 1) Policy Resistance;
- 2) The Tragedy of the Commons;
- 3) Drift to Low Performance;
- 4) Escalation;
- 5) Success to the Successful;

- 6) Shifting the Burden to the Intervener Addiction;
- 7) Rule Beating;
- 8) Seeking the Wrong Goal, and;
- 9) Limits to growth.











Undesirable system archetypes may be spotted and easily fixed if the organization or hospital is very small, as it is with many rural hospitals. It becomes much harder for leaders and their employees to spot these problems, when the hospitals must work within a regional health service model, which may operate across large distances. A system trap can lead to a proliferation of other system traps. As a closed system, all smaller systems within a healthcare authority are interconnected and have the potential to become “entangled spaghetti systems”. Therefore, healthcare organizations and businesses may be vulnerable to system traps if they are not well understood by employees.

When a system trap is spotted, it may take an organization a significant amount of resources to rectify the problem. Information flows, time delays, policies, procedures and the actions of different actors in the system, can lead to the danger of patient harm, regulatory body intervention, lawsuits and the public humiliation of government inquiries. Two well-known examples in Canadian laboratory medicine include the *Commission of Inquiry on Hormone Receptor Testing in Eastern Health*, NFLD (Department of Justice, 2009) and *The Canadian Red Cross Tainted Blood Scandal* (Krever Commission, 2013). The two Canadian catastrophes mentioned, serve as warnings and are humble reminders if undesirable system archetypes are not understood by laboratory leaders and their

employees. Therefore, system traps can occur at any time and appear out of the shadows of complexity, in particular, during organizational change.

Examples of system traps in laboratory medicine have been provided in Table 13 for some clarity. These simple examples can be greatly expounded upon. They can serve as a starting point for discussion, ideas for quality improvement initiatives and for organizational learning. Table 13 is essentially concerned with medical laboratory services and suggests where system traps might arise. However, since laboratory services are interconnected with other health services, the problems can potentially surface anywhere in a healthcare authority and also with other services outside the health authority. Therefore, the examples of common undesirable system archetypes in laboratory medicine can be used by all healthcare employees and focus groups representing users of healthcare services, which will lead to new knowledge.

Table 13: System Traps and Laboratory Examples

SYSTEM TRAP	DONELLA MEADOWS	LABORATORY EXAMPLES
POLICY RESISTANCE	 Various Actors try to pull a system stock toward various goals	<ul style="list-style-type: none"> ➤ Can happen between organizations who are not monitoring performances together in a community ➤ Critical Results -after hours/weekends/Fridays - physicians, departments
THE TRAGEDY OF THE COMMONS	 Involves a common service that every user benefits from, but can be abused, leading to increased costs	<ul style="list-style-type: none"> ➤ Patient's deferred to ER Department after clinic hours, leading to higher resource usage, laboratory call-backs. ER seen as convenience service by patients ➤ Two or more organizations serving the community have policies or processes that need improvement with patient case management
DRIFT TO LOW PERFORMANCE	 Permitting performance standards to be influenced by past performance  "eroding goals" , "Boiled frog syndrome"	<ul style="list-style-type: none"> ➤ NCRs do not lead to any action or investment of resources. Eventually people give up being diligent with NCRs ➤ Budget cuts are always a threat. Organizations may struggle with of erosion of empathy due to need for industrial efficiencies
ESCALATION	 When the state of one stock is determined by trying to surpass the state of another stock, leading into a "arms race", loudness, smear campaigns	<ul style="list-style-type: none"> ➤ A complaint then leads to a counter-complaint, which then escalates into in - fighting between two departments. ➤ Inefficient inventory and supplier chain issues. Increased costs of rush shipments. Causing an oscillation in stock flows.
SUCCESS TO THE SUCCESSFUL	 Winners of a competition are systematically rewarded with the means to win again with the winners taking all.	<ul style="list-style-type: none"> ➤ Department learns of potential equipment funding (foresight), but does not share information to other departments in hospital or other laboratories within the health authority (rural labs) who might be in need of equipment dollars as well.
SHIFTING THE BURDEN TO THE INTERVENOR	 Shifting the burden, or dependence on a party to do a quick fix that treats the immediate symptoms but disguises the systemic problem	<ul style="list-style-type: none"> ➤ Employers who depend on quality consultants to introduce change but cannot effectively do it themselves as leaders. ➤ An employer who deliberately keeps a management position vacant for months, to years, in order to save money, permitting quality to erode in the laboratory.
RULE BEATING	 Behaviour that gives the appearance of obeying the rules or achieving the goals, but that distorts the system .  Usually due to lower levels of hierarchy to over rigid, deleterious, ill-defined rules	<ul style="list-style-type: none"> ➤ Rampant spending at the end of a fiscal year to ensure that budgets are kept intact. ➤ Low political momentum in quality committees, quorums, ➤ Resources beefed up during accreditation peer inspection years to "appear committed". Momentum drops assessment (also a drift to low performance issue)
SEEKING THE WRONG GOAL	 System goals are poorly defined or incomplete, leading to unintended results	<ul style="list-style-type: none"> ➤ Can surface in different ways if it is centralized, mixed, or de-centralized model ➤ If multiple organizations servicing a community - could lead to imbalances

It is this author's opinion, that the investigation of system traps in laboratory medicine would be an excellent area for research. It is a thought that the *Canadian Institute of Health Research* (CIHR, 2015) might find the importance of such investigations and perhaps may fund research projects in laboratory medicine. The results of the medical laboratory workforce study may also suggest that there is an opportunity for funding and for research as well. It may lead one to wonder if the design of the system shapes cultural archetypes. Kurt Lewin's theories on social engineering and group dynamics suggest that several forces at work that shape the overall culture in the laboratory. This understanding appears to be lacking in the current body of knowledge in laboratory medicine. Therefore, the new knowledge gained from such studies could be valuable and this new understanding could lead to new learning supports, internal auditing and monitoring tools within a highly regulated industry.

The CLSI document *QMSI4-A: Quality Management System: Leadership and Management Roles and Responsibilities*, is a guidance document that provides a good starting point for managers and leaders to build a business case for a Quality Management System (QMS). The system conceptual model, proposed by the CLSI, is a process-based model composed of twelve quality system essentials, which are the building blocks of the system (CLSI, 2012, p. ix). The guideline's intention is to assist laboratories in meeting the leadership requirements, cultural requirements and functional requirements, of a sustainable QMS. It includes "words of wisdom" from the committee on what works when arguing for such a system. The document *QMSI4-A*, provides many examples of quality tools which are also endorsed by the American Society of Quality (ASQ, 2015).

For this critique of guidance document *QMS14-A*, this author's goal is not to reinvent what is so well written by the CLSI, but rather to explain the benefits of a quality management system, using the TALiS model and its importance in complex systems. The CLSI document in chapter five provides guidance on making a case for a quality system and presenting the case effectively to key stakeholders, which includes *risk management* and patient safety (CLSI, 2012, p. 15), the *financial* benefits of a QMS (CLSI, 2012, p. 16) and the *internal* benefits to the laboratory (CLSI, 2012, p. 17). The *business case* that must be developed to argue for a QMS is reasoned by this author to be the most important document of any Quality Project Management Plan (QPMP). It is reasoned that such an effort requires a significant investment of money and staffing resources. Therefore, the business case requires significant homework and careful preparation to justify the costs, resources and time involved, versus its *benefits*, to win senior management buy-in and employee support, prior to launching a QMS.

The installation of a QMS should not be taken lightly by senior administration. This becomes important, depending on the size of the organization and its business model. The business model may be centralized, decentralized, or of mixed services. It is reasoned by this author that a QMS supports the TALiS model by “lifting” the current system off the ground and permitting users to see more clearly its “structural silhouette”. A QMS's beauty is its ability to *accommodate all business models and sizes* through simplicity of its design. A QMS can be visualized as the silhouette of a great tree, which can then be better described as the “structural tree of knowledge”. If a QMS is standardized across a healthcare authority, it permits the organization to see beyond the “forest of complexity”

and see the “savannah”, where the customer market is located. With the “trees cleared and parted” in a consistent manner, the customer market can finally be seen, measured, monitored and targeted more effectively. Customer markets are never stationary; it is reasoned by this author that they should be visualized as *moving herds*. A QMS permits the organization as a learning system to make changes to its operational definitions and to effectively do business at a lower cost with more impact through supplier-service chains.

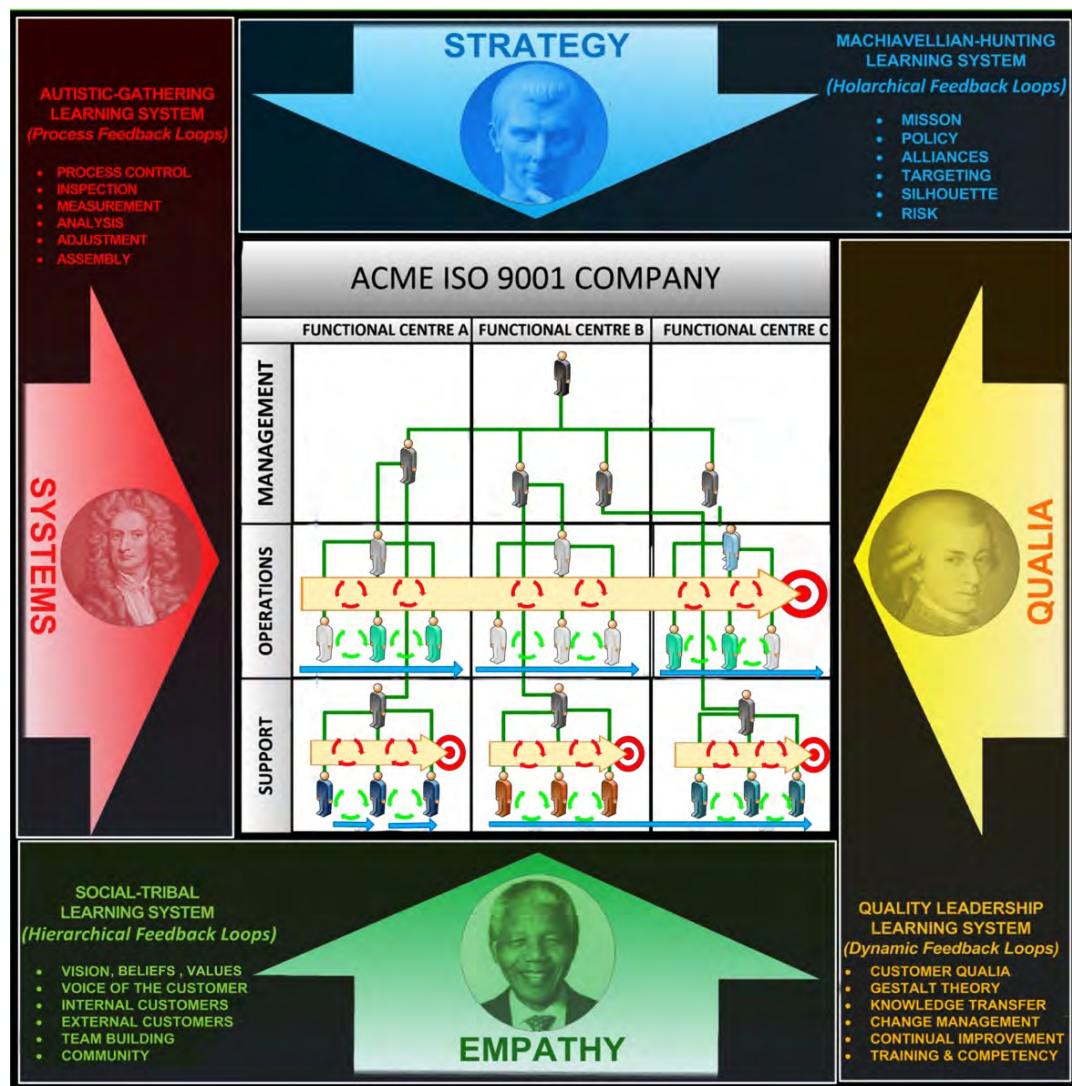


Figure 13: TALiS, ISO 9001 QMS and “Knowledge Qubit” Feedback Loops

Figure 13 delineates feedback information loop types within a QMS, which permits the organizations to meet the requirements of the customer. Without a Quality Management System, the TALiS is reasoned by this author to be “blinded in one eye” through the MHLS and can only see the work performed as *functional holarchies* at the facility site level. TALiS is then reasoned to be limited in its clarity at the *tribe level*. Therefore, two tribes separated by large distances cannot work together as effectively and efficiently without a QMS, which is required to achieve an optimized supplier-service chain.

If an organization adopts a QMS administrative model and obtains ISO certification, the business can more readily pair with suppliers and manufacturers of products and services that are ISO certified as well. An ISO framework also permits the STLS, within the TALiS, to overcome its limitations at the tribe level by *standardization through language*. Donella Meadows said:

“Our information streams are composed primarily of language. Our mental models are mostly verbal. Honoring information means above all avoiding language pollution – making the cleanest possible use we can of language. Second, it means expanding our language so we can talk about complexity.” (Meadows D. H., 2008, p. 174)

ISO 9001:2008 and other standards, tear down barriers to learning due to language, through *terms and definitions*. Therefore, ISO certification leads to a competitive business edge where the healthcare organization can do business and share knowledge with suppliers and service providers, who operate within similar quality systems.

The supplier-service chain can be visualized as a system of industries or “tribes” that work together in a process flow of increasing product-service value for the customer. Supporting the learning requirements of the TALiS model, if the quality systems are standardized and the tribes speak the same language (STLS), the tribes can begin to make changes within their local functional holarchies and integrate them in a flow of work in a *value stream* that provides increasing value and satisfaction for the customer. This pattern of workflow permits the tribes to behave like a “herd”, where through altruistic cooperation, the social systems “walk” towards a “reward” in a chain. The reward from knowledge transfers between the systems is the increasing value and satisfaction for the customer, leading to brand loyalty.

For clarity to the reader, an example of the benefits of ISO certification is illustrated using a Value Stream Map (VSM) in Figure 14. This hypothetical Value Stream Map shows the ordering process, flow of work and transport of blood supplies. Figure 14 provides a visual aid for understanding this flow of work. These administrative system processes which integrate the flow of work and feedback information between the individual tribes are reasoned to behave like mirror neuron systems. This feedback behaviour permits the supplier-service chain to act as if they are *one closed system* and permit new knowledge to flow freely between them.

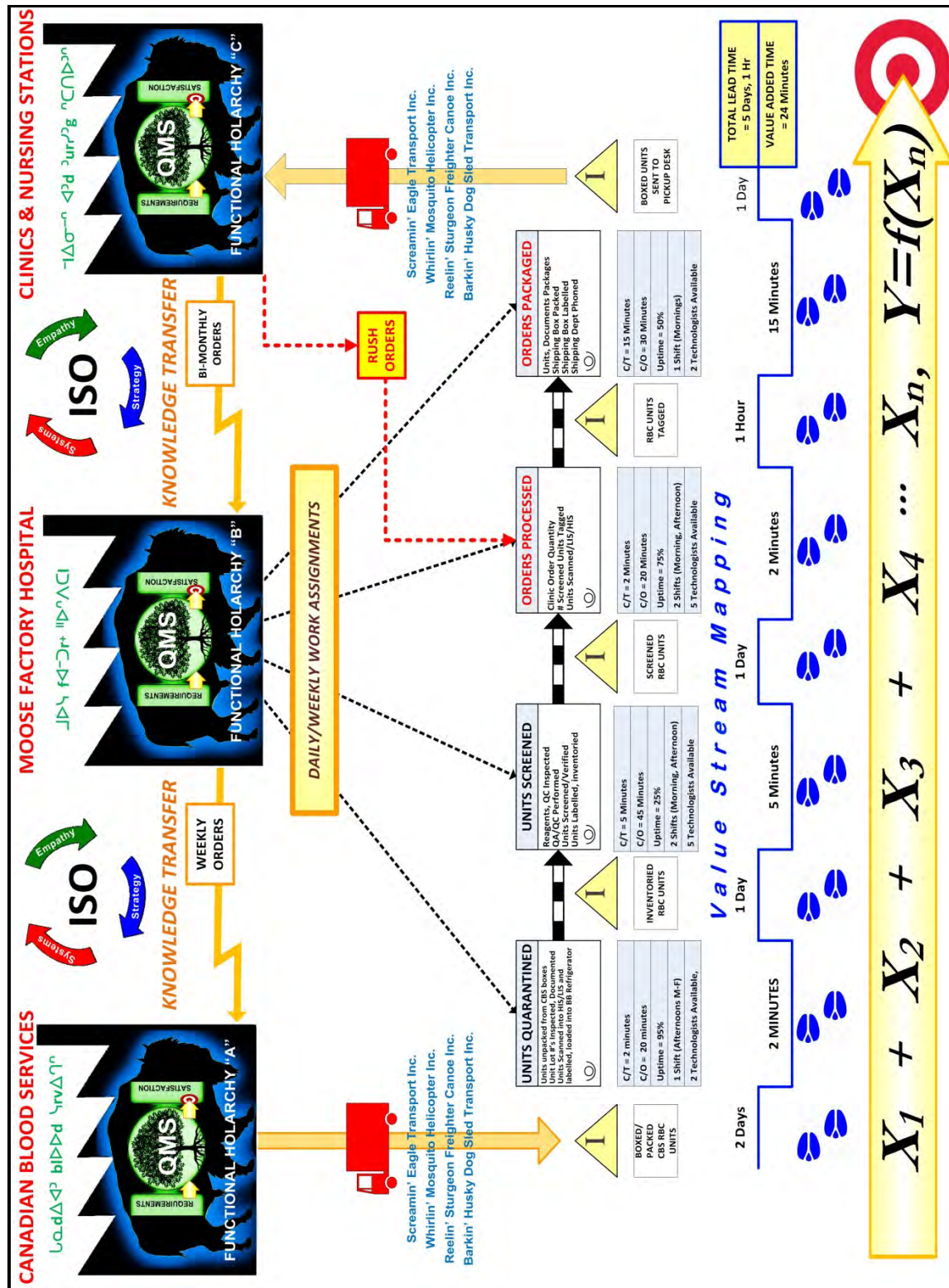


Figure 14: ISO QMS "Mirroring", Supplier-Service Chains and Value Stream Mapping

In addition to improved workflows, a QMS provides even greater leverage within the supplier-service chain. A QMS permits the group to *maneuver* in relation to the *changes* in the *customer market* with less effort. This can easily be visualized when the product-service provider versus the customer market, are seen as two distinct populations within an “open savannah”. Also, by maintaining QMSs, operational risks are reduced. Therefore, the adoption of a QMS supports the learning needs of the STLS, MHLS and AGLS with the TALiS, to achieve both greater perception of value and care by the customer. Value stream mapping, is important in lean systems management when analyzing value added and non-value added activities in a value chain (Quality Progress, 2006).

Organizational Commitment to Quality Improvement

There has been some discussion about undesirable system archetypes and how they impact product and service quality in this thesis. Undesirable system archetypes and their cultures can be resistant to change and quality improvement goals. This thought then leads to the concept of the “zombie system archetype”. The concept of a zombie archetype is indeed, very thought-provoking. This author immediately imagines that “zombie” businesses or health services might be associated with:

- 1) Employees, who have worked their entire career with one employer;
- 2) Cultures that are resistant to change (status-quo);
- 3) Mindless work environments, old business practices, functional silos;
- 4) Change efforts that over time, erode and fall back to the old methods, and;
- 5) Cultures that hold onto tradition with a desire to return to the “good old days”.

This author’s research led to a Google Scholar search for an exact definition. To this author’s surprise, very little literature was found, with the exception of the following concepts:

- 1) “Zombie-Masters” – Individuals who through some self-interest keep bringing up discussions from the “dead” several years after they have been discussed and dismissed (Evans, Barer, Stoddart, & Bhatla, 1993), and;
- 2) “Zombie-like” behaviours of firms that follow others in some business trend for little apparent reason or return (Beattie & Sohal, 1999).

It is reasoned that a “zombie system archetype”, might involve multiple system traps mentioned previously in Table 13. However, a “zombie culture” and its group behaviour within system dynamics might be better described as a type of *stagnant cultural paradigm*.

A cultural paradigm, according to Dr. Meadows, is the hardest leverage point from which to make changes within a system (Meadows D. H., 2008, p. 163). If the quality leader maintains flexibility in conceptualization of the current business model and maintaining that no paradigm is “true” or “right”, it permits them to remain unattached and transcend the current cultural paradigm. In a way, the quality assurance professional can help facilitate discussions and critical thinking by acting as the “Devil’s advocate”; by pointing out weaknesses, obstacles and opportunities with an operational or strategic plan. This approach in quality assurance is important, in that it mitigates the operational and strategic risks associated with *Groupthink* decision making in organizations (Park, 1990). Quality planners can facilitate learning through analysis of the problem from multiple vantage points using different quality tools (ASQ, 2015). The use of different quality tools permits the quality leader and its team to leverage changes within the current cultural paradigm responsible for the “zombie” problem within their organization. Therefore, if quality leaders can influence project team members by continually “thinking outside the box”, through conceptualization and re-evaluating the current business model, this helps mitigate the risk of the “zombie apocalypse”; a stagnant cultural paradigm, which can lead to business or healthcare service crisis and possible failure if the market or the operational constraints suddenly change.

Making major changes within such zombie systems may require significant resources, effort, risk, and a major cultural paradigm shift. This will naturally be challenged and resisted by the status-quo. However, Donella Meadows would offer words of wisdom for those making a change:

“Aid and encourage the forces and structures that help the system run itself. Notice how many of those forces and structures are at the bottom of the hierarchy. Don’t be an unthinking intervener and destroy the system’s own self-maintenance capacities. Before you charge in to make things better, pay attention to the value of what’s already there.” (Meadows D. H., 2008, p. 178)

It is thought by this author, that what Dr. Meadows was inferring, was the nature of *social-functional holarchies* at the bottom of the hierarchy and how they relate to quality. There is a phrase “from silos to systems” used frequently in healthcare which implies that functional silos are outdated models, with cultural patterns of thinking that are perhaps “zombie-like”. It is often used by advocates for regional service models (Simpson, 2011). This opinion is incorrect, in that it depends on the nature of the business, the dimensions of quality wanted by the customer, and the mode of knowledge transfer. Silos have the advantage of fast local feedback loops and can operate as stand-alone systems (Epple, Argote, & Murphy, 1996). Silos permit actors to resolve a product or service issue quickly, rather than go through a complex and possibly rigid, structural *hierarchy* or *heterarchy*, which can result in time delays (Dominici, 2008).

Silos are in fact, small systems and can exist as cultural, functional, geographical, or as business units. Therefore, it needs to be clarified what *type* of silo is causing the problem with knowledge transfer, product or service delivery in relation to the needs of the customer. Specifically, the greater system problem is that for *functional silos*, the actors do not as easily benefit from the *new knowledge transfer* gained from other functional centres within hierarchies or heterarchies, which may span large distances (Dominici, 2008). Therefore, functional silos and their problems with knowledge transfer can be responsible for sub-optimization of processes within a program offered in a regional health services model, when it is viewed as a supplier-service chain.

Based on evidence presented in the literature review, it is questioned by this author, if mirror neuron systems within the local work community may be responsible for a silo's strength, if the TALiS and Orch-OR models are considered. This very important and most fundamental aspect of human biology explains why it can be a challenge to overcome silos during organizational change. Mirror neuron systems have permitted Man to *evolve* and *survive* through the millennia as a species into complex cultural silos, better called "tribes". It is in this light, the quality assurance professional as an intervener should be mindful of mirror neuron systems and their dynamics within *cultural silos*, recognizing their importance and effective self-maintenance capacities within biological systems as social-functional holarchies.

An idiom which may best describe this challenge and social dilemma within change management is called "squaring the circle" (Farlex, Inc., 2015)¹⁷. Silos and redundancies

may be important if the site offering the service is very remote and difficult to access, for instance: 1) *Weeneebayko Area Health Authority* in Northern Ontario (WAHA, 2015); 2) healthcare facilities operating in the Northwest Territories (GNWT, 2015); 3) the Yukon (Yukon Hospitals, 2015), and; 4) Nunavut (Nunavut Department of Health, 2015). However, it is the problem of *new knowledge transfer* that makes remote sites vulnerable. Therefore, it is very important to distinguish between the different types of silos and consider carefully, their positive and negative attributes when making changes within a system, the knowledge requirements of users, with an eye on the customer's vantage point and needs.

No business model is perfect and its design can impact other organizations who are servicing the same community. A regional health services model by its sheer size and design can create undesirable system archetypes. System traps such as “drift to low” *service erosion* can impact the services of other organizations operating within the same community, creating inefficiencies and leading to new archetypes within their systems, called *escalation*. Healthcare authorities and their services may be needed to be designed in a way that distributes wealth fairly through jobs, which in turn, addresses the social and economic needs of smaller communities. If the healthcare service is the largest industry in the community, then the secondary economies benefit from the primary industry as concentric rings of nested social-functional holarchies. An excellent example of a governance model that understands this social ethic is the *Government of the Northwest Territories* (GNWT, 2015). Poverty in communities brings to surface multiple social and health related problems, which can come back and lead to an *escalation* archetype

impacting health and social services. Integral Permaculture is mindful of the interrelationships between the multiple systems that exist within communities.

In addition to social responsibilities, health authorities need to consider the migratory patterns of patients, such as the Baby Boomers (Canadian Home Builders Association, 2006). Evidence supports that the migratory patterns of baby boomers are going in the opposite direction of a health service centralized model. The evidence shows that baby boomers are migrating from large cities to small rural towns (Dowd, 2011). A business model that is mixed-service or decentralized may in fact deliver better care, depending on the services offered and quality requirements of the customer. It is thought that the business case should present all three models (centralized, mixed, decentralized) prior to the approval of a quality project management plan. It is in this light that quality leaders must be mindful of the system trap called the “success to the successful” archetype (Meadows D. H., 2008, pp. 127-130). Stakeholders, who have positions of power and consultants who have privileged access to knowledge within the social hierarchy, may have personal motives with system changes. Therefore, it is reasoned that by presenting all three models in the business case, transparency and objective thinking can be maintained during organizational change.

A method to improve quality and overcome the cultural archetypes during organizational change can be accomplished by adopting the Deming PDSA Cycle within the QPMP. The Deming Cycle model is discussed in detail by the CLSI in their guidance document *QMS06-A3: Quality Management System: Continual Improvement; Approved*

Guideline. The Deming PDSA Cycle is a type of dynamic control feedback loop¹⁸, which permits learning and neuroplasticity within an organization. Deming said that with organizational learning:

“Joy in learning comes not so much from what is learned, but from learning. It’s fun to learn if you learn knowledge. Not fun to learn information. The joy in the job comes not so much from the result, not from the product, but from contributing to optimization of the system where everyone wins” (Deming, 2013).

To paraphrase Deming’s quote in a different light, the “joy of learning” is the excitement experienced by employees through their discovery of a novel idea. It is human nature to share new knowledge. Therefore, the Deming PDSA Cycle permits the group to “break out of its mold”, evolve through revelation with the new knowledge and turn into a new cultural paradigm.

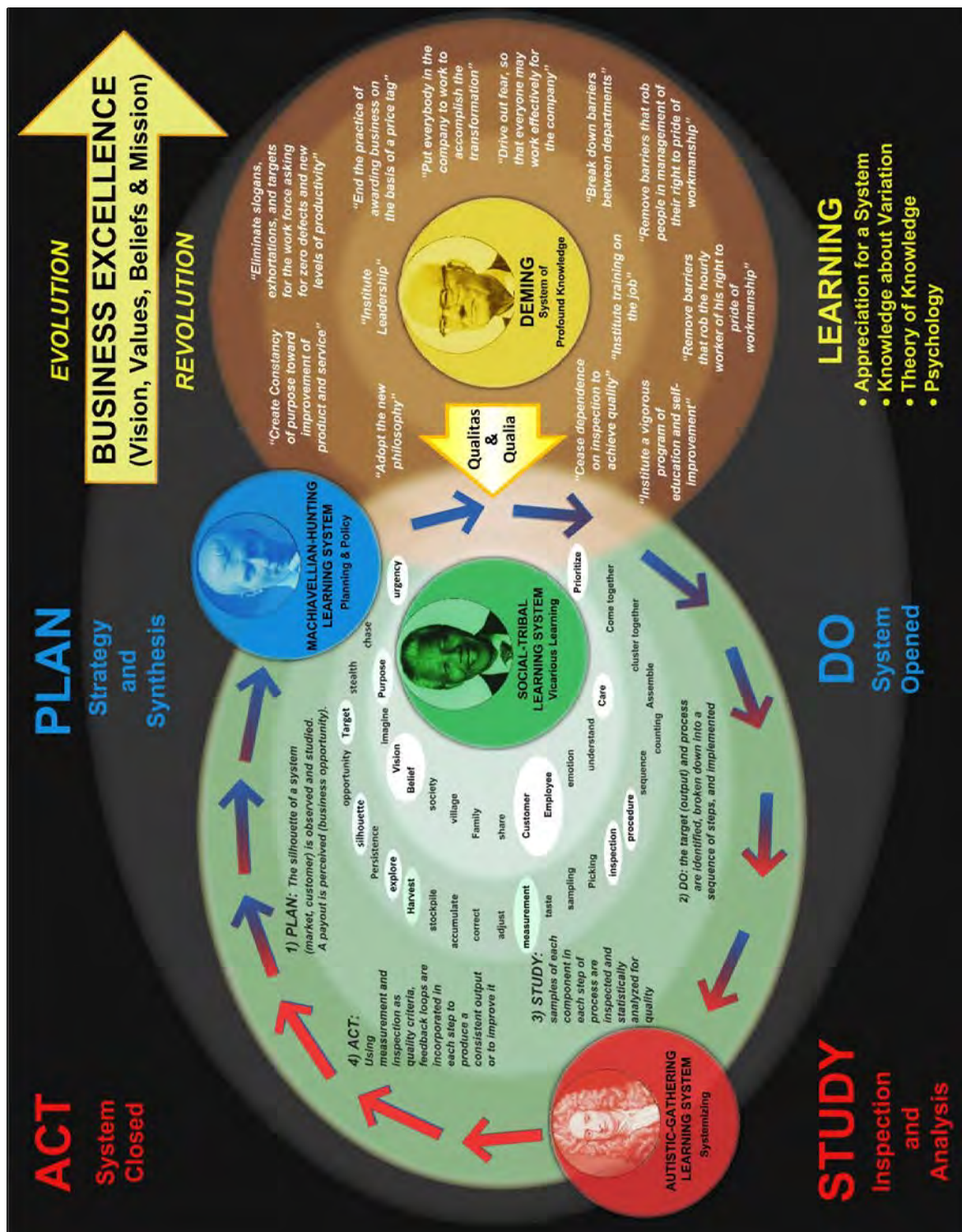


Figure 15: TALiS, the Deming PDSA Cycle and the System of Profound Knowledge

The Deming PDSA Cycle and the dynamical forces interacting within the TALiS model are presented in Figure 15. Through Deming's *System of Profound knowledge*, it is shown that transformation begins with the individual (Deming, 1982, p. 57).

Transformation is accomplished by the construction of a cognitive lens that looks at the system from the outside, in the attempt to overcome a systematic pattern of thought occurring within the current cultural paradigm. Supporting Deming's model, Dr. Meadows stated that with systems thinking an organization must defy the disciplines to see the whole system (Meadows D. H., 2008, p. 183). This requires an interdisciplinary approach and *Variation of Mind*. All disciplines, by their nature, have particular lenses, which have distortions, narrowness and incompleteness of information (Meadows D. H., 2008, p. 183). Therefore, by taking an interdisciplinary approach to problem solving, this forces everyone to teach each other, from their area of expertise, how to solve a quality problem.

Organizational learning has a long history with many published sources by researchers who have developed models in various industries (Yelle, 1979). One of the goals of these models is parameter estimation, with improved quality project planning and budgeting. These models involve the use of a *learning curve*, which is a mathematical description of an employee's knowledge and performance over time. These curves can be linear-log, S-curve, exponential, hyperbolic and others, with many variations (Anzanello & Fogliatto, 2011). *Quality Learning Curve* models have also been proposed (Lapre, Mukherjee, & Wassenhove, 2000). One important study in 1991 used a learning curve model to investigate intra-plant *carry-forward* and *transfer* of knowledge through "learning by doing"; between employees in different shifts and sites (Epple, Argote, & Devadas,

1991). Epple, Argote and Devadas discovered that knowledge as a stock does not embody itself in the technology or tools, but rather, it *flows between employees* (Epple, Argote, & Devadas, 1991). The researchers discovered through several experiments that there was a greater knowledge transfer across shifts within a plant than across production facilities that are geographically separated¹⁹. Knowledge transfer barriers between employees, their teams, and inter-organization knowledge transfer have also been studied in detail (Yih-Tong Sun & Scott, 2005). This evidence suggests the importance of mirror neuron systems in the learning dynamics within organizations and industrial work environments. Therefore, the evidence suggests if the knowledge being transferred is *tacit* or *implicit* knowledge, the best mode of transfer are through effective training programs that lean heavily on action-based learning and careful planning of schedules.

Explicit knowledge transfer has been studied within organizations that have implemented both TQM and ISO 9000 quality programs. In a 2004 study, firms that had implemented TQM and ISO 9000 were compared against organizations that did not have active quality programs (Molina, Javier, Montes, & Fuentes, 2004). The effects of *knowledge transferability* and *knowledge transfers* (internal, supplier and customer) were studied. Firms with TQM and ISO 9000 programs were found overall to have greater knowledge transferability in comparison to other industries that did not have active programs. Firms with TQM programs were found to have improved knowledge over non-TQM firms. However, it was found that ISO firms had a *lower supplier and customer knowledge* than non-ISO firms. An important characteristic of the ISO environments is the high degree of codification that is involved translating knowledge to information.

In system dynamics, knowledge as a *stock* can be categorized into *explicit*, *implicit* and *tacit* knowledge (Johnson, Lorenz, & Lundvall, 2002). Explicit knowledge can be demonstrated, captured, codified, stored and transmitted as an inventory. A diagram in Appendix C has been provided for the reader as a visual aid which shows the capture, codification and flow of knowledge as “qubits” within an ISO 9001:2008 quality management system. The terms “implicit” and “tacit” have been used interchangeably; however, they are not the same. With respect to quality, both terms (implicit and tacit) relate to *qualia*, whereas explicit knowledge is related to *qualitas*. Implicit knowledge can be inferred through empathy, language and socialization. However, tacit knowledge is the skills and expertise within the individual and cannot be communicated; rather, it must be directly seen or experienced in the first person to be clearly understood. This author was unsuccessful in finding literature evidence that clearly explained these differences, in particular where it related to quality assurance. Tacit knowledge relates to mirror neuron systems and action learning. Tacit knowledge is also a *perishable stock* (Epple, Argote, & Murphy, 1996). Tacit knowledge within the individual has a rate of knowledge decay, called the “Power Law of Forgetting” (Wixted & Ebbesen, 1997). The acquisition of knowledge called the “learning curve” within individuals has also been investigated (Ritter & Schooler, 2002).

This author was unsuccessful in finding evidence of studies in laboratory medicine which investigated in detail, the rate of tacit knowledge decay and acquisition in learning, that is: 1) low motor; 2) high motor; 3) low cognitive, and; 4) high cognitive laboratory skills. However, a thesis was discovered which explored in detail the effects of knowledge

acquisition and decay within individuals versus groups (MacKinnon, 2007). Dr. MacKinnon found that for participants who are learning a complex skill, it may be best to formally train them, then allow them to use what they have learned and continue to learn by doing. Also, Dr. MacKinnon found that if mentoring is performed by peers and not an expert, a performance deficit might arise. Therefore, *designated expert trainers* are reasoned to help ward off tacit knowledge decay within medical laboratory environments.

Explicit, implicit and tacit knowledge have been found to decay at different rates (Tunney, 2003). Also, depending on the nature and complexity of the task (motor, high-motor, cognitive, and high cognitive), tacit knowledge itself will decay at different rates (MacKinnon, 2007). It is this author's opinion that Dr. MacKinnon's thesis is valuable to quality assurance and laboratory medicine. His study found that knowledge decays more rapidly in *individuals* than *groups*. MacKinnon also found that when team members *changed roles*, that the decay of knowledge was *slowed*. These findings are very important when considering *cross-training* and the *total knowledge capital* of medical laboratories within a regional health authority. What appears to be not studied, are the types of knowledge decay and their rates of decay within *rural laboratories* versus *regional medical laboratories*. However, there is some indirect evidence that quality assurance measures to reduce knowledge decay, relating to error rates within Point of Care Testing (POCT), has been investigated (Khoury, 2014).

This study has revealed that the Systemizing Quotient may be important and may be related to knowledge transfer and decay. However, the AQ, EQ, and Mach-IV may be very

important as well and where they relate to cognition. Depending on the discipline and skills required for analytic quality, it is reasonable that knowledge which requires a high level of cognitive interpretation (e.g. cytology, microbiology and hematology morphology) would deteriorate more quickly than simpler repetitive tasks (e.g. automated biochemistry or automated hematology). Also, depending on the frequency of the test ordered, technical knowledge may deteriorate as well. It is in this light that the high degree of codification of explicit knowledge is very important within an ISO regulated laboratory environment. However, due to the nature of implicit and tacit knowledge and their vulnerability to decay over time, it appears that a rigorous training program is required as a complement to an ISO quality management system to keep the knowledge stock relatively stable. Therefore, total knowledge (explicit, implicit and tacit) as a pool or stock is maintained by a robust quality management system and training program.

The Deming PDSA cycle supports the TALiS and Orch-OR models through its method of new knowledge capture, translation, codification and transfer within a complex system. New knowledge flows begin with an understanding of the needs of the customer where teams are organized through vertical hierarchies. The new knowledge of the customer quality requirements is captured using quality tools. Once captured, this new knowledge is translated, codified and transferred within a quality system (Epple, Argote, & Murphy, 1996). However, this new knowledge transfer (explicit, implicit and tacit) within a quality system is reasoned to follow a defined sequence within distinct information pathways. The dynamics of learning and knowledge transfer within the TALiS and Deming PDSA cycle are presented in Figure 16.

Using concepts from Kurt Lewin's *Field Theory* and *Change Theory* (Lewin, 1947), a quality project management plan can be visualized and modeled as a *learning space* (See Appendix A). The learning space (a gestalt field) can be mathematically modeled and plotted graphically by using a sigmoid function curve. In project management, the project S-curve is frequently used as a visual plot of the cumulative totals of the resources that are used against time and it is used to depict value against the costs of the project work (Project Management Institute, Inc., 2008).

Within a QPMP, the project S-curve starts off slowly, escalates, and then levels off as the project approaches completion. However, within the project S-curve, a *learning curve* also exists, which can be modeled the same way (Anzanello & Fogliatto, 2011). This learning S-curve plots the new knowledge transfer as a stock within the project learning space. Due to the design of the system and the actors employed, there are *limiting factors* that constrain the QPMP (Meadows D. H., 2008, p. 100). This sigmoid function curve can be described using a simple heuristic formula:

$$P_{LS}\% = f(t, T_{SF})$$

Where:

$P_{LS}\%$ = percentage of the project completed (Knowledge transfer as a stock)

t = time frame within the project implementation

T_{SF} = total time frame of the project (total learning space)

The variable T_{SF} which describes the learning field is bound by the “shape factor” or dimensions of learning and knowledge transfer.

The infographic in Appendix A is a projection of dimensions which makes up the Lewin learning field in a QPMP based on the TALiS model. Four dimensions of learning and knowledge transfer (explicit, implicit and tacit knowledge) are reasoned to be occurring within this gestalt sphere over time. These dimensions of learning making up the overall field surrounding the actors are required to understand the new knowledge and complete the project. Human beings make decisions and act upon them through “bounded rationality”; that is, the actors make the best decisions based on the information and knowledge they have at the time, through their relative vantage points (Meadows D. H., 2008, p. 105). All actors do not have access to perfect information, as “omniscient rational optimizers”. This time delay with information flows is problematic for more actors employed in *distant parts of the system* and also their *perception of time*. To complete the project, all actors require feedback information, to keep the project in control (Meadows D. H., 2008, p. 106). Due to imperfect information and time delays with feedback, the shape factors which describe the total learning space (T_{SF}) are constraints which put a *minimum time limit* on the project S-curve knowledge transfer cycle (change cycle). This means that the time dimensions of knowledge transfer (and feedback control) must be considered within the three-dimensional learning space. Therefore, within a large-scale system, this time limit is a constraint that impacts the organization’s ability to *maneuver* quickly, due to sudden changes in the *market*, if customers’ needs change or if there is threat of *competition*.

The learning space is also a product of the four phases making up the PDSA cycle. QIPs that are of similar nature, such as periodic equipment installations, can be reasoned to have learning spaces with similar *shape factors*. If the *same projects* are managed at *defined phases* in the *same sequence*, the learning space along these dimensions collapses. Using defined phases in the same sequence collapses the shape factors making up the learning space for each PDSA cycle. As the process of change within the QPMP is better understood by the actors (tacit knowledge) for each change cycle, there is less time delay since this knowledge has already been transferred to the actors. Therefore, the importance of the Deming PDSA Cycle and its variants that are used in Six Sigma QPMPs, is their ability to both collapse and smooth the learning process for each step in the cycle, thus reducing total project cycle time within the learning space through improved knowledge transfer for each change, product-service or business lifecycle.

Discussed earlier, knowledge flows through the actors (Epple, Argote, & Devadas, 1991). Quality tools are “neurocognitive prosthetic devices”, which help capture, translate, codify and facilitate the flow of new knowledge between the actors. The flow of knowledge within learning space for the actors involved in the change plan can be expounded upon using TALiS model. The three learning system archetypes (See Figure 16, “STLS”, “MHLS” and “AGLS”) within the TALiS are visualized as three distinct sigmoid learning curves within the overall project learning space sigmoid curve. If the project learning space spans more than one workspace (multiple functional centres) and translated into a stock and flow model for each TALiS learning system archetype, the information flows and knowledge transfer are reasoned by this author, not to be instantaneous and occur at

different rates through functional holarchies and social hierarchies. New knowledge does not transfer to all actors at the same time, due to feedback time delays between each actor in the system. For clarity to the reader, if the project is of minor complexity within one workspace as a simple functional holarchy and involves a small group of employees, mirror neuron systems and their effectiveness at transferring both tacit and implicit knowledge through reciprocal feedback, compensate for any shortcomings of the change plan.

The phase lag of the new flows of knowledge for large scale change projects, however, would be problematic if the area for improvement spans multiple functional holarchies, multiple layers of social hierarchies or heterarchies. This implicit and tacit knowledge transfer obstacle is reasoned to be due to the limitations of mirror neuron systems. Also, the phase lag is due to time delays with the capture, codification and transfer of explicit knowledge. It is in this light, that the Deming PDSA cycle and variants of this dynamic control feedback loop, used in Six Sigma QMPs, become very important in quality assurance. It is questioned by this author if the quality tools that are used in QMPs act as neurocognitive supports, triggering the appropriate mirror neuron activation at the correct sequence to different parts of the TALiS (see Appendix B). As the backbone of a change management project, the Deming PDSA cycle helps project leaders reduce operational risks through effective change sequence and knowledge transfer. Therefore, if the rules, tools and procedures used in the QMP are understood and followed by all team members in the correct sequence, the Deming cycle permits the systems to be safely opened, new knowledge to be transferred and closed within large scale QMPs.

Expounding upon Lewin's Field and Change Theories, the TALiS knowledge transfer model in Figure 16, predicts that there will be time lags with specific types of *new knowledge* transfer within the triad:

- 1) The STLS is first used to understand the *voice of the customer* and begin the capture and translation of customer requirements (qualia and qualitas) as qubits of explicit, implicit and tacit knowledge in the PLAN phase. Reciprocal feedback occurs between team members within the social hierarchies or heterarchies;
- 2) The qubits of knowledge are then characterized and prioritized, using various quality tools in a defined sequence. The project team and their leaders, then figure out which functional centres and their departments (functional holarchies) that are affected by the improvement (QFD). This involves a reciprocal flow of knowledge between the STLS and MHLS;
- 3) The MHLS then figures out the exact entry point into the system using tools such as the House of Quality and constructs the roadmap of changes in a defined sequence, using tools such as Gantt charts. The MHLS begins to *action the plan* and open the social-functional holarchies at the bottom of the hierarchy/heterarchy (DO phase);
- 4) The MHLS then begins to work with the AGLS to introduce feedback loops into the new process flows within the new functional-holarchies. Explicit Knowledge is further codified into tools such as flow charts, checklists, procedures and validated by users. Implicit and Tacit knowledge is transferred through training. Product output quality is measured and compared (inspection and control), against the quality requirements of the customer using tools such as statistical process control charts in the STUDY phase, and;

- 5) The AGLS then makes the appropriate adjustments to the steps in the process flows within each functional hierarchy and improves codification of the new knowledge. This codification in higher detail is accomplished through inspection and control, effectively closes the system (ACT phase). Repetition facilitates the transfer of implicit and tacit knowledge. Through a process of continual improvement as a dynamic learning loop, the AGLS is heavily leaned on, ever tightening the process steps through inspection and control to meet the product or service requirements of the customer (STLS). Explicit, implicit and tacit knowledge has been transferred in the new system.

Therefore, when the project plan and its knowledge flows are visualized as a sigmoid function curve and compared against the action based learning *bell curve*, it is predicted that neural activation, implicit and tacit knowledge transfer within the TALiS will occur as a distinct sequence of steps, at different rates of flow, where action learning escalates between the DO and STUDY phase within the PDSA Cycle.

The type of the change being made within a regional laboratory service and the size of the improvement project may be problematic for quality leaders. The positive correlation between the systemizing quotient versus the laboratory size (see Table 9, SQ-R, $r_s=0.34$, $p<0.10$) suggests that there might be challenges in rural laboratories. Discussed earlier, the lack of correlation between the SQ-R and Mach-IV (see Table 7), along with the higher Mach-IV group mean within the workforce (see Table 11), suggests that there are two distinct forms of perception at play (the AGLS versus MHLS archetype). Both learning system archetypes within the TALiS model have different requirements, which points to different learning supports and reciprocal feedback controls to capture and transfer knowledge. Therefore, it is questioned by this author, if more time is needed, along with

specific learning supports, information access, training and feedback are needed to bring rural laboratories in alignment with the larger regional laboratories during QPMPs.

Large regional laboratories also face challenges as well. It was originally thought by this author, based on the literature review and evidence presented, that individuals with ASDs might have a preference for work environments with smaller social circles and may be motivated to work in rural laboratories, thus avoiding the high social traffic and hierarchies in the larger laboratories. This author's notion may not be correct, based on the evidence in this workforce study. The inverse relationship between the AQ and EQ scales is clearly understood by the psychology researchers and has been validated by prior studies. This relationship was verified in this medical laboratory workforce study and was found to be statistically significant (Table 7, Column 1, row 2, EQ versus AQ, $r_s = -0.59$, $p < 0.001$). However, minor correlations were detected for both the AQ and EQ scales versus "Size of community employed" and "Laboratory size", which seem to hint that the AQ scores *rise* and EQ scores *drop* with *increasing size* of the community or laboratory (see Table 8). The reader is cautioned that this evidence is far from conclusive and these relationships need to be verified in larger studies.

Mentioned earlier, empathy is associated with social dominance and Authoritarian behaviour (Backstrom & Bjorklund, 2007). It appears, based on the evidence in this study, that within a regional model, laboratory leaders think objectively, see the "bigger picture" with common quality goals in mind. If the AQ and EQ scales and the evidence in this study have any predictive utility in change management, it is thought that greater success with

QPMPs might be realized if the team sizes are kept relatively small, perhaps groups of two to five person teams. It is thought by this author that using a small team approach could help reduce staff confusion, information overload, stress, and anxiety²⁰. Too much time may be wasted keeping large teams together. However, the issue of implicit and tacit knowledge transfer, and also decay, within different team models and their relationship with Dunbar's Number needs to be studied in future experiments. These experiments should be studied also within ISO regulated and non-ISO regulated environments. Therefore, more research is needed to better understand the relationships between the workforce population characteristics and knowledge transfer within change management.

A final discussion should be made with Six Sigma methodologies. The CLSI document *QMS06-A3: Quality Management System: Continual Improvement* briefly discusses of Six Sigma and the merits of this methodology. However, the guidance document only discusses the DMAIC methodology. The committee did not mention *Design for Six Sigma* and its variants²¹. There has been a concern expressed by researchers about the lack of evidence in published journal papers, which have examined six sigma methodologies using a rigorous research approach. Nonthaleerak and Hendry found that there was a notable bias where the authors focus only on the positive attributes, with a lack of conclusive empirical evidence showing both the strengths and weaknesses of this approach (Nonthaleerak & Hendry, 2008). Also, Nonthaleerak and Hendry discussed the complexity of six sigma tools, employee literacy, and fear levels, leading to avoidance of undertaking six sigma projects²². These learning obstacles, combined with fear, could lead

to failure. Several issues were identified by Nonthaleerak and Hendry that influence the success of six sigma implementation (Nonthaleerak & Hendry, 2008):

- 1) Black Belt involvement (part-time vs. full time);
- 2) Reporting structure of belts to the Project Champion;
- 3) Inclusion of a technical support team;
- 4) The effectiveness of training programs in six sigma, and;
- 5) Involvement of management.

Despite the numerous benefits of Six Sigma methodologies, such initiatives should not be taken lightly. Six Sigma projects are heavy, data-driven methodologies that require both executive engagement and staff buy-in. As with any change, there is political resistance to six sigma methodology and it is not isolated to the healthcare industry (Feng & Manuel, 2008).

It is a thought by this author, that if there is time and leadership is aware that a six-sigma culture is the direction their organization is headed, *Design for Six Sigma* might be a better starting point. This approach allows the foundation to be laid down first, permitting staff to learn, and appreciate the many merits of six sigma methodology. There is also a great amount of flexibility and creativity, depending on the industry. As an example, a medical laboratory is a hybrid of the manufacturing and service model. Depending on the nature of the service, some tools may be more appropriate than others. It is possible that new tools can be developed that are entirely novel and unique to the industry. Also, through practice and evaluation (“lessons learned”), it may be possible to both ease and

streamline Six Sigma Quality Project Management Plans (QPMPs). The incorporation of *Heuristics* into change plan methodologies might benefit organizations when the project team is facing uncertainty, lack of time and incomplete information (Gigerenzer & Gaissmaier, 2011). Heuristic methodologies, as strategies to speed up decision making, are beyond the scope of this thesis. However, it is felt by this author, that Heuristics is an important area for study in Quality Assurance, valuable in conceptualisation, trial-and-error experimentation, and deserves mention²³. Therefore, QPMPs can combine the best aspects of Heuristics with Six Sigma, leading to novel approaches in change management, giving organizations a competitive edge, with the goal of product-service distinctiveness.

Cultural obstacles with organizational change using Six Sigma methodologies may be explained using the TALiS model. The AGLS archetype and its association with systemizing, has an inverse relationship with the STLS, which is associated with empathy, care, and community. Evidence in the literature review, along with the laboratory workforce study (see table 7), has verified the inverse relationship of the SQ and EQ, supporting Dr. Baron-Cohen's *E-S Theory of Mind* model (ToM) (Baron-Cohen, 2009). However, the two learning system archetypes are reasoned by this author to be distinct in their vantage points in relation to the MHLS. Using Figure 9, the AGLS and STLS are reasoned to interact *within the social space* as dynamical opposites; whereas the MHLS interacts with *both* from a vantage point *outside the social space*. Dr. Deming stated, "Suppose that (1) everybody knew what to do. (2) Everybody did his best. Result: dissipation of knowledge and effort; results, far from optimum. There is no substitute for teamwork and good leaders of teams to bring consistency of effort, along with knowledge"

(Deming, 1982, p. 19). This means that the leadership approach is to reach *within* the social space and cognitively *shift* the project team's vantage point *outside* the social space, so they can see the "bigger picture" from a *distance*. This can easily be accomplished by construction of flowcharts, cross-functional maps, value stream mapping (see Figure 13) and other quality tools (ASQ, 2015). By doing so, the employees can better see how their roles and actions as teams can be optimized by doing things the *same way* to achieve a greater *Transfer Value*, thus supporting the wisdom of Dr. Deming's "consistency of effort" during organizational change (Deming, 1982, p. 19).

Raising the bar and aligning higher quality goals with the mission and vision statements can be a great challenge for leaders, especially when the markets change. This reality may come to a point where the organization may need to make changes to the vision and mission statements. It is well known in the corporate world that within many companies, the vision and mission statements have become "watered down" where they have become meaningless. Vision, mission, and value statements, are powerful transformation tools in quality assurance and are the critical link to product and service *distinctiveness* and long-term sustainability. These tools help the organization and its people understand who they are as a community, their purpose and their relationship with their customer. Therefore, these changes to the vision, mission, and values statement may require careful use of new *persuasive* language, which is not frequently used within the "common tongue" of the group²⁴.

Although it is out of the scope of this thesis, it is questioned by this author if the use of *semiotics*, could be of great benefit to the advancement of quality assurance²⁵. However, Dr. Meadows and Dr. Deming both cautioned quality leaders about the use of “slogans” (Deming, 1982, p. 24) and “language pollution” (Meadows D. H., 2008, p. 174). In the act of trying to achieve organizational distinctiveness, the careless use of new language may lead to employee confusion within the organization. In healthcare, this author proposes that the use of words, to shape the new vision statement should capture the *aura* or *spirit of goodness*. In this light, quality leaders might want to seek moral reasons for a change, with dimensions of spirituality through the art of *rhetoric*. Therefore, in healthcare, the philosophies, science and ethics of *Integral Permaculture* may be a better approach, with the persuasive language to overcome the cultural barriers to QPMPs, thus leading to new cultural paradigms.

Dr. Donella Meadows’s research in systems science and environmentalism may be a great source of inspiration for quality leaders. Dr. Donella Meadows discussed her own “sins” and related them to Thomas Jefferson, stating that both “Tom” and she were “slave-owners” in her article *Thomas Jefferson and Donella Meadows, Slave-Owners* (Meadows D. , 1998). She stated that if she was an average American, she would “consume in fossil fuel the energy equivalent of 80 full-time slaves” (Meadows D. , 1998). Knowing this, she discusses her sins and efforts to mitigate them. Meadows stated, “Like Jefferson, I do my best to mitigate my sins, to use my energy slaves kindly and efficiently, to reduce my load on the groaning earth. But to do that entirely would be to lose my livelihood, my farm, my society, my whole culture” (Meadows D. , 1998).

It is believed by this author, that Donella Meadows's philosophy and wisdom could have a big impact in business and healthcare. In the act of pursuing *a livelihood* and "doing business", an organization, with its stakeholders and employees commit "acts of sin" that impact people, society, and the environment. Dr. Meadows presents an ethical dilemma that no organization can truly transcend as a goal, but can continually work towards it as a community.

Wastes, energy consumption, and environmental harm can be reasoned to be "sins". Dr. Meadows stated to "never erode the goal of goodness" (Meadows D. H., 2008, p. 184). This suggests that Lean Six Sigma and other quality improvement methodologies should be encouraged and reworded in the spirit, ethics and language of integral permaculture so that the organization *sins as little as possible* in the process of doing business. Integral permaculture applies to healthcare organizations. Being conscientious of wastes and using more environmentally friendly and socially responsible approaches, should lead to service stability and long-term sustainability in healthcare. Therefore, there are both *practical* and *moral* reasons for adopting integral permaculture in healthcare and business.

Organizational Learning and Profound Knowledge

A new employee represents a golden opportunity for an organization to evaluate the effectiveness of its own quality system and training program, especially employers who have a "zest for experiment" and wish to study learning curves within their organization. A better understanding of employee learning curves is important for planning and budgeting. No man-made system is perfect. Donella Meadows said "stay humble - stay a learner"

(Meadows D. H., 2008, p. 180). A new employee serves as an opportunity for an organization to detect the systems problems with “fresh quality eyes”, much like an auditing tool. It is quite possible that due to status-quo, long term employees may develop “blind eyes” in some circumstances. Explicit, implicit and tacit knowledge acquisition (and decay) can be measured and monitored. Keeping both current and competitive is a daily challenge for all laboratories. There is also an opportunity for cross-pollination of ideas and new knowledge transfer. Organizations and their employees can learn from one another. Also, this should be seen as the golden opportunity to evaluate the new employee’s character and perception. Quality awareness should be discussed right from the start and encouraged using one of Donella Meadow’s quality rules. Meadows stated, “...be a quality detector. Be a walking, noisy Geiger counter that registers the presence or absence of quality”. (Meadows D. H., 2008, p. 176).

In addition to training checklists, new employees could be provided with non-conformance forms and audit checklists as the “newly appointed interim quality detector”. The learning goal is to bring the new employee into the quality culture as fast as possible. The trainer should find out what impressed the new employee the most about the work environment. The quality goal would be to capture dimensions of the laboratory environment and its distinctiveness, in relation to other experiences the new employee had with other organizations. Therefore, auditing tools can help establishing feedback loops quickly in a training program by tearing down barriers to learning.

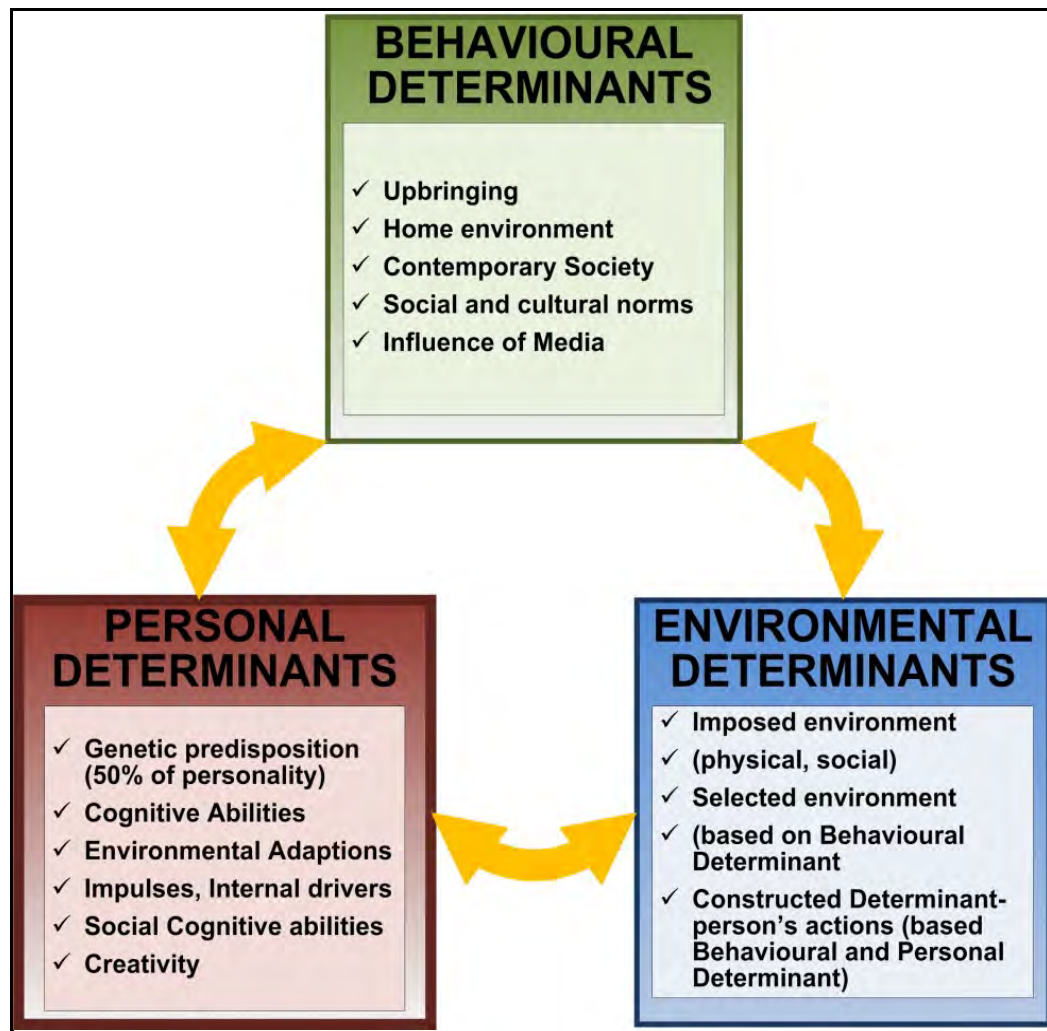


Figure 17: Dr. Albert Bandura's Reciprocal Determinism Model of Social Learning

Auditing tools can be learning tools as well. The auditing tools permits the trainer and organization to figure out what the learner might think is important and their perceptiveness. Bandura's reciprocal determinism model is presented in Figure 17. In order to support the reciprocal determinism model, a training program should have within its design learning supports that recognize the employee's cognitive style, their prior work history and have the capacity to align the new skills to meet the quality goals of the

organization. Therefore, there are sets of feedback loops required, which recognizes that there is both a process of *unlearning* and *learning* involved. New employees may have unique learning needs and may potentially have poor quality habits that can be carried from a previous employer.

The research study on the laboratory workforce is thought-provoking because the evidence suggests that a significant number of technologists may have an autistic personality type. However, this thesis is merely a starting point for future research opportunities. If there are, in fact, laboratories which employ technologists with AS:

- 1) It could be reasoned, based on the evidence in this study, that medical laboratories have enjoyed an overall success with this workforce population;
- 2) Asperger's Syndrome personality traits may be viewed as "desirable qualities", such as high attention to detail, rigid adherence to processes, procedures, and;
- 3) Medical laboratory environments, in relation to other industries, might even be called "autistic friendly" work environments, with many supports.

It is well known that individuals with ASDs can have difficulties with employment (Hurelbutt & Chalmers, 2004). Other industries may want to these individuals who have Autism spectrum conditions for their differences in perceptiveness, but may lack the knowledge that medical laboratories have to employ these individuals successfully. Therefore, if other industries can learn from leaders in laboratory medicine, this could mean a competitive business edge for many businesses.

The CLSI document *QMS03-A3: Training and Competence Assessment* is rich with ideas, words of wisdom, templates, and examples. This body of knowledge provides the structural supports and guidance, to promote effective learning for the new employee. To expound upon the body of knowledge within the CLSI document, this author targeted the following areas discussion and improvement: 1) mirror neuron systems and their differences between employees; 2) perceptions of care by patients, and; 3) social learning and Dunbar's Number. The CLSI document *QMS03-AS* discusses in detail the desirable qualities of a good trainer:

“Trainers should be qualified to impart the necessary knowledge and skills to others and regularly work in the processes and perform the procedures in which they instruct others. The service needs to decide how it will determine which person(s) is (are) qualified to train others” (CLSI, 2009, p. 11)

The CLSI also listed the necessary the personality attributes of a qualified trainer, such as: 1) enthusiasm for working with people; 2) good verbal, observational and listening skills, and; 3) patience and respect for colleagues (CLSI, 2009, p. 11). Therefore, good trainer qualities require a balance of technical and “soft skills” to nurture and develop effective learning.

The CLSI also recommends that the training environment should be conducive to learning, where the learners have a “safe” learning environment and are not punished for their mistakes. Deming stated that management must “drive out fear, so that everyone may

work effectively for the company” (Deming, 2013, p. 132). The CLSI committee endorses the EDIC model of learning (CLSI, 2009):

- 1) *Explain* – The trainer explains why a task is performed within a process;
- 2) *Demonstrate* – Trainer explains steps in procedure (visual and auditory learning);
- 3) *Imitate* – Learner imitates the trainer’s actions (tactile and auditory learning), and;
- 4) *Correct* – The trainer corrects the learner’s errors in a safe manner.

This learning process involves a cyclical feedback loop that benefits both parties.

Therefore, the EDIC process supports the TALiS model, which helps ensure the appropriate mirror neuron activation within each learning system archetype, permitting implicit and tacit knowledge transfer from person to person.

Table 14: ASD Research Evidence and Opportunities for Training Supports

LITERATURE SOURCE	ASD RESEARCH EVIDENCE	COMMENTS
(Baron-Cohen, 2013)	<ul style="list-style-type: none"> ✓ ASD show high levels of morality & care ✓ “Mirror opposites” of Psychopaths ✓ Issues with <i>Cognitive Empathy</i>, not with <i>Affective Empathy</i> 	<ul style="list-style-type: none"> ☹ This paper appears to contradict the finding of (Kukoyi, 2007) Table 1.
(Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007) (Dziobek, et al., 2008)	<ul style="list-style-type: none"> ✓ individuals with ASDs have no issues with affective empathy, but rather impairments with cognitive empathy 	<ul style="list-style-type: none"> ✓ ASD group may struggle with politics and bullying
(Samson, Huber, & Ruch, 2013)	<ul style="list-style-type: none"> ✓ ASD scored significantly lower on cheerfulness than controls ✓ ASD scored significantly higher on seriousness than controls ✓ ASD scored significantly lower on mean-spirited humour than controls 	<ul style="list-style-type: none"> ✓ cultural differences that might exist between laboratories ✓ ASD employee may misinterpret a joke as a personal attack
(Fecteau, Agosta, Oberman, & Pascual-Leone, 2011)	<ul style="list-style-type: none"> ✓ Abnormal language neural network dynamics exist in ASD ✓ Aphasias mentioned 	<ul style="list-style-type: none"> Q Is there an overlap of traits between ASD, faces and names?
(Ashwin, Wheelwright, & Baron-Cohen, 2006) (LoBue, 2009)	<ul style="list-style-type: none"> ✓ People with HFA/AS had a superior ability compared to normal controls in detecting angry or threatening faces in crowds 	<ul style="list-style-type: none"> ✓ Individuals with ASDs may be using different neural systems to detect threats in crowds Q Is this study related to traits found in Machiavellianism?
(Ashwin, Baron-Cohen, Wheelwright, O’Riordan, & Bullmore, 2006)	<ul style="list-style-type: none"> ✓ fear perception differences in HFA/AS group when compared to control group 	<ul style="list-style-type: none"> ✓ A person with ASD may not realize they are triggering fear in another individual (face processing deficits) Q What about <i>tone of voice</i> to detect fear?
(Pierce, Sedaghat, & Courchesne, 2004)	<ul style="list-style-type: none"> ✓ fMRI study compared ASD to normal controls when seeing familiar/unfamiliar faces. ✓ ASD group showed a limited network response to familiar faces in comparison to control group 	<ul style="list-style-type: none"> ✓ ASD employees may take longer to get comfortable with the lab culture Q Is there a relationship between ASD and <i>prosopagnosia</i>?

The goal of the literature review and this medical laboratory workforce study is to provide readers with evidence, which could lead to new ideas for improved training programs. The first step would be to identify the obstacles which specifically are tied to *social learning*. It is reasoned by this author, that better understanding of the dynamics, which relate to social bonding can be realized. Evidence was gathered from studies where researchers investigated social transactions and their dynamics within the ASD population (Table 14). This author has also suggested possible situations where learning obstacles might occur during social learning. Therefore, the aim of Table 14 is to provide the reader the most current information on ASD socialization challenges, where improvements can be made in the employer's training program.

The reader should be aware that some of the evidence presented in Table 14 involved smaller scale studies. Also noted by this author during the literature review, were two published sources that discussed *moral reasoning*, which appear on the surface to contradict one another. Moral reasoning is a product of *social learning*. Dr. Simon Baron-Cohen stated that individuals with ASDs were best described as: 1) “mirror opposites” of psychopaths; 2) often showing high levels of care; 3) are often the most loyal of employees; 4) recognize the immorality of betrayal, and; 5) the importance of “group loyalty” (Baron-Cohen, 2013). In this light, individuals with ASDs appear to have no issues with *affective empathy* and care. However, Dr. Baron-Cohen's discussion, appears to contradict the findings of Dr. Benedictus Kukoyi, who used the *Defining Issues Test* (DIT-2) to investigate moral reasoning among medical laboratory employees in 2007 (see Table 1, n=47). Dr. Kukoyi stated that medical laboratory professionals had “lower levels of

morality” when compared to other healthcare professionals (Kukoyi, 2007). Kukoyi stated in his abstract:

“Moral reasoning forms the basis of ethical behavior and good decision making; this is limited in people with poor moral reasoning score, which could result in incorrect laboratory results being reported to patients and physicians.” (Kukoyi, 2007)

It is this author’s concern that Dr. Kukoyi’s conclusions are misleading. The shortcomings of his study can be explained by understanding of the limitations of the DIT-2 Test.

The *Defining Issues Test* (DIT-2) is a multiple-choice, Likert-scale questionnaire that contains six hypothetical dilemmas, which are used to determine an individual’s moral reasoning skills. There are two very important limitations of this test: 1) none of the dilemmas in the DIT-2 involves a *business scenario*, and; 2) the DIT-2 also involves the use of a *protagonist* (Elm & Weber, 1994). The use of a protagonist requires the participant to *imagine* the dilemma from the protagonist’s *viewpoint*, which requires *cognitive empathy*. It is in this light, the earlier discussion by Dr. Baron-Cohen becomes very clear with respect to Dr. Kukoyi’s study and conclusions. Dr. Kukoyi’s evidence may have provided greater utility if the DIT-2 and EQ tests were used together in the design of his study. It is also important to note that the EQ test used in this study is limited and cannot distinguish between *cognitive empathy* and *affective empathy* (Rogers, Dziobek, Hassenstab, Wolf, & Convit, 2007). However, it is possible that his study may provide a clue, when the limitations of the DIT-2 test are considered in relation to the evidence

presented in this study. Therefore, individuals who may have ASDs and are employed in the laboratory, appear to have no issues with affective empathy and care, but may have possible challenges in busy laboratories which demand *high social attention, rapid attention shifting* and cognitive empathy.

The social learning difficulties which might arise in a laboratory environment are scenarios where an employee is required to quickly cognitively shift to another employee's vantage point. This issue will easily surface in any busy laboratory or workplace environment where employee's attention must quickly shift between the bench, other workers, clinicians and their customers. The discussion of morality, being a form of social learning and where it applies to the medical laboratory workforce is very complex and beyond the scope of this thesis. With limited published research data, including this study, it is very difficult to draw any conclusion. In the spirit of continual improvement, Table 14 is presented to the reader as a source for better understanding which could lead to new ideas and learning supports. It is thought that the gaps in knowledge in Table 14 may be sufficient evidence for laboratory leaders and researchers to argue for research funding through the CIHR. However, this evidence is also thought by this author to benefit all employees through an understanding of social dynamics in the workplace. Therefore, the orientation-learning program should consider the dimensions of social learning, Dr. Bandura's reciprocal determinism model, along with the evidence presented in Table 14, to better accommodate all learning styles and needs.

The EDIC training model endorsed by the CLSI, is reasoned by this author to be a method of “neurocognitive lens training for quality”. Looking at Table 14, the social quality dimensions are related to empathy, bonding and the perception of care. Even with effective training programs, the learner may have difficulty adjusting to the new culture. Table 14 can, therefore, be used as briefing material for the trainer’s own awareness on Autism Spectrum Disorders. It is recommended that there should be clear anti-bullying policies because anxiety and fear are barriers to learning. One item not discussed by the CLSI is the importance of *cultural sensitivity training*. This issue in Canada is very important with respect to clinical services specialized to the needs of the First Nations and Inuit cultures. Therefore, it is reasoned that cultural sensitivity training should be a part of employee education, promoting empathy and community within organizations that service the needs of minority groups and marginalized populations.

Training does not just apply to the new employee. Training also applies to situations where learning needs are identified through:

- 1) Organizational change;
- 2) Technological changes;
- 3) Quality issues in the laboratory (IQC and EQA), and;
- 4) Post-peer review visits by accrediting bodies.

The laboratory workforce study has produced some evidence suggesting that there is a relationship between facility/community size and the systemizing quotient. Individuals employed in smaller laboratory sites scored lower than individuals in larger sites (see Table

9). The predictive validity of the SQ-R questionnaire may be valuable to quality assurance. It is thought by this author that the bigger picture should be considered, which includes all healthcare employees. It is quite possible that a similar relationship may be found for all health disciplines within a regional health services model. However, this author's notion needs be verified in a future study. Therefore, the evidence is not just important to learning requirements of medical laboratories: it may apply to learning needs of all users across the whole healthcare organization and could very well apply to non-healthcare industries.

Due to lack of learning supports, other departments may unknowingly be undermining quality goals and efficiencies of medical laboratories. Even with the best spirit of quality service in mind, healthcare clinicians or other users of laboratory services may be unaware how their actions lead to problems elsewhere within the system. Also, services which support laboratory operations may require training as well. This can include facility services, housekeeping, and materials management. Learning supports may be required for smaller, peripheral health care sites and departments, such as nursing, where training is needed to blood collection procedures, point of care testing (POCT) and computer technologies (HIS, LIS and EMR). The systemizing quotient differences between the medical laboratory group and nursing is thought-provoking. The SQ-R questionnaire serves as an excellent opportunity for employers, who need insight on the learning needs of a workgroup that is undergoing change and also with budget preparations. Therefore, undesirable system archetypes may surface with every laboratory change that is made if countermeasures are not put into place to accommodate the different learning needs of all users.

Although any medical laboratory is potentially vulnerable to system traps, a robust quality system should be able to detect the risk of undesirable system archetypes early. Mentioned earlier by this author, was the relationship between mirror neuron systems that are associated with hand movements. This evidence may point to quality issues with internal QC and external proficiency (EQA). Laboratories by their nature require very stable environments to maintain quality. They can be impacted by the economic, staffing, workload and time pressures. Since mirror neuron systems are related to implicit and tacit knowledge transfer, it is recommended that all laboratory personnel should be regularly checking each other's hand techniques to ward off this form of knowledge decay. This collective effort may help improve analytic precision in disciplines such as biochemistry. However, the question of "bias creep" may be another issue altogether. Two or more laboratories may have excellent analytic precision, but they could have bias issues compared to peer-group values for a given analytic method. Bias problems with analytic quality may point to problems with feedback loops and time delays between the laboratories and higher level quality analysts. Specialists may include biochemists, haematologists, microbiologists or pathologists. Therefore, if this flow of information is well mapped out, the quality specialist (or a technical services department) can better see the overall performance of the laboratories in the region and advise all staff and expert trainers on opportunities for improvement.

It is not entirely clear how the psychometric questionnaires used in this study may relate to mirror neuron systems, cognition, and implicit-tacit knowledge acquisition.

Laboratory techniques can be classified as low-motor, high-motor, low-cognitive and high-cognitive tasks. Simple examples are provided for clarity, but can be expanded upon:

- 1) Low Motor – inventory loading, waste disposal, workflow organization;
- 2) High Motor – pipetting technique, Instrument maintenance, phlebotomy;
- 3) Low Cognitive – reading ESRs, reading instrument computer screens, and;
- 4) High Cognitive – Hematology, Cytology, Microbiology morphology (microscopy).

This author was unsuccessful in finding evidence of prior investigations that studied in detail the rate of knowledge acquisition, retention and decay in laboratory medicine where participants were also required to take standardized cognitive tests in parallel with clinical psychology researchers. Also, this type of research could be linked with fMRI studies. It is thought that the knowledge gained would be valuable for laboratory medicine, psychology, and quality assurance.

Mirror neuron systems and differences in experiences of qualia by the patient during phlebotomy procedures influence their perceptions of care. Earlier in this thesis, qualia have been reasoned by this author, to be an important dimension in quality assurance. Qualia can be seen as quantum waves, which collectively make up the “aura of distinctiveness” within a service transaction, thus shaping the customer’s perception and behaviour. The customer as a patient will experience different types of qualia based on the TALiS model:

- 1) Empathy and perceptions of care (“Green Rules”, STLS);
- 2) Workflow efficiencies, i.e. waiting lines (“Blue Rules”, MHLS), and;
- 3) Phlebotomy hand technique and sample quality for testing (“Red Rules”, AGLS).

The training and performance measurement techniques should incorporate all dimensions of the TALiS model experienced by the patient. All medical laboratories struggle with quality goals due to economic, human resources and time constraints. These pressures are slowly, but surely eroding the allocated transaction times, between providers and their patients.

As a consequence of these pressures, environments over time are placing increasingly higher demands on the employee, which includes high social attention and attention shifting. The erosion of transaction time may lead to a perceived apathy and perceptions of poor quality in care by the patient. Also, the erosion of transaction time impacts *knowledge transfer* (implicit and tacit) between employees and their patients. The new knowledge gained from the literature review and this laboratory workforce study may lead to improvements in training that can be used as countermeasures. Therefore, a better understanding of the nature of mirror neuron systems can help employees ward off “drift to low performance” system archetypes, which can lead to *knowledge transfer failure* and the perception of *apathy* in the service transaction by the patient.

Another problem that can lead to possible system archetypes might arise from a cultural mindset that relies too heavily on certain measurement types and numbers. With respect to quality, Donella Meadows said “pay attention to what is important, not just what

is quantifiable” (Meadows D. H., 2008, p. 175). Dr. Meadows then clarified the differences between quantity and quality, from the perspective of the customer and society as a whole:

“Our culture, obsessed with numbers, has given us the idea that what we can measure is more important than what we can’t measure. Think about that for a minute. It means that quantity is more important than quality. If quantity forms the goals of our feedback loops, if quantity is at the centre of our attention and language and institutions, if we motivate ourselves, rate ourselves and reward ourselves on our ability to produce quantity, then quantity will be the result. You can look around and make up your own mind about whether quantity or quality is the outstanding characteristic of the world in which you live”. (Meadows D. H., 2008, p. 176)

Patients and employees are impacted by service erosion. Mirror neurons impact both employees and the patients they provide service to. The transaction which occurs between the provider and patient *benefits both parties*. This can lead to bonds of care and community. Therefore, mirror neuron systems and their importance in human biology and quality may be the key to improving both patient and employee mental health.

Happy and Healthy Workplace Environments

This workforce study suggests that healthcare employers in Canada are not only doing something right, they also appear to be doing it well with respect to laboratory employees who might be on the autistic spectrum. This could be due to the fact that medical laboratories are highly regulated workplaces. Individuals with AS thrive in structured, environments with predictable routines (Attwood, 2008). This leads to this author's discussion and critique of the CLSI standard *QMS04-A2: Laboratory Design; Approved Guideline – Second Edition*. The CLSI states that the document is merely a guideline. They state that many important and specific issues which need consideration in a well-designed laboratory are beyond the scope of the document (CLSI, 2007). The CLSI also states that it is unreasonable to expect laboratory managers, to be familiar with “thousands of pages of changing and seemingly contradictory regulations, or to master architecture and engineering in their spare time” (CLSI, 2007, p. 1). Therefore, the CLSI recommends that laboratory managers should have a general awareness for these elements in laboratory design.

For this discussion and critique of the CLSI document *QMS04-A2*, the focus of this author's investigation is on Autism. The approach taken was to investigate learning environments, which serviced students who had ASDs. It was found that design specifications for Autistic children were remarkably similar to the guidelines recommended by the CLSI document *QMS04-A2*. What the reader might find fascinating is that that *Lean Systems Design* appears to have been used. This information is presented in Table 15.

Table 15: CLSI Laboratory Design, Ergonomics and HFE Countermeasures

CLSI QMS04-A2	AUTISM RESEARCH STUDIES	REFERENCES
<u>DESIGN PROCESS</u> <ul style="list-style-type: none"> ➤ Lean Design ➤ Value added , remove wasteful practices ➤ one-piece flow processes ➤ 5S, VSM, Control Plan, Data focus, Workstations ➤ Motion Reduction & Visual management 	<ul style="list-style-type: none"> ✓ routine predictable areas , “spatial sequencing” of workstations ✓ Motion reduction improved attention spans by 3x ✓ Spaces - “high stimulus” to “low stimulus” ✓ Reduce fields of peripheral vision ✓ Executive Dysfunction common, but overcome by structured rules in processes ✓ retrospective/prospective memory issues with “stairwell structured rules” 	<p>(Mostafa, 2008)</p> <p>(Rajendran, Law, Logie, Meulen, Fraser, & Corley, 2011)</p> <p>(Hill, 2004)</p>
<u>HEALTH & SAFETY</u> <ul style="list-style-type: none"> ➤ Acoustics – white noise, sound masking ➤ Sound proofing 	<ul style="list-style-type: none"> ✓ background noise reduced to 52.5 dB ✓ Echo ratio reduced from 96% to 57% ✓ Noise gradients should be reduced 	<p>(Sanchez, Vazquez, & Serrano, 2011)</p> <p>(McAllister & Maguire, 2012)</p>
<u>SPACE DETERMINATION</u> <ul style="list-style-type: none"> ➤ minimum clearance and space requirements ➤ open concepts trend in labs (cross-training) 	<ul style="list-style-type: none"> ✓ Proxemics should be in discussions ✓ Autistics need double the space of normal population ✓ “Snoezelen rooms”, quiet rooms ✓ Extra space for high social traffic areas 	<p>(Gessaroli, 2013)</p> <p>(Scott, 2009)</p> <p>(Mostafa, 2008)</p>
<u>VENTILATION</u> <ul style="list-style-type: none"> ➤ Air exchange req. ➤ Temp. & humidity 	<ul style="list-style-type: none"> ✓ Recommends reducing gradients of temperature (hot, cold) ✓ Recommends Universal Design 	<p>(Sanchez, Vazquez, & Serrano, 2011)</p>
<u>LIGHTING</u> <ul style="list-style-type: none"> ➤ recommended lighting requirements for tasks ➤ No mention of full spectrum lighting 	<ul style="list-style-type: none"> ✓ Avoid dazzle, shadow-light sequences ✓ Full Spectrum lighting improves cognitive performance by 33.6% ✓ Avoid flickering and buzzing lights ✓ Avoid glares and bold patterns ✓ Blue light is highly recommended to counter seasonal mood disorders 	<p>(Colau, 2013)</p> <p>(Sanchez, Vazquez, & Serrano, 2011)</p> <p>(McAllister & Maguire, 2012)</p> <p>(Gooley, Rajaratnam, Brainard, Kronauer, Czeisler, & Lockley, 2010)</p>

The studies in Table 15, suggest that architects and investigators have been very conscientious about spacing, reduction of motion and removal of stimuli. These facility design countermeasures are similar to 5S methodology in *Lean Systems Design*. Also noted by this author, was the emphasis the researchers and designers placed on organizing work into processes, with carefully designed workstations. These design countermeasures were found by researchers to improve attention spans by a *factor of three* in Autistic children. It was also found by researchers, that “stairwell structured rules” in workflows, helped Autistic children overcome problems with executive dysfunction and set shifting between tasks²⁶. This evidence is reasoned by this author to have close parallels with current medical laboratory practice. It may explain the ability of laboratory professionals to work effectively within fast-paced environments such as “core laboratories”²⁷, which requires a high degree of multi-tasking. This evidence leads this author to question what lean systems thinking could do for school systems, from primary schools up to post-secondary institutions. Such quality improvement initiatives could help reduce costs with the potential to boost student academic performance. Therefore, it is reasoned by this author that lean systems thinking, clears the clutter of complexity, promotes effective “seeing”, thus facilitating learning and knowledge transfer.

In addition to improvement of workflows and organization, adequate facility space is important as well. Proxemics language should be entered into the vocabulary of laboratory design planners and quality leaders when considering the needs of technologists who may be on the Autistic spectrum. Researchers found that autistic children required double the physical space for social interaction than that of normal controls. It is

appreciated by this author that space requirements will be a highly contentious issue, when planning and budgeting for new laboratories or renovations. However, Dunbar's number and the workforce characteristics may be an important consideration, when building large regional laboratories. Also, high traffic areas that involve social interaction should be expanded. Therefore, recognizing the reality of fiscal constraints, it is reasoned by this author that lean systems design methodologies can be an effective countermeasure to help offset the workspace challenges.

Another thought-provoking idea concerns the use of "Snoezelen rooms" or "quiet rooms" to help employees who are having anxiety issues, to decompress or relax. Snoezelen rooms are multi-sensory environments used for autistic children and are also used for patients who may have neurodegenerative conditions such as Alzheimer's disease. Socialization during coffee or lunch break may not help the Autistic personality type since these transactions require high social attention. Therefore, employees with ASDs during break may not be relaxing. Quiet rooms give personnel who are on the Autistic spectrum a place to retreat from excessive stimuli. Early in this thesis, the introductory evidence suggested that nearly a third of medical laboratory technologists reported psychiatric morbidities in Taiwan (Lee, Lee, Liao, & Chiang, 2009). The goal of these dedicated quiet-relaxation rooms is to permit the employee the opportunity to decompress. There should be no talking, food consumption, or drinks permitted in these rooms since these should be seen as *low stimulus rooms*. Supports like these may be valuable for long-term employee mental health. Therefore, these countermeasures would improve laboratory personnel performance during patient care transactions, which demand high social attention.

Lighting appears to be a very important issue within laboratory design. The CLSI provides recommendations for lighting. However, document QMS04-A2 does not mention full spectrum lighting. Two published sources in Table 15, mention the importance of *blue wavelength* lights to ward off depression and to improve cognitive performance. Full spectrum with blue wavelength lighting was found to improve cognitive performance in Autistic children by approximately 33% (Colau, 2013). It appears as though the blue wavelength is the most important wavelength because of its effect on the circadian rhythm (Gooley, Rajaratnam, Brainard, Kronauer, Czeisler, & Lockley, 2010). This author questions as to whether or not full spectrum lighting could lead to significant improvements in the medical laboratory workforce, both in performance and morale. This may greatly benefit more northerly regions of Canada, such as the Yukon, Northwest Territories, and Nunavut²⁸. There appears to be an opportunity for research and possible funding with CIHR. This author was unsuccessful in finding published evidence where researchers investigated the benefits of full spectrum lighting in the healthcare workforce environments in Canada. This human factors engineering countermeasure, based on the evidence to date, appears to be an easy fix with an impact on laboratory quality. Therefore, full spectrum lighting would benefit both healthcare workers and their patients.

There is an additional item that should be discussed as an intervention and stress reduction method that may benefit all employees. This discussion concerns *Mindfulness* meditation. Mindfulness is a form of meditation that is based on Buddhist and Yoga practices, which has grown in popularity in western culture (Hofmann, Sawyer, Witt, & Oh, 2010). Mindfulness-based therapy (MBT) has become a very popular form of treatment

in psychotherapy. It has been used as a therapy in clinical psychology to help address: 1) Fear and anxiety; 2) Depression, anger and aggression; 3) Concentration, awareness, and; 4) Stress and Insomnia. Many studies support that mindfulness behavioural therapy, shows much promise as an intervention method in clinical populations (Hofmann, Sawyer, Witt, & Oh, 2010). This therapy also benefits adults with autism spectrum disorders (Spek, Ham, & Nyklicek, 2013). Also, mindfulness therapy has been found to work as a countermeasure to reduce hostilities among workers and reduce counterproductive behaviours associated with Machiavellianism (Krishnakumar & Robinson, 2015). However, the use of MBT therapy has not been studied in the medical laboratory workforce, but is thought by this author to be an excellent opportunity for research and may qualify for CIHR funding. Mindfulness therapy shows great potential as both an intervention method to improve laboratory personnel morale and productivity. Therefore, as a learning support, MBT as a countermeasure may be effective at reducing undesirable system archetypes, their costs and wastes, within healthcare organizations.

Ethical Leadership and Integral Permaculture

There has been brief discussions of integral permaculture in this thesis, the literary work and research of Dr. Donella Meadows, who is viewed by many environmentalists to be the “Mother of Integral Permaculture” (Permaculture Science, 2015). The greatest challenge within healthcare is the long-term sustainability and quality of services. There are all-encompassing economic and political forces at play, which will have an impact on Canadian healthcare and its aging population in the long term. Most notable, is the issue of energy, in particular, the use of fossil fuels. The high standard of living that Canadians enjoy will be challenged by the global demand for oil and the global supply limit. All of the easily accessible oil deposits have been extracted and the current reserve is dwindling (Miller & Sorrell, 2013). Unconventional fossil fuel resources and the extraction methods are increasingly causing environmental damage from water table contamination, wildlife habitat, and global warming.

At some point in the near future, the rising cost of fossil fuels, along with the limited resources available, will force change in culture and impact carbon-sensitive industries globally, if another abundant and cheap energy supply is not found. It is predicted that the transport costs due to oil prices will alter world trade affecting businesses that rely on global supply chain networks (Lynch, 2008). Along with it, a shift in the current business model is predicted to occur that will force industries to become unlinked from the global market and become re-localised. Global supply chains are predicted to shift away from global supplier chains, with industries operating locally (Heinberg, 2005).

Lastly, the world is facing a “perfect storm” of food shortages, water scarcity and costly oil predicted by researchers leading to the “ultimate recession” somewhere between 2020 and 2030 (Earth Policy Institute, 2011). Darker predictions for humanity, the state of the planet and its biosphere, have been made for the year 2052 (The Club of Rome, 2011). These models, with historical evidence, predict that the global limit is unsustainable, if the current patterns of consumption and business practices are maintained (PBL, 2009, pp. 10-18). Healthcare organizations, personnel, and their patients will all be impacted by this reality. Global pressures will force decision-making among leaders when attempting to balance the immediate needs of clinicians and their patients, with the long-term goals of sustainability. Healthcare leaders may be forced to consider *degrowth*. Therefore, there is a possibility that organizations will have to make a formal “degrowth declaration” in the future (Schneider, Kallis, & Martinez-Alier, 2010).

As an example, the reader should consider the costs of a chemistry analyzer, both in the short-term time frame and long-term time horizon. Integral permaculture’s long-term thinking reasons that medical laboratories may need to be more conscientious about the *energy requirements* of an analyzer, if they are to deliver the same level of service to their patients in the long term. The purchase, maintenance and operating cost of an analyzer is relatively short-term thinking but looking specifically at the energy requirements of an analyzer is reasoned to be long-term thinking. All of the components that are used to make a chemistry analyzer required various forms of energy to manufacture and transport. All of the inventories that are consumed by a chemistry analyzer required energy to manufacture and transport. All wastes, which are generated by an analyzer, require energy to transport

and dispose of in an environmentally friendly and safe manner. The focus for long-term sustainability should be on the energy requirements of a laboratory service, its environmental and carbon footprint. Even if energy is relatively cheap now, in twenty years it will be more costly and impacting supplier chain networks, which operate globally, if a new and abundant alternative is not found. Therefore, it is reasoned that for long term planning, medical laboratories should be doing business with companies in the US and Canada, who are aware of the growing energy problem and are taking measures proactively to reduce the energy used, carbon and their environmental footprint in their products and services.

Energy, carbon and environmental problems, will force organizations to rethink their business models and make changes, which will impact employees and the patients they serve. The growing problem will affect all healthcare services. A new mindset and value system is needed to adjust to this resource challenge while maintaining a high level of quality services. Using Integral Permaculture, a new “universal” conceptual model for quality assurance, called “The Quality System of Goodness” is proposed by this author (see Figure 18). Integral permaculture is a holistic and ethical approach to system design with the goal of a healthy, sustainable and eco-friendly environment. The philosophy and ethics of integral permaculture requires a fundamental change of thought about value systems, habits of consumption and what is truly important with regards to sustainability.

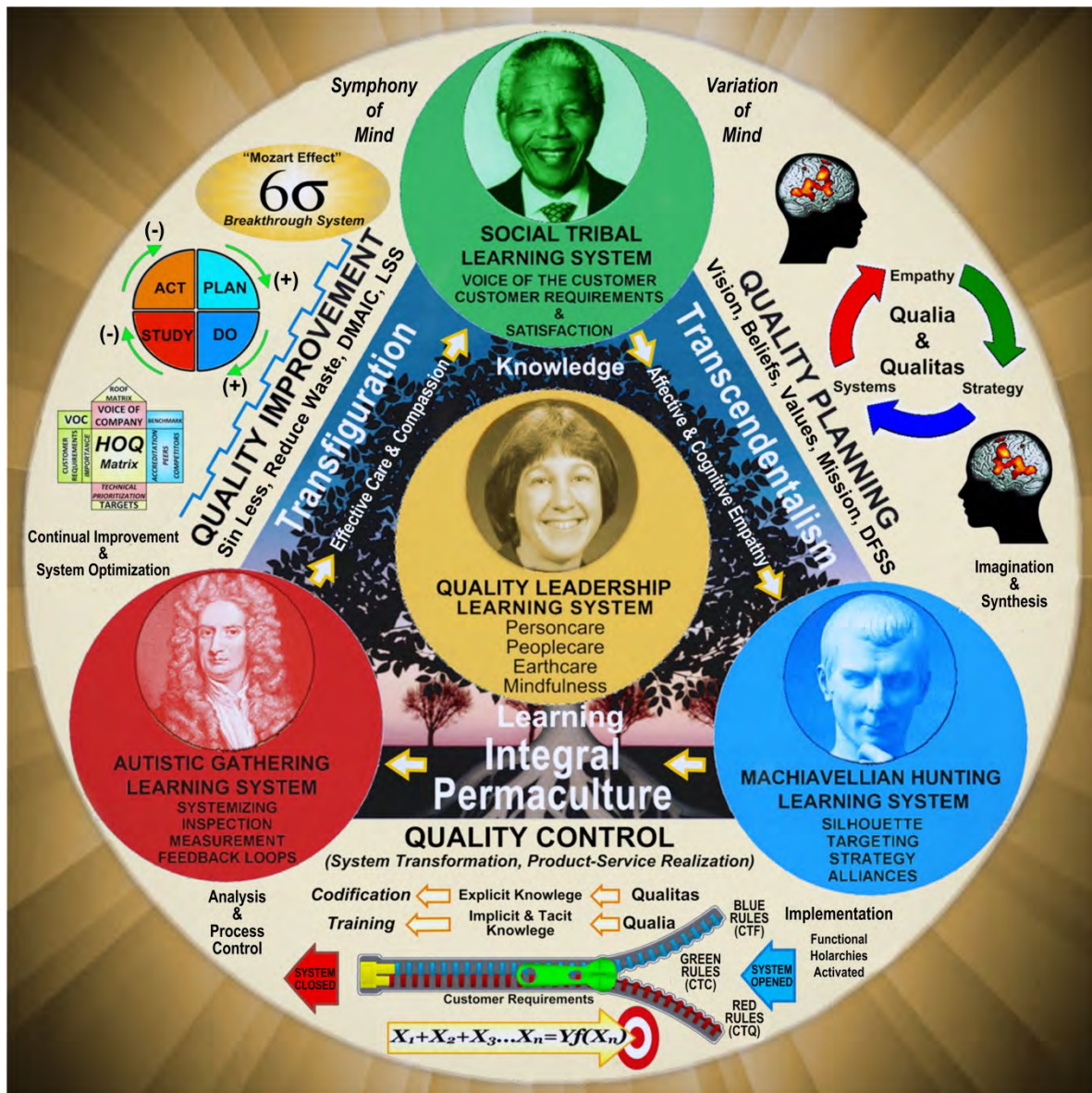


Figure 18: The Pharos of Quality - TALiS and the *Quality System of Goodness*

Integral Permaculture is based on three frameworks; *Person Care*, *People Care* and *Earth Care* (Integral PermaCulture Academy, 2015). All three frameworks are compatible within the TALiS model and the Juran Trilogy. During the act of doing business and pursuing a livelihood, all organizations, including healthcare, commit acts of “sin” to

deliver quality services for the patient. It is reasoned by this author that a profound shift in attitudes, on the patients' part, will be required about conservation. This is likely to be the hardest challenge for healthcare leaders and their employees to face when providing services for their patients. These change efforts will require an organizational commitment to learning. The goal of goodness within quality leadership is to seek a pathway for the organization, which balances environmentalism, sustainability, with quality excellence and customer care. Therefore, new persuasive language is needed to educate, inspire and shape mindsets of the employees through Integral Permaculture.

Where do leaders find guidance on sources that support integral permaculture and reach the goal of goodness? The *International Standards Organization* (ISO) has several published guidelines that support the philosophy of integral permaculture design. They include:

- 1) *ISO/FDIS 14001 Environmental management systems* (ISO, 2015);
- 2) *ISO 26000 Social responsibility* (ISO, 2010);
- 3) *ISO 50001 Energy management* (ISO, 2011), and;
- 4) *ISO 113611 Community interpreting* (ISO, 2014).

The published ISO standards which support integral permaculture are not limited to the guideline documents listed above. It is important to recognize that integral permaculture is not just a morally “right” approach to system design. Integral Permaculture has many practical reasons as well, with regards to waste reduction and costs. This can lead to long

term profitability and sustainability. Therefore, ISO standards can support the goal of goodness through Integral Permaculture design.

To adopt the philosophy and ethics of integral permaculture, a new visionary is needed for quality assurance, which supports the TALiS and the Quality System of Goodness. Considering the bigger picture, the current state of the planet, its biosphere and the warnings from the Club of Rome, a woman's perspective is overdue. To mark a new age for quality assurance, there is a need for a new visionary leader. Dr. Donella Meadows and her wisdom represent the "soul" of the TALiS model as a spiritual "shaman". This author wonders if the "hunter-gatherer-tribe" triadic framework of the TALiS and the Juran Trilogy, combined with integral permaculture, could have an appeal to the First Nations and Inuit cultures within Canada. However, the TALiS model is thought to be a "universal design" for organizational learning and knowledge acquisition, which could apply to any culture globally, since it represents the potential of humanity.

Health and social services, which are specialized in the needs of the First Nations and Inuit cultures in Canada, may benefit from the TALiS and integral permaculture model for quality. The Quality System of Goodness could have greater reach. The quality assurance professional, based on the TALiS model, is reasoned to be closely associated with that of a shaman, who through a new vision leads the culture to a spiritual transfiguration. Therefore, Dr. Donella Meadows is reasoned by this author to be a true visionary; a spiritual quality leader and environmental medicine woman, whose philosophies best supports the culture of goodness in healthcare across Canada and abroad.

Speak the Truth

“Speak the truth.

Speak it loud and often, calmly but insistently,

And speak it, as the Quakers say, to power.

Material accumulation is not the purpose of human existence.

All growth is not good.

The environment is a necessity, not a luxury.

There is such a thing as enough.”

(Meadows D. , *Wise Words from Dana*, 2015)

CHAPTER 5

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Summary of Research and Areas for Future Investigation

There is a paucity of literature evidence where researchers have investigated the relationship between Autism and Machiavellianism within workforce populations employed in healthcare. Much of the literature focuses on: 1) the relationships between Autism and social cognition, and; 2) Machiavellianism and its relationship to social cognition. This may be due to a lack of a clear insight by researchers, of the dynamical relationship between Autism and Machiavellianism and more importantly, how they relate to quality assurance. It is this author's aim that the models and evidence presented, may provide insight and will encourage dialogue, debate and ideas for future research. Empathy is an important learning system archetype, which binds the medical laboratory workforce together as a community, to meet the needs of their customers through care.

This medical laboratory workforce study is merely a starting point and perhaps a compass for further discovery and learning. This exploratory research has brought to the surface some statistical evidence that there is a pattern in the medical laboratory workforce population personality characteristics. This evidence may be important to regulators and quality leaders within laboratory medicine. The most important finding is that there is evidence to support that there is a relationship between systemizing quotient scores of employees and the size of laboratory/community size, where the highest scores are in the

largest sites and the lowest scores are in the smallest sites. Also, it was found that individuals who scored the highest on systemizing were males and those employed in non-unionized positions. This discovery is important for quality assurance since highly regulated and rule-bound ISO environments in theory should lead to relative consistency within the workforce performance characteristics. It appears that ISO regulated environments may mitigate operational load imbalances across large-scale healthcare systems, thus leading to relative consistency in quality levels.

What is not known is how the psychometric scores for the workforce relate to the accumulation of knowledge capital within regulated regional health systems. These psychometric scores may be related to knowledge acquisition, transfer and decay in laboratory medicine. One area of interest and possible future research are the relationships between the psychometric scores and: 1) internal process control, and; 2) external proficiency testing. Explicit, implicit and tacit knowledge within laboratory medicine should be studied in parallel with standardized cognitive tests and perhaps fMRI studies. A better understanding of mirror neuron systems and how they impact quality assurance in laboratory medicine is needed. This study found a relationship with the SQ-R scores for rural labs versus regional laboratories and may be important for quality assurance. For the larger sites, the relatively low empathy scores of the workforce population brings into question Dunbar's number, project team sizes, and knowledge transfer. The EQ score has limitations where it cannot differentiate between affective and cognitive empathy. It is not known if there is a correlation between the empathy quotient scores and the Dunbar's number, therefore it is an experiment in itself. Since both areas of knowledge deal with

social cognition, it is reasoned by this author that there must be some sort of relationship. Therefore, future research studies of this nature would benefit quality leaders, who face challenges balancing the needs of so many employees and the customers they serve across large geographical distances.

Symphony of Mind and the Mozart Effect

What is true genius within Quality Assurance? Quality begins with qualia and is at the heart of what it means to be human. Genius is linked to the inner conscious potential within all employees and their uniqueness in minds, to imagine great things of value for the customer as a community. *Variation of Mind* is the key to profound knowledge, which leads to a cultural paradigm shift, thus resulting in breakthrough systems. Neurodiversity in the workforce supports organizational neuroplasticity. Understanding the requirements of the customer is accomplished both through empathy and Variation of Mind. A quality system is an extension of the TALiS and Orch-OR models; a human-based knowledge system which supports the collective genius and voice of all employees. Quality Assurance orchestrates intellectual synergy within all minds across complex healthcare systems, called the *Symphony of Mind*. It is through neuro-optimization, that the Symphony of Mind achieves the *Mozart Effect* in quality excellence.

The Mozart Effect is the customer perception of a product's or service's "aura of distinctiveness", which sets it apart from other competitors. Therefore, a true genius system meets the following requirements:

- 1) Manufactures a product or offers a service with quality features that are *distinctive*;
- 2) The product-service quality features cannot be replicated by *competition*;
- 3) A quality system that is unique due to its *internal information design*;
- 4) A cultural paradigm that is unique due to its employees' *talents* and *cunning*;
- 5) Closes the gap between the provider and the customer through *customer care*;
- 6) Profound knowledge is nurtured by cultural commitment to continual *learning*;
- 7) Brand loyalty through value, satisfaction and the *aura of moral goodness*.

The Quality System of Goodness is offered as a new vision for organizational excellence. It is reasoned by this author that the greater gift that an organization can give back to civilization goes beyond the distinctiveness of a product or service and its quality features. The organization must impress upon the public, that the world is a much better place through its moral actions as a role model, holding fast the goal of goodness (Meadows D. H., 2008).



Figure 19: The Goal of Goodness - Customer Care, Community and Environmentalism

The propensity of people, to do good things of value for one another, is at the heart of what it means to be human. Empathy is instinctive and found in every culture. It is part of Man's evolution. Goals are achieved through cooperation, mutual understanding, and care. It is central to Quality Assurance. Empathy binds people together as a community within healthcare, society and abroad. Quality Assurance, through its methodologies, tools

and standards, facilitates organizational Symphony of Mind. Collective genius across large scale systems is orchestrated and synchronized by quality systems. Quality Assurance celebrates system complexity, promotes seeing and understanding through learning. Through quality assurance, Man as a species has conquered complexity, uniting people separated by vast distances as a global learning village. Quality through care and learning nurtures the culture of goodness, leading to greatness in Mankind.

The Dance

1. Get the beat.
2. Listen to the wisdom of the system.
3. Expose your mental models to the open air.
4. Stay humble. Stay a learner.
5. Honor and protect information.
6. Locate responsibility in the system.
7. Make feedback policies for feedback systems.
8. Pay attention to what is important, not just what is quantifiable.
9. Go for the good of the whole.
10. Expand time horizons.
11. Expand thought horizons.
12. Expand the boundary of caring.
13. Celebrate complexity.
14. Hold fast to the goal of goodness.

(Meadows D. , *Dancing with Systems*, 2015)

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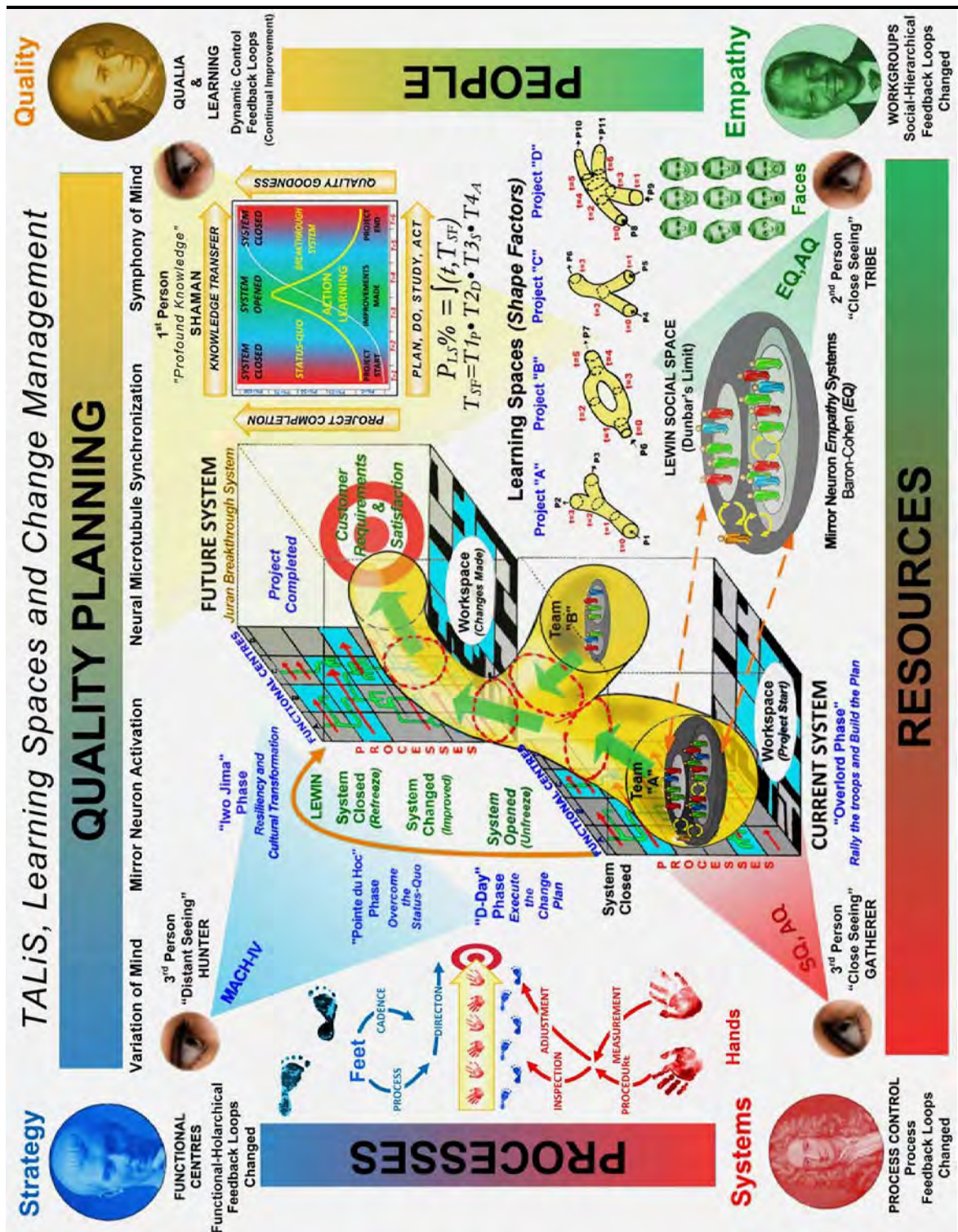
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APPENDIX A

TALIS, LEARNING SPACES AND CHANGE MANAGEMENT

TALiS, Learning Spaces and Change Management



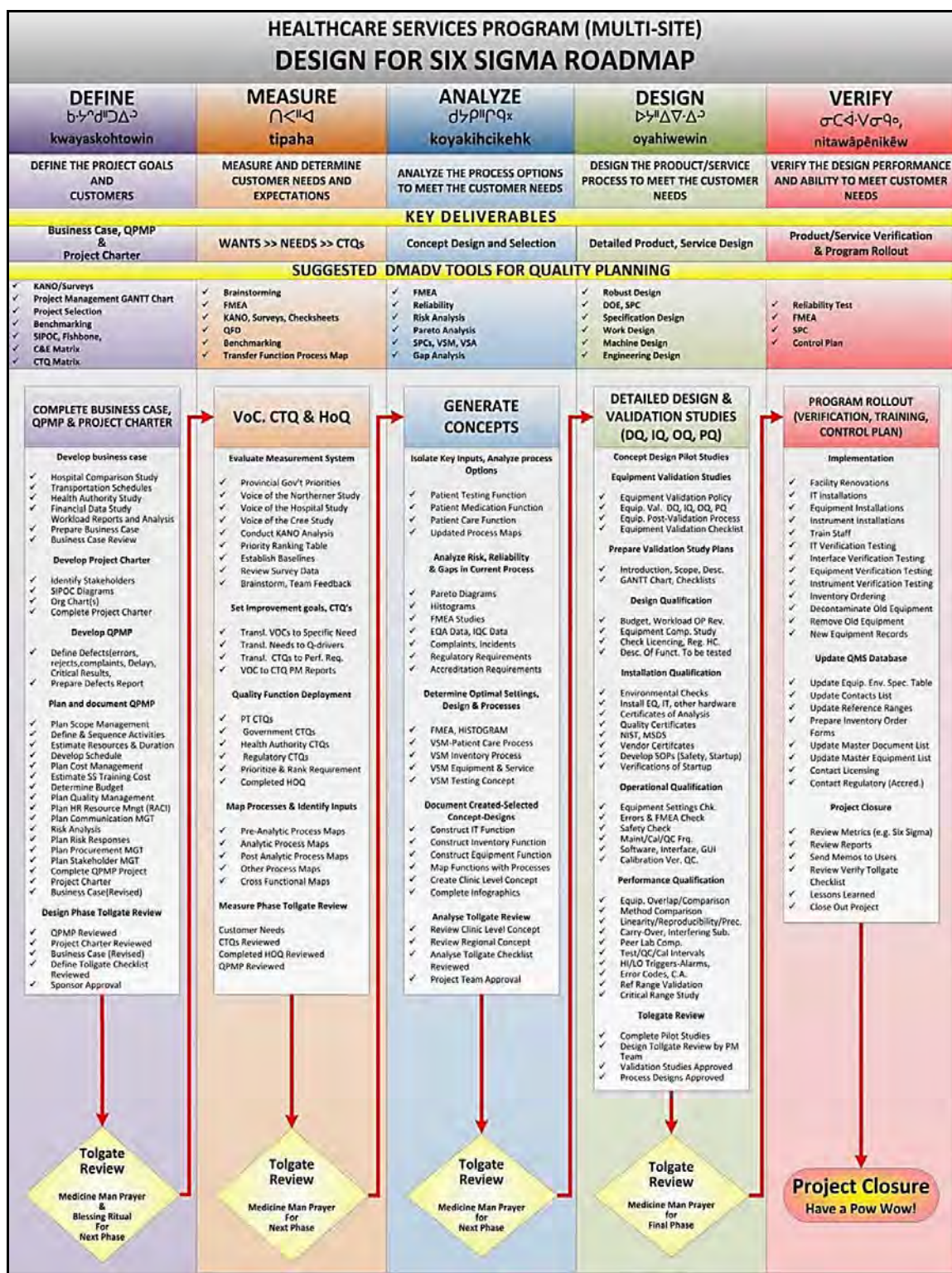
APPENDIX B

ASQ QUALITY TOOLS AND TALIS

ASQ Quality Tools and TALiS

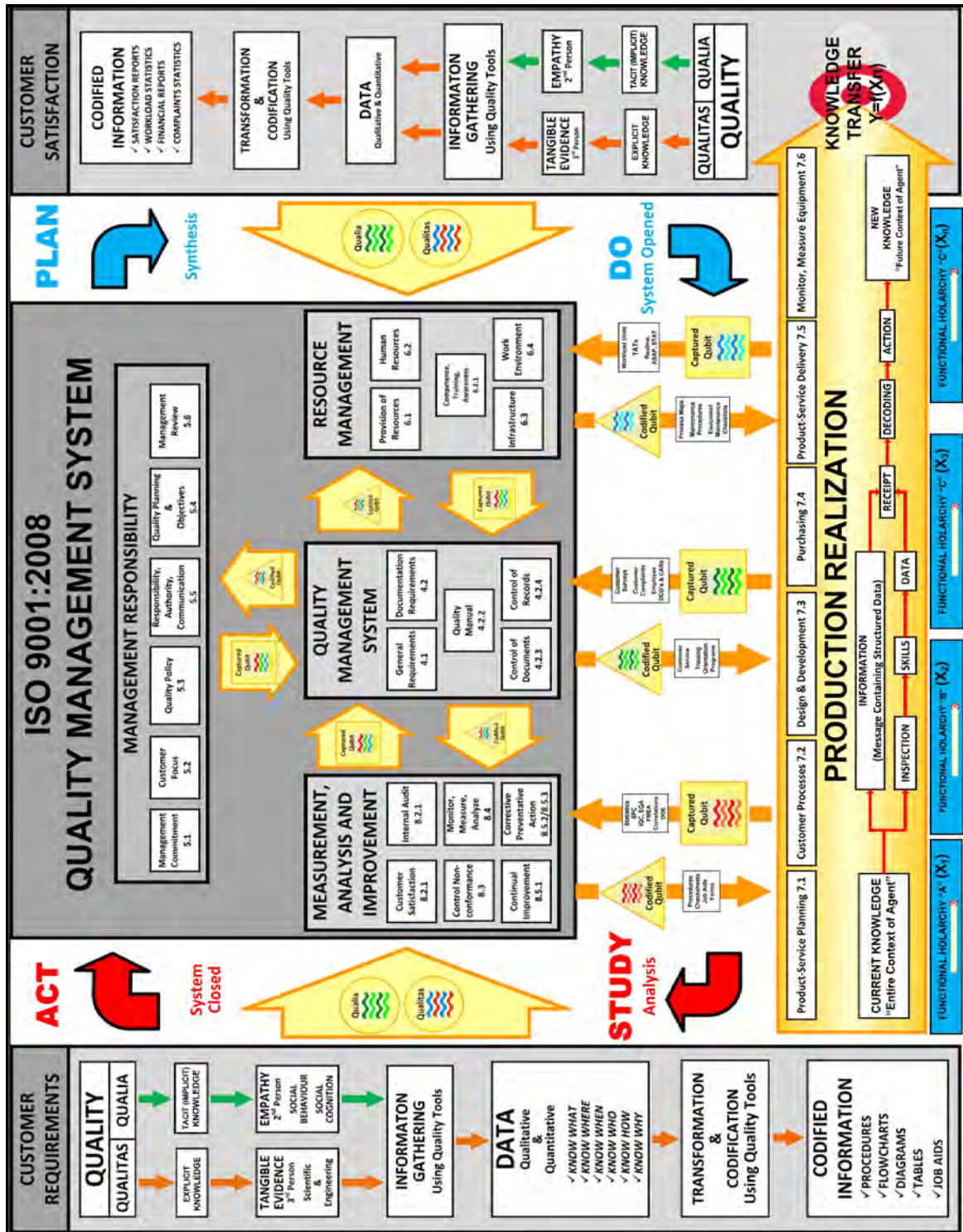
ASQ QUALITY TOOLS*	TALiS			COMMENTS
	STLS	MHLS	AGLS	
1. A3 Report	√	√	√	proposals, problem solving ,story boards
2. Affinity diagram	√	√	√	Brainstorming tool
3. Arrow Diagram		√	√	used with CPM
4. Balanced Scorecard		√		Strategic management tool
5. Benchmarking		√		Measurement against competition
6. Box and Whisker Plot			√	
7. Brainstorming		√		
8. Cause-and-effect		√		Ishikawa, Fishbone Diagram
9. Check Sheet			√	"Gathering Tool" (AGLS)
10. Control Chart		√	√	Process Variation vs. Time
11. Decision Matrix	√	√		Evaluation Prioritization Tool
12. Design of Experiments			√	
13. Eight Disciplines (8D)	√	√	√	Powerful QI methodology
14. FMEA		√	√	Process problem solving tool
15. Five S (5S)		√		Work environment improvement
16. Five Whys, Five Hows (5W5S)		√	√	Process improvement tool
17. Flowchart		√		"Silhouette" of process seen
18. Force Field Analysis		√		Strategic Decision Making tool
19. Gage repeatability			√	
20. Gantt chart	√	√		Monitoring Chart, Tasks, Timelines
21. Histogram			√	
22. House of Quality (HOQ)	√	√	√	Powerful "Lens" for SS projects
23. Impact Effort Matrix		√		Prioritization Tool for Implementation
24. Kano Model	√			Customer Needs Tool
25. Matrix Diagram			√	
26. Mistake-Proofing	√	√		Also called Poka-yoke
27. Nine Windows	√	√		Powerful tool for Social Change
28. Nominal Group Technique	√			Brainstorming tool
29. Pareto Chart			√	
30. PDSA	√	√	√	Model for Continuous Improvement
31. Problem Conc. Diagram	√	√		Supports "Rules of Herds" model
32. Decision Program Chart		√		Tree Diagram showing relationships
33. Quality Function Deployment	√	√	√	
34. Relations Diagram	√	√		Cause-and-effects relationships
35. Scatter Diagram			√	
36. SIPOC+CM Diagram		√		
37. SMART Matrix		√		Planning and Communication Tool
38. Spaghetti Diagram	√	√		Lean tool- helps improve workflows
39. Success and Effect Diagram		√		Similar to Fishbone Diagrams
40. Survey	√			Used for Voice of the Customer
41. Tree Diagram		√		
42. Value Stream Mapping		√		Lean tool

APPENDIX C
DESIGN FOR SIX SIGMA (DMADV)



APPENDIX D:
ISO 9001:2008 QUALITY MANAGEMENT SYSTEM
AND
KNOWLEDGE TRANSFER

Quality Management System and Knowledge Transfer



APPENDIX E

CSUDH IRB STUDY APPROVAL, APRIL 2014

CSUDH IRB Study Approval April, 2014

CSUDH Institutional Review Board

for the Protection of Human Subjects in Research

Date: April 10, 2014**To:** Robert Spencer, PhD
Dept.: Quality AssuranceRobert Sean Davies
Dept.: Quality AssuranceJanine Montgomery, PhD
University of Manitoba, Canada

CC: File

From: Judith Weber, IRB Compliance Coordinator
CSUDH Institutional Review Board (IRB)**Subject:** 14-135: Change Management in the Medical Laboratory Industry
Approved: April 10, 2014

The IRB is pleased to inform you that it has approved your proposal. We have determined that your research qualifies for exemption from the requirements of 45 CFR 46 according to **Exempt Category 2** concerning "research involving the use of educational tests (cognitive, diagnostic, aptitude achievement), survey procedures, interview procedures or observation of public behavior, unless: (i) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects; and (ii) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability or reputation." (CITE: 45CFR46.101.b.2).

The stamped Informed Consent document is enclosed and should be used as a template for distribution to your subjects.

Procedural changes or amendments must be reported to the IRB and no changes may be made without IRB approval except to eliminate apparent immediate hazards. Please notify the Office of Research and Funded Projects (a) if there are any adverse events that result from your study, and (b) when your study is completed.

If you have any questions, you may contact the Office of Research and Funded Projects at (310) 243-3756.

Thank you.

**Approval expires one
year from above date**

*Subject recruitment and data collection may not be initiated prior to formal written approval from the
IRB Human Subjects Committee*

APPENDIX F

NIH RESEARCH ETHICS CERTIFICATE

NIH Research Ethics Certificate

Certificate of Completion

The National Institutes of Health (NIH) Office of Extramural Research certifies that **Robert Davies** successfully completed the NIH Web-based training course "Protecting Human Research Participants".

Date of completion: 10/01/2013

Certification Number: 1290104

APPENDIX G
CHANGE MANAGEMENT SURVEY

Change Management Survey

Introduction and Disclaimer

California State University, Dominguez Hills

Consent to Act as a Research Subject

Change Management in the Medical Laboratory Industry

You are being asked to participate in a research study. Before you give your consent to volunteer, it is important that you read the following information and ask as many questions as necessary.

Principal Investigator:

Robert Spencer, MA, MS

Adjunct Professor, Quality Assurance Dept., CSUDH

email: rspencer@csudh.edu

Co-Investigators:

Robert Sean Davies, BA, MLT (CMLTM) Graduate Student, MSQA Program, CSUDH email: rdavies1@csudh.edu

phone: (204) 372-6560

Janine Montgomery, PhD (Advisor)

Associate Professor, Psychology Department

University of Manitoba

email: Janine.Montgomery@umantioba.ca phone: (204) 474-8306

Purpose of the Study:

The purpose of this study is to determine the personality characteristics of the medical laboratory workforce. A new change management model will be developed that will help organizations and their employees overcome interpersonal conflict, resistance, and anxiety to operational change.

This study will involve recruiting approximately 5000 potential participants. All employed laboratory professionals are eligible to participate in this study.

Description of the Study:

You, the participant will be asked to complete an online survey through Qualtrics, involving a series of questions related to different topics in laboratory quality management:

- 1) Social Systems and Teamwork
- 2) Systems Thinking
- 3) Emotional Intelligence
- 4) Leadership

In addition to the above tests, you will be asked about your age, gender, and questions related to employment.

Risks or Discomforts:

No known or potential risks are anticipated with this study. Subject identifying information will not be collected for this research. All potential risks are considered to be minimal at worst, and most likely nonexistent. Your personal data will not be made available to your peers, employer, or regulatory college.

In the event that you feel uncomfortable with the survey questions, you may discontinue participation at any time, and it will not affect your relationship with the principal investigator, CSUDH, the University of Manitoba, your employer, or your regulatory college.

Benefits of the Study:

The results of the research are of immediate value to the disciplines of laboratory medicine, industrial psychology, human factors engineering, and organizational behavior.

The goal of this research is to propose a new model in change management that will reduce anxiety, resistance, and interpersonal conflict in the medical laboratory.

Confidentiality:

Data collected will be stored using an online survey website called Qualtrics (www.qualtrics.com). All subject information is password and encryption protected. Confidentiality will be maintained to the extent permitted by law and the policies outlined by California State University, Dominguez Hills. Anonymity is protected since the individual's identity is not known to the researchers, and is never recorded or associated with the data collected.

Incentives to Participate: None

Voluntary Nature of Participation:

Your participation in this study is voluntary. Your choice of whether or not to participate will not influence your future relations with California State University, Dominguez Hills, the CMLTM, SSMLT, or your employer. If you decide to participate, you are free to withdraw your consent and to stop your participation at any time.

Questions about the Study:

If you have any questions about this study or your rights as a participant, you may call the co-investigator (Sean Davies, 204-372-6560), Professor Robert Spencer (rspencer@csudh.edu), or the Institutional Review Board for the Protection of Human Subjects at CSUDH, 310-243-3756.

CMLTM, SSMLT and U of M Disclaimer:

When you link to this survey, you are no longer using the CMLTM and SSMLT websites and this linked website (www.qualitrics.com) is not under the control of the CMLTM, the SSMLT and the U of M. This link is provided for information and convenience only. The CMLTM, SSMLT, and the U of M are not responsible for the content of this linked website and do not endorse the contents of this linked website. As such, the CMLTM, SSMLT, and the U of M cannot be held liable for any damages caused as a result of the use of this linked website.

By entering the CAPTCHA code below, this indicates that you have read the information in this document and have had a chance to ask any questions you may have about the study. Your CAPTCHA code also indicates that you agree to be in the study and have been told that you can change your mind and withdraw your consent at any time. You have been given a copy of this consent form. You have been told that by entering the CAPTCHA code into this electronic consent form you are not giving up any of your legal rights.



CHANGE MANAGEMENT SURVEY

Demographic Information

DEM1. What is your sex?

- ☐ Male
- ☐ Female

DEM2. What is your age?

DEM4. What is the population size of the community you live in?

DEM5. What is the population size of the community you are employed?

DEM9. What is your highest educational level achieved?

- ☐ Community College Certificate (1 Yr)
- ☐ Community College Diploma (2-3 Yr Diploma)
- ☐ Bachelor's Degree
- ☐ Master's Degree
- ☐ Doctorate Degree

Q280. Which Country do you live in?

- ☐ Canada
- ☐ United States
- ☐ Other

Employment Statistics Questions

Q1. What is your current title?

- ☐ Laboratory Assistant/Technician
- ☐ Laboratory Technologist
- ☐ Senior Technologist, Section Head (one department)
- ☐ Laboratory Supervisor/Manager/Chief Technologist (Multiple departments)
- ☐ Regional Manager/Laboratory Director
- ☐ Other

Q2. What role best describes your scope of responsibilities?

- ☐ General Duty Technologist/Core Lab
- ☐ Specialized in Hematology
- ☐ Specialized in Chemistry
- ☐ Specialized in Transfusion Medicine
- ☐ Specialized in Microbiology/Virology/Parasitology
- ☐ Specialized in Histology
- ☐ Specialized in Cytology

- ☐ Specialized in Genetics/Molecular Biology
- ☐ Laboratory Information Systems
- ☐ Administration/Management
- ☐ Quality Management
- ☐ POCT Coordinator
- ☐ Instructor
- ☐ Other

Q5. Is your primary employer a

- ☐ Private Medical Laboratory
- ☐ Urban Hospital or Regional Teaching Hospital
- ☐ Rural Hospital
- ☐ Biomedical Equipment/Reagent/Supply/LIS firm
- ☐ Academic institution
- ☐ Regulatory Body/Agency
- ☐ Nursing Station/Physician's Clinic
- ☐ Pharmaceutical Firm
- ☐ Other

DEM9. What is the size of your laboratory? If your employer is not a hospital or private medical laboratory, please state the number of employees at your immediate worksite.

DEM10. What is your employment status?

- ☐ I work full time
- ☐ I work part time (permanent)
- ☐ I work part time (casual)
- ☐ Other

DEM11. Are you a unionized employee?

- ☐ Yes
- ☐ No

Q280. How many years have you been employed in your profession?

Q281. How many years have you been employed with your current employer?

Q282. How many employers have you been employed with over your career?

Social Systems and Teamwork

AQ1. I prefer to do things with others rather than on my own.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ2. I prefer to do things the same way over and over again.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ3. If I try to imagine something, I find it very easy to create a picture in my mind.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ4. I frequently get so strongly absorbed in one thing that I lose sight of other things

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ5. I often notice small sounds when others do not.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ6. I usually notice car number plates or similar strings of information.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ7. Other people frequently tell me that what I've said is impolite, even though I think it is polite.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ8. When I'm reading a story, I can easily imagine what the characters might look like.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ9. I am fascinated by dates.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ10. In a social group, I can easily keep track of several different people's conversations.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ11. I find social situations easy.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ12. I tend to notice details that others do not.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ13. I would rather go to a library than a party.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ14. I find making up stories easy.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ15. I find myself drawn more strongly to people than to things.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ16. I tend to have very strong interests which I get upset about if I can't pursue.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ17. I enjoy social chit-chat

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ18. When I talk, it isn't always easy for others to get a word in edgeways.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ19. I am fascinated by numbers

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ20. When I'm reading a story, I find it difficult to work out the characters' intentions.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ21. I don't particularly enjoy reading fiction.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ22. I find it hard to make new friends.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ23. I notice patterns in things all the time.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ24. I would rather go to the theatre than a museum

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ25. It does not upset me if my daily routine is disturbed.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ26. I frequently find that I don't know how to keep a conversation going.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ27. I find it easy to "read between the lines" when someone is talking to me.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ28. I usually concentrate more on the whole picture, rather than the small details.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ29. I am not very good at remembering phone numbers.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ30. I don't usually notice small changes in a situation, or a person's appearance.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ31. I know how to tell if someone listening to me is getting bored.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ32. I find it easy to do more than one thing at once.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ33. When I talk on the phone, I'm not sure when it's my turn to speak.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ34. I enjoy doing things spontaneously.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ35. I am often the last to understand the point of a joke.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ36. I find it easy to work out what someone is thinking or feeling just by looking at their face.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ37. If there is an interruption, I can switch back to what I was doing very quickly.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ38. I am good at social chit-chat.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ39. People often tell me that I keep going on and on about the same thing.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ40. When I was young, I used to enjoy playing games involving pretending with other children.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ41. I like to collect information about categories of things (e.g. types of cars, types of birds, types of trains, types of plants, etc.)

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ42. I find it difficult to imagine what it would be like to be someone else.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ43. I like to plan any activities I participate in carefully.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ44. I enjoy social occasions

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ45. I find it difficult to work out people's intentions.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ46. New situations make me anxious.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ47. I enjoy meeting new people.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ48. I am a good diplomat.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ49. I am not very good at remembering people's date of birth

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

AQ50. I find it very easy to play games with children that involve pretending.

☐ Definitely Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Definitely Disagree

Emotional Intelligence

EQ1. I can easily tell if someone else wants to enter a conversation.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ2. I prefer animals to humans.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ3. I try to keep up with the current trends and fashions.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ4. I find it difficult to explain to other things that I understand easily, when they don't understand it the first time.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ5. I dream most nights.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ6. I really enjoy caring for other people.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ7. I try to solve my own problems rather than discussing them with others.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ8. I find it hard to know what to do in a social situation.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ9. I am at my best first thing in the morning.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ10. People often tell me that I went too far in driving my point home in a discussion.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ11. It doesn't bother me too much if I am late meeting a friend.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ12. Friendships and relationships are just too difficult, so I tend to not to bother with them.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ13. I would never break a law, no matter how minor.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ14. I often find it difficult to judge if something is rude or polite.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ15. In a conversation, I tend to focus on my own thoughts rather than on what my listener might be thinking.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ16. I prefer practical jokes to verbal humor.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ17. I live life for today rather than the future.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ18. When I was a child, I enjoyed cutting up worms to see what would happen.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ19. I can pick up quickly if someone says one thing but means another.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ20. I tend to have very strong opinions about morality.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ21. It is hard for me to see why some things upset people so much.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ22. I find it easy to put myself in somebody else's shoes

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ23. I think that good manners are the most important thing a parent can teach their child.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ24. I like to do things on the spur of the moment.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ25. I am good at predicting how someone will feel.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ26. I am quick to spot when someone in a group is feeling awkward or uncomfortable

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ27. If I say something that someone else is offended by, I think that that's their problem, not mine.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ28. If anyone asked me if I liked their haircut, I would reply truthfully, even if I didn't like it.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ29. I can't always see why someone should have felt offended by a remark.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ30. People often tell me that I am very unpredictable.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ31. I enjoy being the centre of attention at any social gathering.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ32. Seeing people cry doesn't really upset me.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ33. I enjoy having discussions about politics.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ34. I am very blunt, which some people take to be rudeness, even though this is unintentional.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ35. I don't tend to find social situations confusing.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ36. Other people tell me I am good at understanding how they are feeling and what they are thinking.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ37. When I talk to people, I tend to talk about their experiences rather than my own.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ38. It upsets me to see an animal in pain.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ39. I am able to make decisions without being influenced by people's feelings.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ40. I can't relax until I have done everything I had planned to do that day.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ41. I can get upset if I see people suffering on news programs.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ42. Friends usually talk to me about their problems as they say that I am very understanding.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ43. Friends usually talk to me about their problems as they say that I am very understanding.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ44. I can sense if I am intruding, even if the other person doesn't tell me.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ45. I often start new hobbies but quickly become bored with them and move on to something else.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ46. People sometimes tell me that I have gone too far with teasing.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ47. I would be too nervous to go on a big rollercoaster.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ48. Other people often say that I am insensitive, though I don't always see why.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ49. If I see a stranger in a group, I think that it is up to them to make an effort to join in.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ50. I usually stay emotionally detached when watching a film.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ51. I like to be very organized in day to day life and often make lists of the chores I have to do.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ52. I can tune into how someone else feels rapidly and intuitively.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ53. I don't like to take risks.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ54. I can easily work out what another person might want to talk about.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ55. I can tell if someone is masking their true emotion.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ56. Before making a decision I always weigh up the pros and cons

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ57. I don't consciously work out the rules of social situations

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ58. I am good at predicting what someone will do.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ59. I tend to get emotionally involved with a friend's problems.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

EQ60. I can usually appreciate the other person's viewpoint, even if I don't agree with it.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

Systems Thinking

SQ1. I find it very easy to use train timetables, even if this involves several connections.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ2. I like music or book shops because they are clearly organized.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ3. I would not enjoy organizing events e.g. fundraising evenings, fetes, conferences.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ4. When I read something, I always notice whether it is grammatically correct.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ5. I find myself categorizing people into types (in my own mind)

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ6. I find it difficult to read and understand maps.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ7. When I look at a mountain, I think about how precisely it was formed.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ8. I am not interested in the details of exchange rates, interest rates, stocks and shares.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ9. If I were buying a car, I would want to obtain specific information about its engine capacity.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ10. I find it difficult to learn how to programme video recorders.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ11. When I like something I like to collect a lot of different examples of that type of object, so I can see how they differ from each other.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ12. When I learn a language, I become intrigued by its grammatical rules.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ13. I like to know how committees are structured in terms of who the different committee members represent or what their functions are.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ14. If I had a collection (e.g. CDs, coins, stamps), it would be highly organized.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ15. I find it difficult to understand instruction manuals for putting appliances together.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ16. When I look at a building, I am curious about the precise way it was constructed.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ17. I am not interested in understanding how wireless communication works (e.g. mobile phones)

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ18. When travelling by train, I often wonder exactly how the rail networks are coordinated.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ19. I enjoy looking through catalogues of products to see the details of each product and how it compares to others.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ20. Whenever I run out of something at home, I always add it to a shopping list.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ21. I know, with reasonable accuracy, how much money has come in and gone out of my bank account this month.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ22. When I was young, I did not enjoy collecting sets of things e.g. stickers, football cards, etc.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ23. I am interested in my family tree and in understanding how everyone is related to each other in the family.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ24. When I learn about historical events, I do not focus on exact dates.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ25. I find it easy to grasp exactly how odds work in betting.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ26. I do not enjoy games that involve a high degree of strategy (e.g. chess, Risk, Games Workshop)

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ27. When I learn about a new category I like to go into detail to understand the small differences between different members of that category.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ28. I do not find it distressing if people who live with me upset my routines.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ29. When I look at an animal, I like to know the precise species it belongs to.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ30. I can remember large amounts of information about a topic that interests me e.g. flags of the world, airline logos.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ31. At home, I do not carefully file all important documents e.g. guarantee insurance policies.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ32. I am fascinated by how machines work.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ33. When I look at a piece of furniture, I do not notice the details of how it was constructed.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ34. I know very little about the different stages of the legislation process in my country.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ35. I do not tend to watch science documentaries on television or read articles about science and nature.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ36. If someone stops to ask me the way, I'd be able to give directions to any part of my home town.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ37. When I look at a painting, I do not usually think about the technique involved in making it.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ38. I prefer social interactions that are structured around a clear activity, e.g. a hobby.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ39. I do not always check off receipts etc. against my bank statement.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ40. I am not interested in how the government is organized into different ministries and departments.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ41. I am interested in knowing the path a river takes from its source to the sea.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ42. I have a large collection e.g. of books, CDs, videos etc.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ43. If there was a problem with the electrical wiring in my home, I'd be able to fix it myself.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ44. My clothes are not carefully organized into different types in my wardrobe.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ45. I rarely read articles or webpages about new technology.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ46. I can easily visualize how the motorways in my region link up.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ47. When an election is being held, I am not interested in the results for each constituency.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ48. I do not particularly enjoy learning about facts and figures in history.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ49. I do not tend to remember people's birthdays (in terms of which day and month this falls).

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ50. When I am walking in the country, I am curious about how the various kinds of trees differ.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ51. I find it difficult to understand information the bank sends me on different investment and saving systems.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ52. If I were buying a camera, I would not look carefully into the quality of the lens.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ53. If I were buying a computer, I would want to know exact details about its hard drive capacity and processor speed.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ54. I do not read legal documents very carefully

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ55. When I get to the checkout at a supermarket, I pack different categories of goods into separate bags.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ56. I do not follow any particular system when I'm cleaning at home.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ57. I do not enjoy in-depth political discussions.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ58. I am not very meticulous when I carry out D.I.Y. or home improvements.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ59. I would not enjoy planning a business from scratch to completion.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ60. If I were buying a stereo, I would want to know about its precise technical features.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ61. I tend to keep things that other people might throw away, in case they might be useful for something in the future.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ62. I avoid situations which I cannot control.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ63. I do not care to know the names of plants I see.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ64. When I hear the weather forecast, I am not very interested in the meteorological patterns.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ65. It does not bother me if things in the house are not in their proper place.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ66. In mathematics, I am intrigued by rules and patterns governing numbers.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ67. I find it difficult to learn my way around a new city.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ68. I could list my favourite 10 books, recalling titles and authors' names from memory.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ69. When I read the newspaper, I am drawn to tables of information, such as football league scores or stock market indices.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ70. When I'm in a plane, I do not think about the aerodynamics.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ71. I do not keep careful records of my household bills.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ72. When I have a lot of shopping to do, I like to plan which shops I am going to visit and in what order.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ73. When I cook, I do not think about exactly how different methods and ingredients contribute to the final product

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ74. When I listen to a piece of music, I always notice the way it's structured.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

SQ75. I could generate a list of my favourite 10 songs from memory, including the title and the artist's name who performed each song.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

Leadership

MACH1. Never tell anyone the real reason you did something unless it is useful to do so.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH2. The best way to handle people is to tell them what they want to hear.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH3. One should take action only when sure it is morally right.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH4. Most people are basically good and kind.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH5. It is safest to assume that all people have a vicious streak and it will come out when they are given a chance.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH6. Honesty is the best policy in all cases.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH7. There is no excuse for lying to someone else.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH8. Generally speaking, people won't work hard unless they're forced to do so.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH9. All in all, it is better to be humble and honest than to be important and dishonest.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH10. When you ask someone to do something for you, it is best to give the real reasons for wanting it rather than giving reasons which carry more weight.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH11. Most people who get ahead in the world lead clean, moral lives.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH12. Anyone who completely trusts anyone else is asking for trouble.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH13. The biggest difference between most criminals and other people is that the criminals are stupid enough to get caught.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH14. Most people are brave.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH15. It is wise to flatter important people.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH16. It is possible to be good in all respects.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH17. P.T. Barnum was wrong when he said that there's a sucker born every minute.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH18. It is hard to get ahead without cutting corners here and there.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH19. People suffering from incurable diseases should have the choice of being put painlessly to death.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

MACH20. Most people forget more easily the death of their parents than the loss of their property.

☐ Strongly Agree ☐ Slightly Agree ☐ Slightly Disagree ☐ Strongly Disagree

APPENDIX H

PHEROMONE IMAGE APPROVAL

Pheromone Image Approval

PHEROMONE

BY CHRISTOPHER MARLEY

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ENDNOTES

ENDNOTES

¹ “Baby boomers” are a population group that were born after world war two. This group includes people born between 1946 and 1964.

² The “Generation X” group are the population generation born after the baby boom post World War II. Demographers propose that this group was born between the early 1960s and early 1980s.

³ Dunbar’s number may be very important in quality assurance and customer service. This number is predicted to vary depending on the occupational group.

⁴ People in social groups as “tribes” can be visualized as social holarchies “nested” within greater mixed hierarchies. An example would be multiple occupational groups on a floor in a hospital who share a common space that their different departments are nested within, but all report to a higher reporting structure. Holarchies arise from the ability of biological systems to self-organize into groups. It is reasoned that mirror neuron systems are responsible.

⁵ Functional Magnetic Resonance Imaging is a MRI technology that images subtle changes in brain activity associated with blood flow (oxygen rich, oxygen poor) linked with neuron activity.

⁶ The phrase “Left-Brained” should not be interpreted literally. The Machiavellian fMRI study suggests that the brain is “leaning” on the left hemisphere when figuring the solution to a problem.

⁷ The word “Talis” comes from Latin, meaning “of such a kind”, “such”; “so great”; “so excellent”; “of such kind”.

⁸ This Author obtained permission through written consent by Christopher Marley, the Artist behind the “beautiful beetles” background in the TALiS model (See Appendix F). Christopher Marley’s work is available online. <http://www.pheromonedesign.com/>

⁹ The term “neurocognitive social astigmatism” might be a more “politically correct” term to describe the condition, but this idea is to be put forth for the reader’s consideration by this author. Also, the term “deficit” may be inappropriate as well, in that the word “deficit” can mean different things to different people. The phrase “neurocognitive astigmatism” may be a better term to use in workplace discussions relating to different learning needs of employees.

¹⁰ It is believed that a technology could be developed based on the “Rules of Herds”. It would be based on motion silhouette. Once validated, the technology when used in conjunction with experiments in systems dynamics could reveal hidden feedback patterns within organizations, pointing to undesirable system archetypes not previously known. The technology would need to first establish a baseline set of metrics based on common motions. It would become progressively more intelligent in detecting motion cues that point to trends, oscillations, or escalation scenarios. This technology could operate globally, becoming an “invisible hand”.

¹¹ It is believed that the silhouette technology could be developed to improve supplier chain inventory flows. For every customer that purchases a product in a store, there may be several or many people that come close enough to the product to inspect it for quality, with the possibility of purchasing. The purchases captured by the financial electronic transaction system within the store have some predictive value for trends, but the silhouette motion system has greater reach, with respect to customer intentions to buy in the future. This information is captured through motion cues. By going one step further, less waste in holding time for inventories is reduced. Therefore, waste is reduced through energy consumption, inventory movement and labour.

¹² The same silhouette technology could be developed to improve patient workflows by monitoring only silhouette movements, thus protecting patient confidentiality. The technology would look for periodic motions in common areas such as hallways and advise on areas for improvement. This would complement a pre-existing Health Information System. Within a healthcare organization spanning large geographical distances, the metrics captured can lead to improvements with workflows using the “Rules of Herds”.

¹³ For the reader, it should be noted that the *Born-Einstein Letters* is a significant body of work which spanned a time frame of 39 years. The correspondence between Einstein and Born occurred from 1916 to 1955 (Einstein, Born, & Born, 1971).

¹⁴ To be clear to the reader, “social cognitive deficits with empathy” does not mean lack of empathy or care. This relates to the speed of the social transactions within group settings and the ability to a person to understand the point of view of another person during these social transactions. This understanding comes from the brain’s ability to process facial expressions, motion cues and language, during high speed social transactions in busy workplace scenarios.

¹⁵ This notion can be explained further by an example in healthcare. The laboratory department is composed of several smaller departments such as chemistry, microbiology, hematology, transfusion medicine, cytology and histology, which are “nested” as functional holarchies. The laboratory may work with the ECG

department and the diagnostic imaging departments which are also nests (x-ray, ultrasound, CT, MRI, etc.). These departments can be seen through two vantage points: 1) their function, the flow of work and patient in-out flows, or 2) by reporting structure. All of the departments can then be seen as nested holarchies that have a mixed hierarchy (heterarchy) under a functional centre called “Diagnostic Services” within the hospital or health authority.

¹⁶ The choice of colours is credited to the literature source *Delivering Knock Your Socks off Service* by Performance Research Associates, Inc. The authors discussed the concept of “Red” and “Blue” rules in Healthcare. “Red Rules” are “rules that cannot be broken” and are based on clinical, regulatory, scientific and engineering reasoning. Blue Rules are designed to make the “hospital experiences run more smoothly for patient and staff alike” (Performance Research Associates, Inc., 2012). The “hospital experience” can be expanded upon where Blue Rules are only concerned with efficiency of workflows, functional holarchies and supplier-service chains (Lean System Design), and “Green Rules” are concerned with the perceptions of care during the patient-clinician transaction and “social holarchies”. Green Rules mesh with “Personcare” and “Peoplecare” language of Integral Permaculture Design. Greater clarity can then be achieved by using “Critical to Quality” (CTQ) as a “red rule”, “Critical to Flow” (CTF) as a “blue rule” and “Critical to Empathy” (CTE) or “Critical to Care (CTC) as a “green rules”.

¹⁷ The “Squaring the Circle” idiom can be expanded upon where the quality leader as an intervener is attempting to place the organization and its functional centres within an “ISO Box”.

¹⁸ It should be clarified that the Deming Cycle is the best known dynamic control feedback loop, but there are other types within systems dynamics such as the OODA Loop (Owen, Burstein, & Mitchell, 2004).

¹⁹ This author proposes that the same study can be replicated in medical laboratories which operate under a health authority. It is predicted that the same results will be found and conclusions will be drawn.

²⁰ Auditory Processing Disorders are commonly found with individuals who have Autism Spectrum Disorders (O'Connor, 2012). Individuals on the Autistic spectrum, with this condition, have greater challenges following social transactions groups and keeping up with dialogue, therefore long meetings may be exhausting.

²¹ Design for Six Sigma (DFSS) as a QPMP can take on various forms, depending on the organization, whether or not it manufactures a product or offers a service. Some versions may include DMADV, IDOV, DCCDI, and DMEDI (I-Six Sigma, 2015). See Appendix G.

²² It is an opinion by this author that the use of coloured belts may be counterproductive and may in fact project Authoritarian behaviour, since the idea of belts comes from the martial arts such as Karate, Kobudo, Judo, Jujitsu and other variations. Martial arts are directly related to warfare. Such a ranking system may be inappropriate within an industry that is predominantly female or healthcare.

²³ A Heuristic is a strategy that ignores part of the information (or reasons with incomplete information) with the goal of making decisions more quickly, frugally, and/or accurately than more complex methods (Gigerenzer & Gaissmaier, 2011).

²⁴ Words form mental pictures, which can have different meanings to different people. Words strung together in sentences form larger pictures and with mind maps, can help construct conceptual models. By carefully studying the words and their associations with other words using online tools such as *Visuwords* (<http://www.visuwords.com/>), new cognitive lenses can be created. This approach can lead to new vision statements or improvements with the current vision statement. Therefore, the study of semiotics may be useful in Quality Assurance.

²⁵ Semiotics is the study of analogies, metaphors, and symbolism in language.

²⁶ This Author questions the term “multi-tasking” and where it might related to executive dysfunction, ASDs, and work environments. Could Autistic personality types be better described as “Fast Serial Sequencers”, rather than “Multi-Taskers”? No direct evidence was found to support this idea.

²⁷ Core Laboratories have a carefully designed portfolio of tests in different disciplines such as biochemistry, immunochemistry, haematology, transfusion medicine and urinalysis. They may include some microbiology testing as well. Core Laboratories are engineered for fast TATs.

²⁸ There is also a relationship between Vitamin-D Levels and mental health. A 2010 Study in Sweden found a relationship between geographic latitude, Vitamin-D levels, and psychiatric morbidities. It was found that individuals with Autism had the lowest Serum 25-OH-vitamin D levels. The psychiatric out-patient department was located in Gustavsberg, Sweden, at geographic latitude of 59.3° north (Humble, Gustafsson, & Bejerot, 2010). Therefore, at this latitude, this infers that Medical Laboratory Technologists employed in the Yukon, Northwest Territories, and Nunavut would be most impacted.