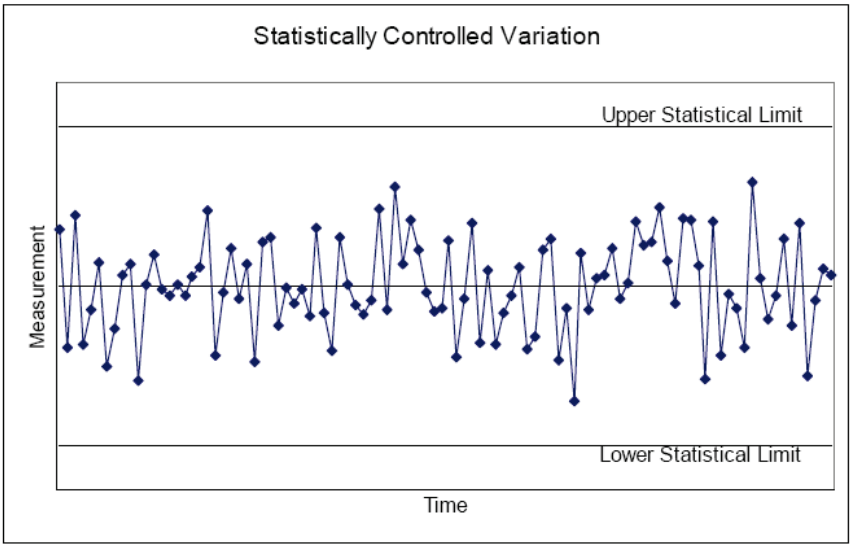
Figure 9



capabilities and expecting people who work in the system to reach those targets without any changes to the system will generally not produce sustainable improvement. Systematic learning focused on understanding the system and the factors that affect the results and actions based on that understanding can produce sustainable improvement.

Management seems to call for action as events occur. In a very large firm, the hard drive was stolen from a computer. The hard drive contained no proprietary or confidential information, but the reaction was to hire a security firm to close down as many potential security leaks as possible. Electronic surveillance was installed at all pedestrian exits from company buildings. "Random" searches of trunks of cars were conducted when cars left company property. Employee access to fax and copy machines and the internet was restricted. In another case, a large factory put locks on gas pumps on the company property as a result of a single incident of an employee putting gas in his personal car from a company gas pump. Review of performance indicators leads the management of an organization to ask why certain numbers went in the wrong direction; for example, overtime costs went up the most recent month over what they were the previous month, or sales went down this month below what they were for the same month last year. Employees come to expect requests for explanations so they spend time preparing explanations that will appear to be plausible. These examples illustrate two common errors that can occur in reacting to events without correctly taking context into account.

Deming identified both of the errors illustrated above. One of these errors is to change the system in reaction to a special cause. For example, a single event occurs and a new policy is instituted. Or a single event occurs and a new regulation is put into effect. The actions taken to increase security in reaction to the theft of one hard drive is an illustration of this kind of mistake. The system changes to increase security resulted in great expense to the company for what could have been little reason. In the case of theft of gasoline, no action was taken to deal with the employee – the "special cause." "Can't

let that happen again" thinking produced an action that led to loss of time for highly-paid employees; they now had to fill out forms and check out gas pump keys to use a company car to go on a business trip. Overreactions to what could be rare events can be extremely costly in terms of the human energy required to cope with an increasing number of policies and regulations. When there are legitimate signals of the action of special causes, the appropriate action is to identify the special cause and then take further action on the special cause only when the special cause makes results worse and is relatively likely to occur again or carries with it a catastrophic cost.

There has been a special cause signal in the case of atmospheric carbon dioxide levels. The most likely special cause has been identified as large scale burning of fossil fuels. The catastrophic costs of global warming justify action to drastically reduce large scale burning of fossil fuels. Rather than to address directly the issue of fossil fuel burning, there are other proposals that are generally called "geo-engineering." The proposals include (1) sequestration of carbon dioxide in deep ocean trenches or underground, (2) space based mirror arrays, (3) dust and soot delivered into the atmosphere with high altitude balloons and large guns, (4) aluminum powder and barium oxide sprayed into the troposphere by commercial and private aircraft to increase cloud cover and reflect more heat out into space, (5) sulfur burned by ships to increase cloud cover, and (6) adding iron oxide to oceans to stimulate mass plankton growth. These proposals involve attempts to deal with the consequences of large scale burning of fossil fuels, rather than to address that special cause directly. The consequences of adopting these proposals are not fully understood and, in some cases, are known to be harmful. For example, one consequence of burning sulfur is acid rain, which is known to kill forests. Deforestation leads to increased atmospheric carbon dioxide.[21] Any technique that targets earth surface temperature reduction without consideration of reducing carbon dioxide levels fails to address the devastating problem of ocean acidification which occurs as carbon dioxide is absorbed by the oceans. Addressing the special cause directly appears to carry far less uncertainty. Applying "band aids" that address symptoms often carries unintended consequences and results in increased cost. This may be the case with our planetary problem as well as in business.

The other common error in interpreting fluctuations in results is what Deming called "tampering." Tampering occurs when a special cause explanation is sought for every fluctuation in a series of results that are in statistical control and managers react to the explanations by making changes. We are assaulted every day in the news media by special cause explanations for common cause variation. The accounting systems in organizations sometimes help managers seek special cause explanations for random fluctuation by presenting data in tabular form that ought to be plotted as a simple time series graph including more than two time periods. To seek an explanation for why this month's figure for some type of cost went up this month over what it was last month

[21]A few climate scientists have, nevertheless, seriously considered introducing sulfur into the atmosphere. One of these scientists is Nobel laureate Paul Crutzen. He expresses concern that nations will not soon enough and seriously act to reduce carbon dioxide levels and the sulfur approach may have to be used to stave off complete disaster. See Crutzen, P.J., "Albedo Enhancement by Stratospheric Sulfur Injections: A Contribution to Resolve a Policy Dilemma?" *Climatic Change*, 2006, 17.

without having access to the context provided by the degree of variation seen in the past is to invite an erroneous explanation. Production costs per unit produced may have increased this month over last month, but it may simply be fluctuation of the same size generally seen in the series of past costs per unit. When a series of results is statistically controlled, tampering will increase the variation.

Often, increases in variation are accompanied by additional strains on the system. A large food products company had a sales group that had a practice of conducting grocery store promotions when sales volume went down from one period to the next. Since sales without promotions would have had volumes that were statistically controlled, the net effect was to create greater variation in volume. This, in turn, produced larger fluctuations in demands placed on the production system and the network of suppliers to the organization. Manufacturing executives had responded by building inventory, adding significantly to the costs of producing the products. The net effect was to reduce margins. Sales executives were judged to be successful if sales volume went up month to month, even though the net effect on the company's profits was negative. The use of narrow objectives for different functional groups in the company produced the opposite of what was desired.

Some knowledge about variation, combined with a good understanding of the interdependencies among functions in an organization, can produce different approaches to managing an organization from those often used for lack of an alternative. A synthesis of appreciation for an organization as a system and knowledge about variation provides an alternative that can produce sustained improvement in performance. Knowledge about variation is also essential to understanding the causes of climate change and to finding solutions that address those causes.

Theory of Knowledge

Everyday business activity involves prediction. Staffing decisions, financial decisions, procurement decisions, production plans, project plans, marketing plans, and every other decision-making and planning process of an organization involve prediction. Likewise, development of business strategy must include the essential step of prediction. Deming repeatedly stated "management is prediction."[22] He could have substituted the word living for management in his statement. There is no better example than the issue of dealing with the world's climate. Respected scientists the world over have issued a warning that involves prediction: if decisive actions are not taken to significantly reduce the carbon dioxide put into the earth's atmosphere by use of fossil fuels, the results will be catastrophic. On an individual level, each of us makes everyday decisions based on predictions of what is likely to happen. We decide whether to spend the day outdoors depending on the weather forecast (prediction). We decide when to leave for work depending on our estimate (prediction) of travel time. We decide whether to make a particular investment based on predictions of the risks and potential returns.

[22] Deming, W.E., *The New Economics 2nd Ed.*, MIT Press, 1994.

Rational Prediction

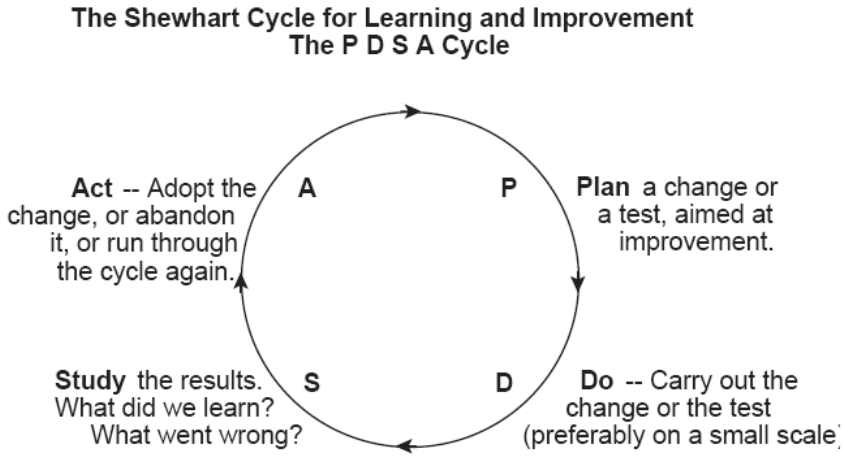
Deming spoke of rational prediction. We can predict anything we want: we can predict that the high temperature in New York tomorrow will be 148 degrees and the low temperature in Cairo will be 2 degrees; we can predict that sales of a product will triple next year; we can predict that the Chicago Cubs will win the World Series this year. However, if we wish for our predictions to have a chance of being correct, we need to have sound reasoning, that is, a sound rationale to support the prediction. Deming argued that rational prediction requires theory. Some who consider themselves to be practical would scoff at such an idea. For them, theories are for the ivory tower. However, we all use theories to plan and to act, whether we recognize it or not. The economist Keynes stated, "Practical men who believe themselves to be devoid of any intellectual influences are usually the slaves of some defunct economist."[23] Theories and models we construct form the basis for prediction, and consequently for planning and action.

It would serve us well to understand something about the theories that form the basis of our predictions. A stunning example has been presented in the form of the economic crisis of 2008 and 2009. Many holders of 401Ks had thought that their investments in the stock market were completely safe. This belief may have been based on the advice of financial advisors who explained that diversification of investments in the market protected against loss. Actually, the protection provided by diversification within the stock market doesn't provide protection against overall market risk. This misunderstanding of theory and the additional assumption that the future would be like the past contributed to an unpleasant surprise.

The Shewhart Cycle

Theory enables learning and improvement through the use of scientific method, described by Deming in what he called the Shewhart Cycle. Figure 10 shows Deming's description of the Shewhart Cycle – the PDSA Cycle. Use of scientific method involves the building

Figure 10[24]



[23] Keynes, J.M., *The General Theory of Employment, Interest and Money*, 1936.
[24] Deming, W.E., The New Economics, 2nd Ed., MIT Press, 1994.

of knowledge through comparison of observations with predictions made on the basis of a theory. When observations agree with predictions, degree of belief that the theory is correct is increased. When observations disagree with predictions, questions arise as to the source of the disagreement, trials that yielded the observations are repeated, or theory is revised or even abandoned. When there are competing predictions, as there are in the case of global warming, the soundness of the work that has gone into development of each prediction must be evaluated so that degree of belief in different predictions may be assessed. "Judgment of the relative substance of the theories underlying each prediction, the degree to which such theories have been tested in use and by peer review"[25] must be taken into consideration.

Knowledge is built through the systematic and continuing use of the PDSA cycle. Deming advocated the same practice in business to systematically improve products and services and business performance. Knowledge of the earth's climate and the factors which affect it is being built using scientific method with the participation of scientists throughout the world. Similarly, knowledge that will form the basis for new energy technologies will be built using scientific method.

Theories Help Us Understand Experience

We should use existing theories to help us understand experience – what happens in the business world and in the physical world. Deming said, "to copy an example of success, without understanding it with the aid of theory, may lead to disaster."[26] One of the most popular business books of the twentieth century involved the authors selecting forty-three businesses that they identified as great performers. Then they observed what each was doing and identified rules for doing well from their observations. So far as we know, they did not attempt to disprove their rules by identifying unsuccessful organizations and seeing whether they were also following some or all of the rules. Within a few years, some of the forty-three were in serious difficulty. Although the study might have been a place to start exploring some ideas about business performance, their rules were unable to stand up to even the test of further near-term observations. As Shewhart stated, "empirical evidence is never complete," and theories are subject to ongoing revision.

Theory of knowledge deals with what we know and how we know it. According to Deming, theory of knowledge "teaches us that a statement, if it conveys knowledge, predicts future outcome, with risk of being wrong, and that it fits without failure observations of the past." Knowledge is built by looking through the window of theory. Deming argued that information is not knowledge. As Deming said, "without theory, there is no way to use the information that comes to us on the instant."[27] To enable continued life and economic development, managers, scientists, educators, and members of government will need to develop and use new knowledge.

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[25] Dr. Ian S. Bradbury, personal communication 8/21/09.
[26] Deming, W.E., *The New Economics, 2nd Ed.*, MIT Press, 1994.
[27] Deming, W.E., *The New Economics, 2nd Ed.*, MIT Press, 1994.

New Knowledge

W. Edwards Deming once posed this question to a class of MBA students: "Where does new knowledge come from?" After his question was met with silence, he answered it himself: "New knowledge comes from the innately curious individual – responsible to no one."[28] Deming pointed out that information is not knowledge, and experience is not knowledge. But if information and experience can get us to think, and if in thinking we develop new theories to be explored, new knowledge can be born.

The history of climate change is the history of innately curious individuals: individuals like Jean-Baptiste Fourier who in 1827 wrote a paper describing a phenomenon he called *the greenhouse effect*. Fourier theorized that the only way the earth could maintain the comfortable temperature of 57° F was if the atmosphere acted like the glass of a greenhouse, capturing some of the sun's energy as it reradiates back out into space. Some thirty years later the independent scientist Dr. John Tyndall showed how water vapor and CO_2 absorbed infrared radiation, giving credence to Fourier's theory. Then in 1895, after a year of tedious hand calculations, Svante Arrehenius estimated the increase in global surface temperatures due to increased concentrations of CO_2 in the atmosphere. All three of these men were innately curious individuals who created new theory.

Today, those who continue to question the validity or urgency of human-induced climate change often dismiss it as "just a theory." Yet, human civilization has been built on theory. Without Newton's theories of gravity and motion, there would have been no industrial revolution. Without Darwin's theory on the origin of species, modern natural science would not exist. And without Einstein's Theory of Relativity human knowledge of the universe would be stunted. The greatest achievements of Newton, Darwin and Einstein were their theories – and those theories reshaped mankind and our planet. Climate change theory is already shaping the future and changing the ways humans interact with our surroundings – and it is opening the door to new knowledge.

Business as Usual or Transformation?

In the mid-1960's a Dutch chemist named Paul Crutzen began studying the effects of chlorofluorocarbons (CFC's) on the earth's atmosphere. CFCs are man-made chemical compounds invented in the 1930's and put into wide industrial use by the 1960's. Crutzen's research was showing that CFCs were rapidly destroying the protective ozone layer of the earth's atmosphere. Backed by this science, governments in the 1980's forged an international agreement for the regulation and reduction of CFCs. Crutzen went on to share the 1995 Nobel Prize in chemistry for his important contribution to the science.

Crutzen's experience with CFCs made him aware of the power of human industry to change the physical world on a planetary scale. Not only had human industry come very close to destroying the ozone layer, but it was in the process of reconfiguring the chemical composition of greenhouse gases in the earth's atmosphere. By the year 2000, Crutzen was asserting in scientific publications his belief that the earth had entered a new

[28] Deming, W. Edwards, Lectures at Columbia University, Spring, 1991.

age – in fact a new geological epoch.[29] The *Holocene* period, which began at the retreat of the last ice age, was over and the earth now found itself in the *Anthropocene* – an entirely new chapter in earth's history defined primarily by the impact of human activity on the planet.

The Anthropocene era (*anthropos* is Greek for human being) represents unique challenges to humanity and to business. The biggest of these challenges is sustaining a vital global economy while addressing the urgent issue of climate change. Climate change is different from any problem business has faced in the past. Yet, in one respect it is similar to a problem America has been facing for decades – competitive decline. America's decline and climate change are similar in that they both represent systems problems. In part, competitive decline was the consequence of a lack of appreciation for business as a system; climate change is the consequence of a lack of appreciation for the interdependence between the global economic system and the earth's biosphere.

Two decades ago, W. Edwards Deming called for changing the ways of American management in order to address America's competitive decline. He knew that tweaking business-as-usual practices would be ineffective and indeed counterproductive. Transformation was needed, and it had to be informed by knowledge. Today we are living in a new geological epoch, where the term 'business-as-usual' refers to the continued practice of burning fossil fuels. Some in industry are advocating sticking to business-as-usual or perhaps tweaking it around the edges. But such action will be ineffective and indeed counterproductive. A great transformation is required to avoid the worst consequences of a warming world – a transformation that aligns the global economy with the workings of the earth's ecosystem. This transformation will impact every enterprise in the global economy and will require skillful management informed by new knowledge – the very same ideas Deming introduced to transform management.

How companies will organize in the age of human-induced climate change will depend whether management chooses to operate in a business-as-usual mode or to incorpor profound knowledge into their thinking. The following nine organizing principles give sense of the differences.

	Business As Usual	Using Profound Knowledge
1	Focus on **competition**	Alert to opportunities for "**coopetition**"
2	Management through **division** and **compartmentalization**	Management informed by an understanding of **interrelationships** and **interdependencies**
3	Management sees **disparate** economic, social and environmental security needs	Management realizes the **interdependence** of economic, social and environmental security

[29] Crutzen, P.J. and Stoermer, E.F., "The 'Anthropocene, '" *The International Geosphere-Biosphere Programme (IGBP) Newsletter*, 41, May, 2000.

	Business As Usual	Using Profound Knowledge
4	Management sees the future of business like the past; e.g., ever increasing in **energy intensity**	Management examines potentialities for a transition from energy intensity to **information intensity**
5	Addressing climate change is seen as a **burden**, putting American business at a **disadvantage**, killing U.S. jobs	Addressing climate change is seen as a **transformational opportunity** to build a sustainable U.S. economy and boost global competitiveness
6	A quick solution to climate change would be to **geo-engineer the climate** to align with human needs	The long-term solution to climate change is to **align the human economy** with the workings of the biosphere
7	Appoint a **Chief Sustainability Officer**	Executives **learn** about climate change and sustainability and **accept responsibility** to lead the organization's efforts
8	Business is highly quantifiable and the task is **to manage what you measure**	**The greatest gains and losses cannot be measured**, but they must be managed
9	Profit is the **aim** of a well-managed business	Profit is a **consequence** of managing well

FOUNDATION AND HISTORY OF THE PDSA CYCLE

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1. Introduction

Much confusion continues today about W. Edwards Deming's PDSA Cycle. I had a unique opportunity to communicate with Dr. Deming over the 1981-1993 time frames. I managed his monthly visits to Pontiac Motor Division of General Motors from 1982 through 1986 and was a Deming helper at 70 of his famous 4-day seminars from 1982 through 1993. He also reviewed several papers and a book that I co-authored in that time period.

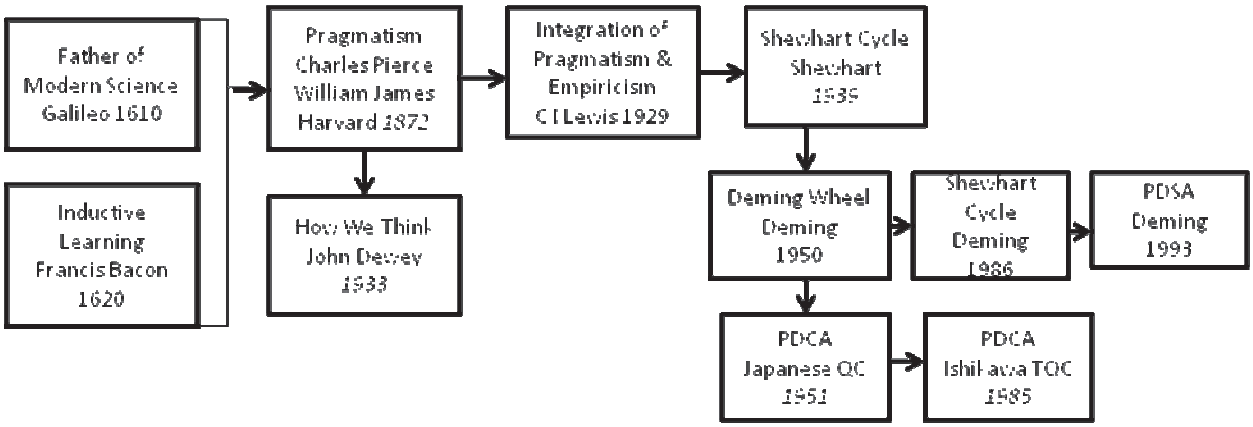
The confusion can be summarized in these three basic questions:

1. How did Deming's PDSA evolve?
2. Did Deming create the PDCA?
3. Are the PDCA and PDSA related?

2. Scientific Method: Foundation for the PDSA Cycle

Figure 1 provides a brief sketch of the history of the scientific method beginning with Galileo in 1610 through pragmatism of the early 1900's and the evolution of the PDCA Cycle and the PDSA Cycle through 1993.

Figure 1 – Evolution of the Scientific Method and the PDSA Cycle



Galileo Galilei (1564-1642) is considered by many to be the father of modern science. Galileo made original contributions to the science of motion and strengths of materials by combining designed experiments and mathematics. Conducting designed experiments are a cornerstone of science and the scientific method.

Francis Bacon (1561-1626) made his contribution as a philosopher who was very concerned about the manner in which knowledge is developed. Bacon believes that the generation of knowledge needs to follow a planned structure. Science at the time depended on deductive logic to interpret nature. Bacon insisted that the scientist should instead proceed through inductive reasoning, from observations to axiom to law. Bacon's contribution completed the interplay between deductive and inductive logic that underlies how we advance knowledge.

Charles Peirce and William James [1] met in Cambridge outside of Harvard in January of 1872 to form a discussion group called the "Metaphysical Club." This group of people would forever be linked with the uniquely American philosophy that we call "pragmatism." They stated that the function of thought is to guide action, and that truth is preeminently to be tested by the practical consequences of belief.

John Dewey (1859-1952) [2] became a leading proponent of *pragmatism* and his works would influence philosophy, education, religion, government, and democracy around the world. The pragmatism of James and Dewey could be summarized in the statement: people are the agents of their own destinies.

Clarence Irving Lewis (1883-1964) [3] an American pragmatist educated at Harvard was heavily influenced by both William James and Charles Pierce. Lewis set out three main ideas in *Mind and the World Order* to further the pragmatist's influence:

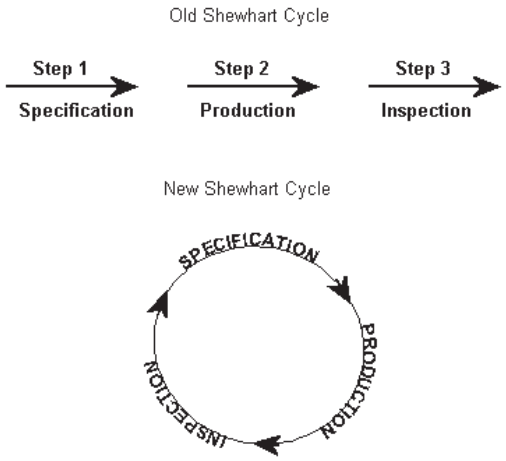
1. *a priori* truth is definitive and offers criteria by means of which experience can be discriminated;
2. the application of concepts to any particular experience is hypothetical and the choice of conceptual system meets pragmatic needs; and
3. the susceptibility of experience to conceptual interpretation requires no particular metaphysical assumption about the conformity of experience to the mind or its categories.

The book of C. I. Lewis had enormous influence on Dr. Walter A. Shewhart and Dr. W. Edwards Deming in bringing the scientific method to twentieth century industry.

Shewhart [4] displayed the new version of the "Shewhart Cycle" in 1939. Figure 2 contrasts the idea of the cycle with the old view of specification, production, and inspection. Shewhart wrote,

These three steps must go in a circle instead of in a straight line, as shown . . . It may be helpful to think of the three steps in the mass production process as steps in the scientific method. In this sense, specification, production, and inspection correspond respectively to making a hypothesis, carrying out an experiment, and testing the hypothesis. The three steps constitute a dynamic scientific process of acquiring knowledge.

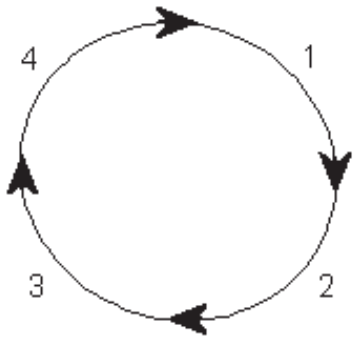
Figure 2 – Shewhart Cycle, 1939



Shewhart's 1939 book was edited by a 39-year-old W. Edwards Deming. Deming [5] modified the Shewhart cycle at a Japanese Union of Scientists and Engineers (JUSE) sponsored eight-day seminar on statistical quality control for managers and engineers in 1950. His straight line: Step 1- Design, Step 2 – Produce, Step 3 - Sell was converted to a circle with a forth step added: Step 4 - Redesign through marketing research.

Deming stressed the importance of constant interaction among design, production, sales, and research and that the four steps should be rotated constantly, with quality of product and service as the aim. Deming's Shewhart cycle was modified slightly in 1951 and is shown in Figure 3. The Japanese called this the "Deming wheel" (or Deming Circle).

Figure 3 – Deming Wheel, 1950



1. Design the product (with appropriate tests).
2. Make it; test it in the production line and in the laboratory.
3. Put it on the market.
4. Test it in service, through market research, find out what the user thinks of it, and why the non-user has not bought it.
5. *Re*-design the product, in the light of consumer reactions to quality and price.

Continue around and around the cycle.

3. The PDCA Cycle Evolves

Imai [6] stated the Japanese executives recast the Deming wheel from the 1950 JUSE seminar into the Plan-Do-Check-Act (PDCA) cycle. Imai shows the correlation between the Deming wheel and the PDCA cycle in Figure 4.

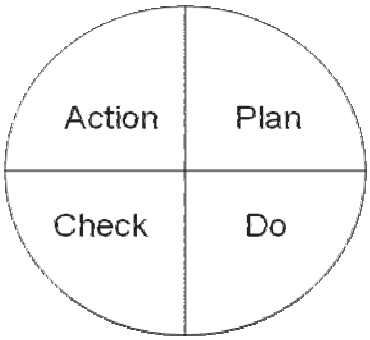
Figure 4 – Correlation between the Deming Wheel and the Japanese PDCA Cycle

1. Design > Plan	Product design corresponds to the planning phase of management
2. Production > Do	Production corresponds to doing-making, or working on the product that was designed
3. Sales > Check	Sales figures confirm whether the customer is satisfied
4. Research>Action	In case of a complaint being filed, it has to be incorporated into the planning phase, and action taken for the next round of efforts

Imai didn't provide any details as to whom and how the executives translated the Deming Wheel into the PDCA Cycle. No one person claimed authorship and I found no evidence to dispute Imai's translation.

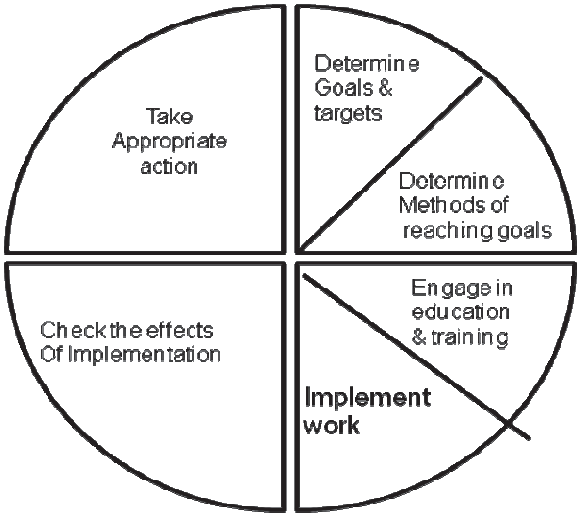
The resulting PDCA cycle is shown in Figure 5. The four step cycle for problem solving includes planning (definition of a problem and a hypothesis about possible causes and solutions), doing (implementing), checking (evaluating the results), and action (back to plan if the results are unsatisfactory or standardization if the results are satisfactory). The PDCA cycle emphasized the prevention of error recurrence by establishing standards and the ongoing modification of those standards.

Figure 5 – Japanese PDCA Cycle, 1951



Dr. Ishikawa [7] redefines the PDCA cycle to include determining goals and target and methods for reaching the goals in the planning step. In the do step, he includes training and education to go with the implementation. He say good control means allowing standards to be revised constantly to reflect the voices of consumers and their complaints was well as the requirements of the next process. The concept behind the term control (kanri) is deployed throughout the organization.

Figure 6 – Japanese PDCA Cycle, 1985



The PDCA cycle with goals and targets and methods described by Ishikawa can be traced back to Dr. Mizuno in 1959. Lilrank and Kano [8] state the 7 basic tools (check sheet, histograms, Pareto chart, fishbone diagram, graphs, scatter diagrams, and stratification) highlight the central principle of Japanese quality. These tools together with the PDCA cycle and the QC story format became the foundation for improvement (kaizen) in Japan and are still being used today.

The history of the PDCA was presented by Moen and Norman [9] at the Asian Network for Quality (ANQ) in Tokyo in 2009.

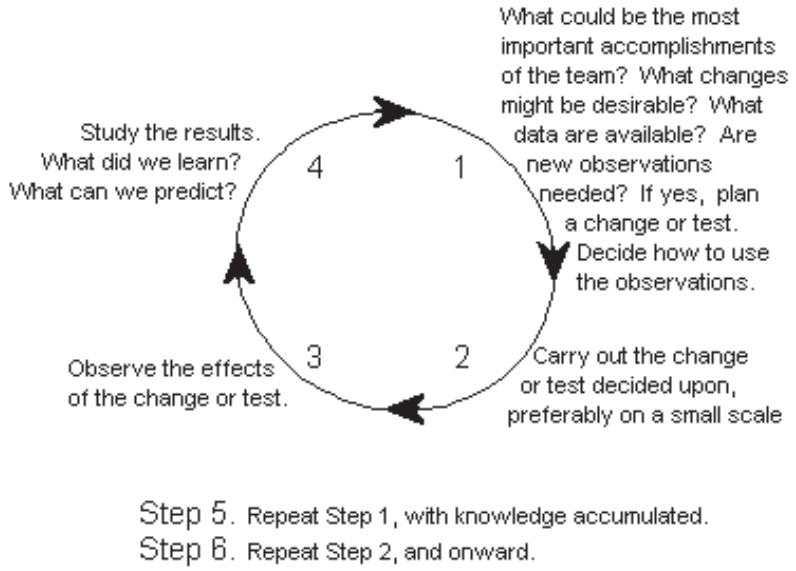
4. The PDSA Cycle Evolves

Deming [10] reintroduces the Shewhart cycle in 1986. He states that it came directly from the 1950 version. Figure 7 illustrates the procedure to follow for improvement. He states:

Any step may need guidance of statistical methodology for economy, speed, and protection from faulty conclusions from failure to test and measure the effects of interactions.

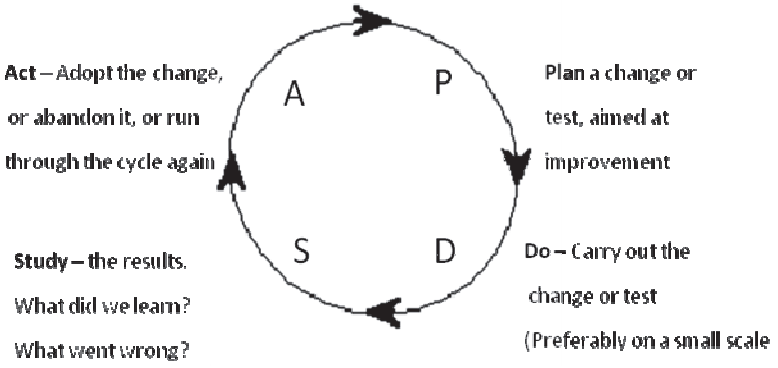
Deming presented this version in his 4-day seminars in the 1980's. Frequently, he warned audiences that the plan, do, check, and act version is inaccurate because the English word "check" means "to hold back."

Figure 7 – Shewhart Cycle: Deming, 1986



Deming [11] again modified the Shewhart cycle in 1993 and called it the Shewhart Cycle for Learning and Improvement- the PDSA Cycle. He described it as a flow diagram for learning, and for improvement of a product or of a process. It is illustrated in Figure 8.

Figure 8 – PDSA Cycle: Deming, 1993



Some of Dr. Deming's reactions to the PDCA Cycle are:

In a GAO transcript of a Roundtable discussion with Dr. Deming on August 19, 1980 [12], Deming was asked how the QC Circle: plan, do, check, and act and the Deming Circle: design it, make it, sell it, then test it in service relate? Deming's response was *"They bear no relation to each other."*

In a letter to Moen on November 17, 1990 [13], Deming commented on a Moen, Nolan, and Provost [14] manuscript, *"… be sure to call it PDSA, not the corruption PDCA."*

From a review of the Library of Congress Archives, Peter B. Petersen [15] summarizes his readings of Deming with respect to the use of the term PDCA Cycle. In responding to a letter he received in 1991, Dr. Deming had the following view about a chart labeled Plan/Do/Check/Act. *"What you propose is not the Deming Cycle. I don't know the source of the cycle that you propose. How the PDCA ever came into existence I know not."*

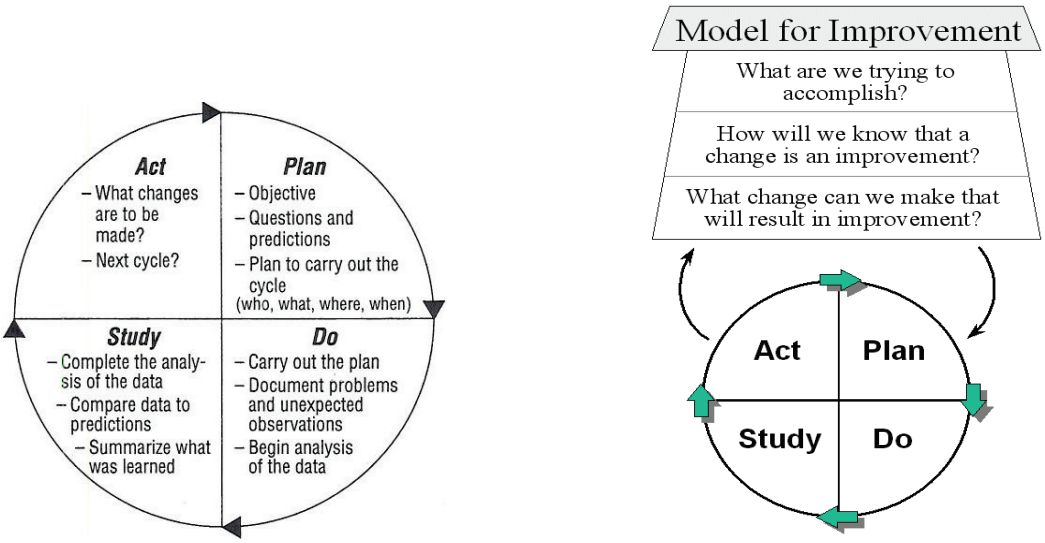
In summary:

- The Japanese developed the PDCA based on Deming's JUSE seminars in 1950 (no one person claims authorship)
- PDCA is used for implementation and compliance and has not changed in the last 40 years
- Deming evolved the PDSA from 1986 until 1993and always called it the "Shewhart Cycle for learning and improvement
- PDSA is used for testing and implementing
- Deming never embraced the PDCA
- The PDCA and PDSA are only related through the scientific method

Has the Deming PDSA Cycle evolved? In 1991, Moen, Nolan and Provost [14] added to the planning step of the improvement cycle required prediction and associated theory. The study step compared the observed data to the prediction as a basis for learning. This provides the deductive/inductive interplay necessary for learning as required in the scientific method. It is not enough to determine that a change resulted in improvement during a particular test. As you build your knowledge, you will need to be able to predict whether a change will result in improvement under the different conditions you will face in the future.

Langley, Nolan, and Nolan [16] added three basic questions to supplement the PDSA cycle. Both the detailed cycle and the model are given in Figure 9.

Figure 9 – PDSA Cycle and Model for Improvement, 1991, 1994



The Improvement Guide [17, 18] expands on The Model for Improvement as a basic framework for the science of improvement. The Model for Improvement supports improvement efforts in a full range from the very informal to the most complex (e.g. introduction of a new product line or service for a major organization).

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THE WORK OF DR. W. EDWARDS DEMING HAS LEGS

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Abstract

In the theater, the phrase *it has legs* is used to indicate that the play is interesting enough that it will continue to be of interest for some time to come. It has become obvious that the work of W. Edwards Deming, PhD, *has legs*.

Dr. Deming's articles and books have been used around the world in hundreds of industries for more than seventy years. His early paper on van der Waals absorption of gases, written in 1940, has been cited 483 times in journal articles, and as recently as 2002 by authors in the School of Public Health in Taipai Medical University. Deming's early statistical papers on least squares and statistical theory, written in the 1940's, have been quoted by more than a thousand writers. His detailed paper on least squares was most recently cited in 2009 by an author who said there are as yet unexplored applications of Dr. Deming's ideas in that paper.

As Dr. Deming's interest in the practice of statistics commanded his attention, he created a number of methods to make statistical theory practicable for the working statistician. Ideas from his books and articles on sampling methods have been referred to in thousands of articles and books written by others. Publisher John Wiley & Sons named his book on sample design a "classic," vowing never to let it go out of print. Toward the 1980's Dr. Deming's writings broadened into the need for transformation of management. His management books and articles have been cited in no fewer than 10,000 works by others.

This paper will discuss Dr. Deming's published writings and their use by others.

CREATING THE MARKETING EXECUTIVE OF THE FUTURE VIA THE DEMING APPROACH

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INTRODUCTION

The marketing management function is critical to the success of any organization. Marketing, by definition, is the strategy in which organizations can identify and meet human and social needs profitably. (1). Marketing encompasses all aspects associated with the 4 Ps of Marketing (Product, Price, Promotion and Place) and thus must not only be cross functional in nature but must also be central within the overall corporate strategy of an organization.

This concept of marketing management and its importance within the success of an organization is not new. For example, David Packard, one of the founders of the Hewlett-Packard company once stated "Marketing is too important to be left to just the Marketing Department." Furthermore, even dating back to the 1960s, there were various examples that support this thinking. In 1963, a *News Front* article declared "the Marketing Executive" as the new key figure in industry and also stated "You must develop Marketing Manpower who can and will carry the marketing program to a successful and profitable conclusion." (2). In 1967, *The Marketing Executive of the Future* was published (AMACOM Press) and within the text the author stated "Marketing will experience continuing and accelerating change in the years ahead....There will be a critical need for more sophisticated and more knowledgeable marketing executives." (3). Even a former Vice President of Marketing at Honeywell Incorporated, during this time period, stated the following:

> The marketing management function is becoming so significant in American business life today that a good marketing man should be involved in many of the significant decisions made by the corporation. I think marketing is going to become increasingly more scientific, more computer oriented and generally more vital to the profit success of any enterprise. (4)

Overall, while the importance of the marketing management function for organizational success and prosperity has been documented for some time, little has been written on how to professionally develop this "new key figure in industry." *The Marketing Executive of the Future* (1967) was the first and only text of its kind in preparing and developing future marketing executives with very little follow up.

With this as a background, the purpose of this research is twofold. It will first discuss select theories of Deming and its overlap that exists within the marketing management frameworks. It will also then analyze select principles within *Deming's 14 Points* and how essential these frameworks are in creating the marketing executive of the future. It is the general belief and hypothesis of this exploratory study that the Deming Approach to Management can not only be extremely useful within the marketing management function but can also be effective in creating the marketing executive of the future.

DEMING'S OVERLAP WITHIN SELECT MARKETING MANAGEMENT FRAMEWORKS

Much of Deming's philosophy focuses on increasing overall quality while simultaneously reducing costs. By incorporating such a philosophy of continual improvement to a system, an organization can, in the big picture, reduce waste, rework, staff attrition and litigation costs while improving customer loyalty. (5). There exists much overlap between Deming's general philosophy and the general definition, as stated

previously, that exists for marketing which focuses on identifying and meeting human and social needs profitably. Both viewpoints are to not only meet the needs of the customer in a cost effective way but to also develop loyalty. For Deming, this goal is achieved via quality and his track record throughout his illustrious career has proven that. The end goals in meeting the needs of the customer and building loyalty are the same. Hence, the major overlap between both philosophies.

A second example where there exists overlap between Deming's views and the marketing management principles can be seen with the definition of a customer. To Deming, the customer is "a rapid learner, compares one product to another, one source with another....a satisfied customer may switch. Why not?" (5). The same holds true in how the marketing management frameworks now views the customer. The information economy has developed a customer that is more shrewd and sophisticated than ever before. With information on products and services just "click away", customer have mastered the art of "comparing one product with another, one source with another." (6). Organizations are now scrambling to discover new methods to win the customer over. While many are not utilizing a quality approach, there exists overlap with the general viewpoint of the customer.

A third example that illustrates the overlap that exists between both frameworks can be seen with innovation. Deming has stated that "It is good to introduce, by innovation a new product that will do the job better....The moral is that it is necessary to innovate, to predict the needs of the customer, give him more. He that innovates and is lucky will take the market." (5).

The marketing management principles are similar. Innovation is the key to organizational growth and prosperity. Innovation can take the form of product innovation, service innovation, experiential innovation and pricing innovation. (1). While most organizations who are not market leaders simply focus on new product extensions to its current customer base since it is more risk averse as opposed to new-to-world innovations to an entirely new segment, there does exist overlap on the importance of innovation among both frameworks.

The fourth and final example of how the Deming Approach to Management overlaps with the marketing management frameworks can be seen with the importance of management/leadership and its impact on an organization. Deming had mentioned, on countless occasions, that "management is the problem" and this problem "is at the top." He had also mentioned that we are "living under the tyranny of the prevailing style of management." (5). Overall, if an organization is going to make significant strategic change, the leadership of an organization is responsible for such change and it must be a top down approach.

The same can be stated for the marketing management principle. The marketing management program is so important for an organization that is must be a top down approach to the firm's central strategy. (1). Whether it be pricing, branding, new product development, innovation, segmentation or promotion each link must be central within an organization's strategy. For example, if an organization would like to become a sales organization, it must declare "sales" as its primary focus. (7). If an organization would like to become more innovative, perhaps a "Declaration of Innovation", from the top, is in order. (8). Overall, if an organization wants to achieve significant progress within a specific area, both the Deming Approach and the marketing management frameworks both agree that it is a leadership/management issue and its direction must come from the top.

In closing, this section illustrates select strategic similarities that exist between Deming's views and the marketing management frameworks. More specifically, similarities can be seen with the role of the organization, the definition of the customer, the importance of innovation and the impact top level management can have on an institution. The next section of this research will analyze select principles within *Deming's 14 Points* and how these principles can be instrumental in developing the marketing executive of the future.

THE MARKETING EXECUTIVE OF THE FUTURE AND DEMING'S SELECT 14 POINTS

As stated previously, the marketing concept is critical for the strategic growth and prosperity of all organizations and little has been researched in developing the marketing executive of the future. With this

as a background, this next section will link select principles from *Deming's 14 Points* and will illustrate the importance of these principles for the professional development of marketing executives.

The first principle that will be analyzed is the importance of driving out fear so everyone can work effectively with each other in the company. (9). No where is this concept more important than in the innovation and new product development areas of an organization. In general, organizations can be their own worst enemy when it comes to corporate innovation. The innovation process is time consuming and CEOs and other corporate leaders are generally unwilling to engage in a true innovation process in that earnings must be reported every ninety (90) days. (8). Therefore, most organizations lack an "innovative mindset" in that true innovation requires "out of the box" thinking that can sometimes result in failure. As a result, organizational leaders are unwilling to risk failure on new-to-world product innovations to an entirely new segment. What generally occurs within new product development and innovation are merely "product extensions" to an already established customer base. (8).

The marketing executive of the future must therefore become adept at driving out fear within an organization in order to instill the required corporate innovative mindset. This mindset must be a top down approach and this future marketing executive must be skillful at obtaining top leadership "buy-in" that failure is part of the true innovation process. The Deming Principle is very applicable to the role of the marketing executive specifically when discussing innovation and new product development.

The second Deming Principle that can easily be linked to the marketing executive can be seen with breaking down the barriers between departments. (9). Deming mentioned that professionals in research, sales, design and production must work collaboratively to foresee, in advance, potential problems with the product or service in question.

Again, no where is this principle more important than for the marketing executive. Marketing, as stated previously, by virtue of its breadth, scope and complexity, must be central within the overall corporate strategy of an institution. An example of this type of thinking can fall within the strategy and tactics of pricing. Since pricing falls within the marketing management function, one can ask if this very important strategic initiative be left in a silo? The answer to this question is no as pricing must be cross functional in nature. Professionals in sales, marketing, finance, accounting, operations and the legal department, for example, should all be involved in the pricing strategy as each employee could not only add something useful to the discussion but each brings in a needed perspective that should be considered. (10). This simple example illustrates the importance of breaking down the barriers and silos within an organization. The marketing executive of the future must be able to bring areas together during strategic discussions concerning "product", "promotion", "price" and "place." Departments must operate cross functionally and the marketing executive of the future must be able to make this happen.

The third Deming Principle that can be linked and helpful to the marketing executive of the future can be seen with instituting a vigorous education and self improvement program for all employees. (9). In 1967, *The Marketing Executive of the Future* was published and one of the key takeaways from that study was that even though the marketing management function is critical, very few organizations have an established education development program for this key executive. (3). While organizations do allot funds for training and development, many times these budgets are the first to be slashed in weak or unknown markets. (11). In addition, it has been noted that even present day marketing executives still do not have an organized professional development and educational plan in place for this very important role. Overall, as marketing continues to evolve during this technological and information age, it is imperative that all marketing professionals engage in a "vigorous education and self improvement program" for their strategic role within their organization.

The final select Deming Principle which would be very useful to the development of the marketing executive can be seen with creating a constancy of purpose to improving a product and/or service. (9). There is much overlap between this principle and that of breaking down barriers between departments. Overall, whether one works in sales or customer service or receivables or any other unit within an organization, these individuals must know not only their important role but also their impact on the key stakeholder--the customer. Once these professionals know and understand the key role they play with the

customer, they will take more pride in their work as a result of this understanding. With this said, it is very important that the marketing executive of the future is an effective communicator in allowing each individual understand the role that they play with the customer. If the customer is of primary importance, then the marketing executive of the future must ensure all employees within the marketing management function and beyond understand this premise. Developing this constancy of purpose, among all employees, in improving a product and/or service, is certainly a needed skill for this executive.

CONCLUSION

In closing, the Deming Approach to Management has many key recommendations that can be useful for marketing executives. This exploratory study analyzed select Deming recommendations and their subsequent importance and applicability for the marketing executive. Overall, there needs to be more research conducted on how to effectively develop future marketing executives and how Deming's philosophies can be quite useful for the development of this executive in the future.

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THE QUALITY APPROACH TO THE SCIENCE OF LAWS

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Introduction

A review of the legislative process (of all governments) reveals that lawmaking is devoid of quality standards. There are, for all intents, no quality design standards for the creation of legislative bills and no quality assurance or quality improvement programs for enacted laws. The result of the lack of quality standards is that laws often contain design defects and incorporate "pork barrel" or special interest provisions that are harmful to the public. Also, outmoded, ineffective, and purposeless laws remain in force and continue to consume societal resources without producing a public benefit. The continued growth of the size and complexity of the bodies of laws adds to the chaos of laws and governments must enforce laws selectively in violation of the rule of law.

The advent of quality programs for laws and lawmaking promises to make a dramatic improvement in the performance of government. Quality design (QD) standards will require proposed new laws (bills) to be designed to solve societal problems efficaciously; quality assurance (QA) programs will "weed out" outmoded and ineffective laws; and quality improvement (QI) programs will enhance the effectiveness, cost-efficiency, and user-friendliness of laws. Among the consequences of the application of quality programs to laws will be the emergence and growth of the science and engineering disciplines of laws, and the transformation of lawmaking into a knowledge industry.

Lawmaking

The present discussion of quality programs focuses on the legislative process of democratic governments in which laws (statutes) are created by legislatures (Davies, 3; Gross, 5; California Legislature, 6; Kernochan, 9; and Willet, 14). For a democracy, the purpose of a law is to make a beneficial societal change for the benefit of the people as a whole. Laws are thus the problem-solving *means*, or tools, of government by which the *ends* of government are achieved.

The Failure of Traditional Lawmaking

The problem, for democracies, is that laws have mostly failed to satisfy their useful purpose. Despite the continuing enactment of laws by governments (the federal and state governments of the United States enact tens of thousands of laws annually, for example), societal problems such as illiteracy, poverty, and health insurance issues remain unresolved. Since laws consume and divert resources, the poor performance of laws is accompanied by growing government debt that threatens the living standards of the people. As governments continue to enact new laws, another problem – too many laws – has emerged. The bodies of laws have now grown so large that no one can "know the law" in its entirety, and governments must enforce laws selectively in violation of the rule of law.

Lack of Quality in Lawmaking

The poor performance of laws led to an investigation of the traditional method of lawmaking (Schrunk, 13). The results revealed that the lawmaking process is devoid of standards of quality for the creation, evaluation, and disposition of laws. In fact, there are nine separate defects in the traditional method of lawmaking that limit the ability of governments to solve societal problems in the best interests of the people.

The first defect of the traditional method of lawmaking is that it is not a problem solving process. The problem solving method (Schrunk, 13) dictates that a problem must be defined before it can be solved; it is impossible to solve a problem that has not been defined. The traditional method of lawmaking omits the problem-definition step of the problem solving method and begins, instead, with the creation of a law-solution. For example, the web site for the legislature of California (California Legislature web site, 6) states that, "All legislation begins as an idea or concept. Ideas and concepts can come from a variety of

sources. The process begins when a Senator or Assembly Member decides to author a bill." By this approach to the creation of laws – beginning with an idea for a law-solution rather than the definition of the problem that needs to be solved – the traditional method of lawmaking is incapable of solving problems and can be nothing more than a lawmaking process. The result of lawmaking is that laws are enacted but problems (illiteracy, homelessness, poverty…) remain unsolved, and governments are unable to satisfy their obligation to serve the best interests of the people.

Although the traditional method of lawmaking observes intricate parliamentary rules and procedures, it is, in effect, a simple "feed-forward" control system in which the input (ideas for new laws) drives the actuating mechanism (the legislature), and the output is more laws. As long as people have ideas for new laws, legislatures will continue to produce more laws as depicted in Exhibit 1.

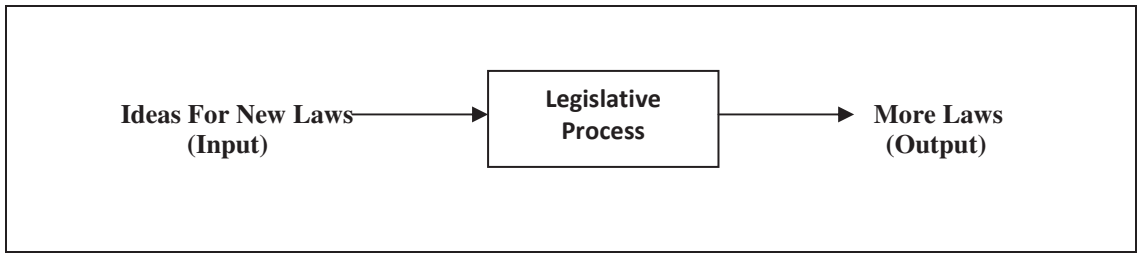

Exhibit 1. **The Traditional Method of Lawmaking**.
The traditional method is a feed-forward control system that begins with ideas for laws and ends with the enactment of more laws. Note that this control system operates without reference to societal problems or a beneficial public outcome.

The second defect with the traditional method of lawmaking is that it does not assign priorities to problems for solution. Since problems are not defined, it is not possible to assign priorities for their solution, and limited government resources can be expended on low priority issues (e.g., designation of the "national watermelon month" by the 110th U.S. Congress, 2nd Session, H. RES. 578) instead of more pressing problems (reference 7).

The third defect is that it does not require laws to contain a statement of purpose, or measurable goal. In fact, the Office of Legislative Counsel to the U.S. House of Representatives advises law designers to exclude "findings and purposes" from laws (Office of Legislative Counsel, 10). The problem with the lack of a stated purpose is that those people who enforce, interpret, and comply with the law must make their own judgment as to the intent of the law, and their various interpretations of intent may be at odds with, and defeat, the original public-benefit intent of the legislature.

The fourth defect is that there is no requirement for a thorough accounting of the costs of a law. It is crucial (for democracies) that the problem-solving benefit of a law exceed the sum of its costs and other burdens so that its net benefit (benefit minus burdens) is positive. Therefore an accounting of the total costs of a law must be made so that the benefit / cost profile of the law can be estimated. The value of benefit / cost analyses is that proposed new laws that are estimated to have a zero or negative net benefit will be identified and prevented from being enacted into law.

There are eight separate costs that need to be investigated for each proposed new law: 1) research and development costs, 2) the cost of the legislative process, 3) the drain of funds from the treasury, 4) administrative costs (e.g., to promulgate the new law), 5) judicial costs, 6) compliance costs (by those who are subject to the law), 7) loss of opportunity costs, and 8) the costs of quality assurance (Schrunk, 13). When costs are estimated by the traditional method of lawmaking, they are typically limited to the predicted drain of funds from the treasury, and other costs are usually ignored. The problem with the underestimation of costs is that many harmful bills (net benefit < = zero) are enacted into law.

The fifth defect is the lack of a requirement to analyze the risks and side effects of laws. Every purposeful action disturbs the natural order of things, has an element of risk, and produces unintended and unwanted

side effects. When a law of government is enforced, the public may be placed at risk (e.g., of a trade war and unemployment caused by a tariff on imported goods) or burdened with additional tasks (e.g., paper work) that divert resources away from productive activities. The traditional method of lawmaking neglects the well being of the public when it allows laws to be designed without consideration of risks and side effects.

The sixth defect is lack of knowledge. There is no requirement that bills contain a citation of references and law designers are thus free to use opinions, anecdotes, half-truths and even falsehoods in the creation of laws. Thus tax laws can be designed without knowledge of economics; health care laws can be designed without knowledge of health care; any law can be designed without knowledge. Lack of knowledge is a fundamental and fatal defect of the traditional method of lawmaking. It is not tolerated in the design of products by any responsible industry and it cannot be justified for the creation of laws.

The seventh defect is lack of restraint from unethical practices such as the use of deliberate deception and intentional vagueness to insert "pork barrel," special interest, and political agenda provisions into laws (Davies, 3; Gross, 5). These extraneous measures consume and divert public resources away from the original problem-solving task of the law and they rarely, if ever, provide a net benefit to the public.

The eighth defect is the lack of a requirement of licensure or other measure of competency for law designers. For the creation of complex devices that have an impact on the safety and well being of the public, such as transport aircraft, designers are required to meet high standards of design expertise (e.g., to have a Ph.D. in design). Law designers are the exception to this rule. Although laws deal with momentous issues such as war and peace and the financial stability of nations, the individuals who design laws are not presently required to meet competency standards of design expertise. The lack of knowledge (sixth defect) and design expertise in the creation of laws foredooms laws, with rare exceptions, to mediocrity or failure.

The ninth defect is the lack of follow up evaluation and improvement programs for laws. Useful products and services may contain design flaws that limit their performance or that present a risk to the public. For this reason it is the norm for pharmaceuticals and nuclear reactors, for example, to undergo thorough and periodic quality assurance reviews and quality improvement programs.

In recognition of the value of quality assurance and improvement programs for useful products and services, governments have created regulatory agencies (e.g., FDA, FAA, EPA, NRC…) to ensure that useful products are, and continue to be, effective and safe. The major exception to the observance of quality assurance and quality improvement programs by productive industries is the lawmaking industry. Once a law is enacted, "the legislature's job is done" (Davies, 3), and no quality review of laws is currently performed. The lack of quality assurance and quality improvement programs means that the government (and the public) have no knowledge of the performance of laws — a condition of ignorance that is not tolerated for any other useful product or enterprise that has an impact on the public well being.

Summary of Defects

The traditional method of lawmaking is devoid of quality. It is structurally incapable of solving complex societal problems and it lacks purpose, design expertise, ethics, and a basis in knowledge. The continued output of poorly designed laws leads to an increase in the size and complexity of the bodies of laws, an increase in government debt, and a drift towards arbitrary rule while problems remain unsolved. The traditional method of lawmaking is unprincipled, undisciplined, unreliable, and irresponsible.

The Opportunity for Excellence in Governance

The lack of quality in the traditional method of lawmaking offers the opportunity for a dramatic and sustained improvement in the performance of government. All that is needed is to expand the concepts of quality, as pioneered by Edwards Deming (Deming, 4) and others (Crosby, 2; Juran, 8), to encompass laws and the lawmaking process. The precedent for the use of quality in a wide range of industries has been established and its application is mandated, ironically, by government regulatory agencies.

Quality Assurance

The first step in the improvement of the performance of government is to establish a competent and independent quality assurance (QA) program for legislative laws (statutes). The QA program will use Deming principles to make objective analyses of the performance of every law. Those laws that are found to be ineffective, outmoded, purposeless, conflicting, harmful, redundant or unenforced will be identified and referred to the legislature for repeal. The elimination of these non-productive laws will substantially improve the performance of government through the reduction of the size, cost, and complexity of the bodies of laws.

The QA program for laws will evaluate the benefit, costs, and other relevant parameters that are affected by each law, and a report of each law's net benefit will be presented to the legislature. Aside from effectiveness in problem solution and associated costs and burdens, what are the parameters that must be included in the quality assurance evaluation of the performance of each law? These parameters are the human rights, living standards, and quality of life standards – any or all of which may be affected by a given law. It is therefore essential that they be defined so that a QA program can be developed for laws.

Human Rights

Human rights are freedoms of action and freedoms from harm for the people who are governed by democratic governments. Human rights are bounded by three conditions. First, they are inalienable (neither bought nor sold). Second, they are inherently equal in every individual. Third, the exercise of human rights by one individual cannot interfere with the human rights of any other individual. It is noted that human rights are the exclusive property of individuals; governments do not possess human rights and do not have the power to bestow human rights to anyone. The parameters that define human rights are 1) substantive rights, 2) property rights, 3) political rights, and 4) legal rights. Human rights are listed in Exhibit 2 (Schrunk, 13).

HUMAN RIGHTS

SUBSTANTIVE RIGHTS; the right

to life, liberty and security of person
to freedom from torture
to freedom from slavery
to freedom from interference with home, family or correspondence
to freedom from attacks upon reputation or honor
to freedom of thought, conscience and religion

PROPERTY RIGHTS; the right

to purchase, own, and dispose of property, including contracts and the knowledge and skills that one gains from an education or work experience
to protection of copyrights and patents

POLITICAL RIGHTS; the right

of citizenship and nationality
of the citizens to determine the authority of their government
of representation and participation in the government
to freedom from press censorship or coercion (freedom of the press)
to freedom of opinion and expression (freedom of speech)
to freedom of peaceful assembly and association, including the right *not* to be forced to join an organization or association

LEGAL RIGHTS; the right

to equal status and equal protection under the law

to protection of human rights by the government
to petition the government for a redress of grievances
to freedom from arbitrary arrest or detention (right to a writ of habeas corpus)
to freedom from bills of attainder and ex post facto laws
of the accused to be presumed innocent until proven guilty
of the accused to a public trial by a jury of peers

Exhibit 2. Human Rights.

Living Standards Living standards describe the economic status of individuals within the jurisdiction of a government. As contrasted with human rights, which deal with equal and inalienable rights, living standards are concerned with *alienable* commodities (goods and services that are bought and sold), and the ability of individuals to purchase those commodities. The criteria in Exhibit 3 define living standards (Schrunk, 13).

It is noted that living standards cannot be accurately calculated by dividing the gross domestic product (GDP) of a government by its population-count, i.e., GDP per capita. GDP per capita overstates living standards because GDP includes the operations of government institutions, which do not contribute to individual income or net worth. For example, government-owned military installations, courthouses, museums, jails, and libraries are needed to maintain human rights and provide high quality of life standards, but they add nothing to individual income or net worth and, to the extent that the operation of these assets is supported by taxes, they decrease individual disposable income. While GDP per capita may be a convenient economic indicator of the overall economic performance of government, it is an unacceptable measure of living standards of the people.

LIVING STANDARDS

The level of individual disposable income in terms of the government's currency.
The purchasing power and stability of the government's currency.

The level of individual net worth. The cost of consumer goods and services.

Exhibit 3. Living Standards.

Quality Of Life Standards

The parameters that define quality of life standards are the measures of the physical and cultural environment of the people within the jurisdiction of a government. The indices listed in Exhibit 4 are used to derive quality of life ratings (Schrunk, 13).

	QUALITY OF LIFE STANDARDS
POSITIVE INDICES	Quality and availability of consumer goods and services. Quality and availability of public use facilities such as parks, museums, and transportation networks.
NEGATIVE INDICES	Incidence of war. Incidence of crime. Incidence of preventable disease, disability, and death. Incidence of pollution.

Exhibit 4. Quality of Life Standards.

The objective of government, in terms of quality of life standards, is to secure and maintain high positive indices and low negative indices. It is noted that efforts to secure high quality of life standards also consume societal resources that are obtained by the government from taxes, fees, and other revenue sources that decrease living standards. The determination of the best balance and trade-offs between quality-of-life standards and living standards is a matter for deliberation by the legislature, which is obligated to serve the people's best interests in terms of their liberty and well being, i.e., human rights, living standards, and quality of life.

Recommendation for the Repeal of Laws

Based upon the foregoing discussion, the QA program will evaluate the performance of each law within a specified time period (e.g., every ten years) and send a recommendation to the legislature for the repeal of laws that do not meet QA standards. Examples of laws recommended for repeal are listed in Exhibit 5 (quality of laws web site, 15). The repeal of laws by the legislature on the recommendation of the QA program will improve the performance of government by decreasing the size, cost, and complexity of the body of laws. The added value and savings that are realized by the repeal of non-productive laws will help to offset the cost of the QA program (Crosby, 2). Those laws that are not recommended for repeal by the QA program will be referred to the quality improvement (QI) program for design changes that will improve their performance.

LAWS RECOMMENDED FOR REPEAL BY THE QUALITY ASSURANCE PROGRAM
Laws that address problems that have not been defined Laws that address problems that no longer exist Laws that address more than one problem

Laws that lack a stated, measurable problem-solving goal, or purpose
Laws that are not enforced
Laws that violate human rights
Laws that are overly vague or complex
Laws that fail to achieve their goal
Laws that lack a citation of references
Laws whose burdens on the public are greater than their problem-solving benefits
Laws whose benefits and burdens are equal
Laws whose results cannot be measured
Laws that interfere with other laws
Laws that duplicate other laws
Laws that have not undergone QA analysis within a specified time frame, e.g., ten years

Exhibit 5. Criteria for the Repeal of Laws by the QA Program.

Quality Design Standards Major industry groups (health care, energy production, transportation…) observe quality design (QD) standards for the creation of products that are effective, cost-efficient, user-friendly, and free from serious side effects. The observance of QD standards reduces overall costs because design defects are minimized and major re-design efforts are rarely necessary. For regulatory agencies, the rationale of QD standards for industries is to protect the safety and well being of the public. The proven success of QD standards for a wide range of industries indicates that QD standards will be equally effective and beneficial for the lawmaking industry.

Proposed QD standards for laws are listed in Exhibit 6 (Schrunk, 13). These standards are derived from the QD standards that now apply (as a matter of law) to every major productive industry (quality of laws web site, 15). QD standards require that the design of laws be based upon reliable knowledge and that laws solve societal problems in the best interests of the people as a whole. The design objective for laws is the IDEAL LAW. The characteristics of the ideal law are listed in Exhibit 7 (Schrunk, 13). QD standards will correct the flaws and omissions of the traditional method of lawmaking. They will cause lawmaking to have a basis in knowledge (thus transforming lawmaking into a knowledge industry) and channel the efforts of legislatures towards the achievement of optimum outcomes in terms of the liberty and well being of the public.

Quality Improvement Program for Laws The QA program for laws will evaluate the efficacy of enforceable laws and, in so doing, will uncover flaws in their structure and operation. In the effort to improve the quality of the body of laws, therefore, the QA program will be followed by a quality improvement (QI) program that simplifies laws, removes defects, and improves their performance. For the amendment (redesign) of reviewed laws, the QI program will observe the quality design standards listed in Exhibit 6 and make a recommendation to the legislature for specific improvements (i.e., amendments) in the law.

The Value of Quality Programs The combination of QD, QA, and QI programs for laws will make substantial improvements in the performance of government. As discussed earlier, the traditional method is a feed-forward control system that is driven by ideas for laws and whose output is more laws (see Exhibit 1). In contrast, the quality of the output is the critical controlling parameter of a feedback control system. (The cruise control on an automobile is an example of a feedback control system that maintains the desired speed of the automobile.) When quality programs are applied to lawmaking, the legislature will address societal problems rather than ideas for laws, and the driving force of the legislature will be the quality of the problem-solving performance of laws in terms of the human rights, living standards, and quality of life of the public. In other words, quality programs will cause the momentous transition of the lawmaking process from a "feed-forward" control system that makes laws to a "feedback" control system that solves problems in the best interest of the public.

QUALITY DESIGN STANDARDS FOR PROPOSED NEW LAWS

Each proposed new law (bill) shall contain a statement of verification of each of the following items:

Definition of the societal problem that the bill addresses.
Results of analyses of the size and nature of the problem.
Priority assignment of the problem by the legislature.
Name and qualifications of the law design institution and law designer(s).
Measurable goal of the bill (the purpose, or "intent of the law").
Justification of the sanction (tax, fine, subsidy, lawsuit, etc.) of the bill as the optimum solution of the problem in the best interests of the people.
Model ("blueprint") of the bill, which was used to simulate and optimize the bill during the design process, and to predict its outcome.
No extraneous provisions ("pork barrel," special interest exemptions…) are included in the bill.
The method(s) and milestones for measuring and verifying results.
References to all of the above.

Exhibit 6. **Quality Design Standards**. These standards apply to the amendment of existing laws as well.

THE IDEAL LAW OF GOVERNMENT

The Ideal Law of Government has the Following Characteristics:

It is simply stated, succinct, and has a clear meaning It is imperative that those who enforce and interpret the law, and those who are subject to the law, are able to understand both the letter and the intent of the law.
It is completely successful in achieving its objective Every law in a democracy has a problem-solving purpose, or objective, that serves the best interests of the people and reflects their highest aspirations. The ideal law is completely successful in attaining its objective.
It interacts synergistically with other laws Laws often have an effect upon, and are affected by, other laws. The ideal law is designed so that its interaction with other laws is synergistic in the attainment of its problem-solving objective.
It produces no harmful side effects All human-made products, including laws, have unintended side effects that may be beneficial, neutral, or detrimental. A law that accomplishes its problem-solving goal is not acceptable if its unintended side effects degrade the established living standards or quality of life of the people, or infringe upon human rights. Therefore, the ideal law produces no detrimental side effects upon the human rights, living standards, or quality of life of the people.
It imposes the least possible burdens on the public The ideal law imposes the least possible costs, restrictions, and other burdens upon the people so that the maximum positive net benefit of its enforcement is attained. It is cost-efficient, safe, non-intrusive, and user friendly.

Exhibit 7. **The Ideal Law of Government.**
Exhibit 8 depicts the "quality feedback control system" for legislatures that adopt quality programs (QD, QA, QI) for laws. Note that non-productive laws are repealed during each lawmaking cycle and the remaining laws undergo quality improvement. In this manner, the performance of each law will approach that of the ideal law over time and the size and cost of the body of laws will be kept to a minimum. Of significance, quality programs for laws will give rise to and provide impetus for the emerging new science of laws.

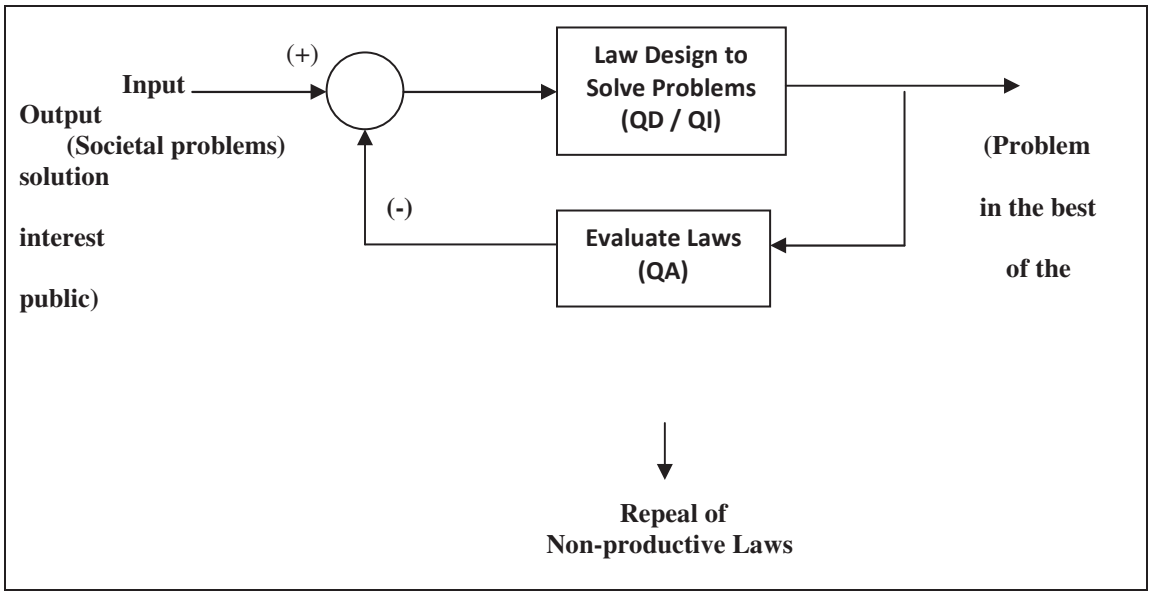

Exhibit 8. The Quality Feedback Control System of Legislation. Quality programs will transform the lawmaking process into a problem-solving feedback control system. This system will be self-correcting in the direction of optimum outcomes of laws in the best interests of the people as a whole.

The Science of Laws

Laws operate within and have an effect upon the physical world, which is the domain of science; laws are eminently suited to scientific investigation. In response to the need for reliable knowledge of the mechanics ("cause and effect") of laws and the need to satisfy quality design standards for laws, a new science, the science of laws, is emerging. This inchoate science of laws consists of two co-equal branches: investigative science and creative science (Schrunk, 11, 12, and 13; science of laws web site, 16).

The Investigative Science of Laws

The investigative science of laws is not yet organized as a separate science. However, peer-reviewed articles that describe the mechanics of laws are now being published in the scientific literature (Chorba, 1) and a body of published scientific knowledge of laws has been assembled (science of laws web site, 16). As the efforts to derive additional knowledge of laws continue, it is anticipated that a formal science of laws will eventually be recognized as a separate science, with a society of peers and the publication of journals of the science of laws.

The investigative science of laws, when fully developed, will be the principled scientific discipline that employs knowledge, tools, scientific methodology, and peer review to derive, record, organize and promulgate scientific knowledge of the laws of government. The importance of the science of laws is that it will, like all other sciences, add to the store of scientific knowledge of the physical world. That knowledge will allow law designers to avoid the mistakes of the past and enable the creation of sophisticated and accurate models of laws that can predict, with increasing degrees of certainty, the outcome of proposed new laws for the benefit of the public.

The Creative Science of Laws

The implementation of quality design standards for laws will give rise to the creative (engineering) science of laws (Schrunk, 13; science of laws web site, 16). The engineering discipline of laws will be a principled scientific discipline analogous to other engineering disciplines such as aeronautics and electronics. Its purpose will be to employ scientific knowledge and tools to create and optimize laws of government that solve societal problems efficaciously. It will derive, record, organize and promulgate reliable knowledge of design methodologies related to laws and lawmaking, and formulate ethical standards for the creation of laws.

The engineering discipline of laws will correct the flaws of the traditional method of lawmaking and bring scholarship, quality standards, and design expertise to the lawmaking process. The combined efforts of the science and engineering of laws can be expected to produce the optimistic scenario wherein knowledge of laws and lawmaking is continuously growing, societal problems are being solved by ever-improving means, and problems of the next higher order of complexity are in the process of being solved.

College Curricula

To meet the requirements of quality programs and the science of laws, new college curricula will need to be developed (Schrunk, 13). There are presently no schools that provide an education in the design of law-solutions for societal problems or in the accumulation of reliable knowledge of the mechanics of laws. The curricula of law schools, for example, do not include the design techniques needed for the creation of laws that solve societal problems. For both the science and engineering disciplines of laws, therefore, college curricula, to the Ph.D. level, will need to be developed. The principal coursework will emphasize software and systems engineering programs as they apply to lawmaking and will include courses in government, science, mathematics, law, history, and economics; it will constitute the ultimate "liberal" education.

Conclusion

Quality programs, as pioneered by Edwards Deming, have been successfully applied to a wide range of industries. However, one major industry – the lawmaking industry – has not adopted quality programs for its product, laws, and governments have thus been severely limited in their ability to solve societal problems in the best interests of the public.

The expansion of the concepts and practices of quality to encompass laws of government and the lawmaking industry promises to make a substantial improvement in the performance of government. Quality programs will cause the bodies of laws to decrease in size, cost, and complexity as they become more effective in solving societal problems. Lawmaking will be transformed into a knowledge industry, a new science of laws will emerge, and the performance of laws will parallel the patterns of success that now characterize the fields of science.

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IT'S THE PROCESS!!

(Student Success is Not Determined by the Teacher, Student, Parent, Demographics, Testing, Administration, Building, Books, Etc.)

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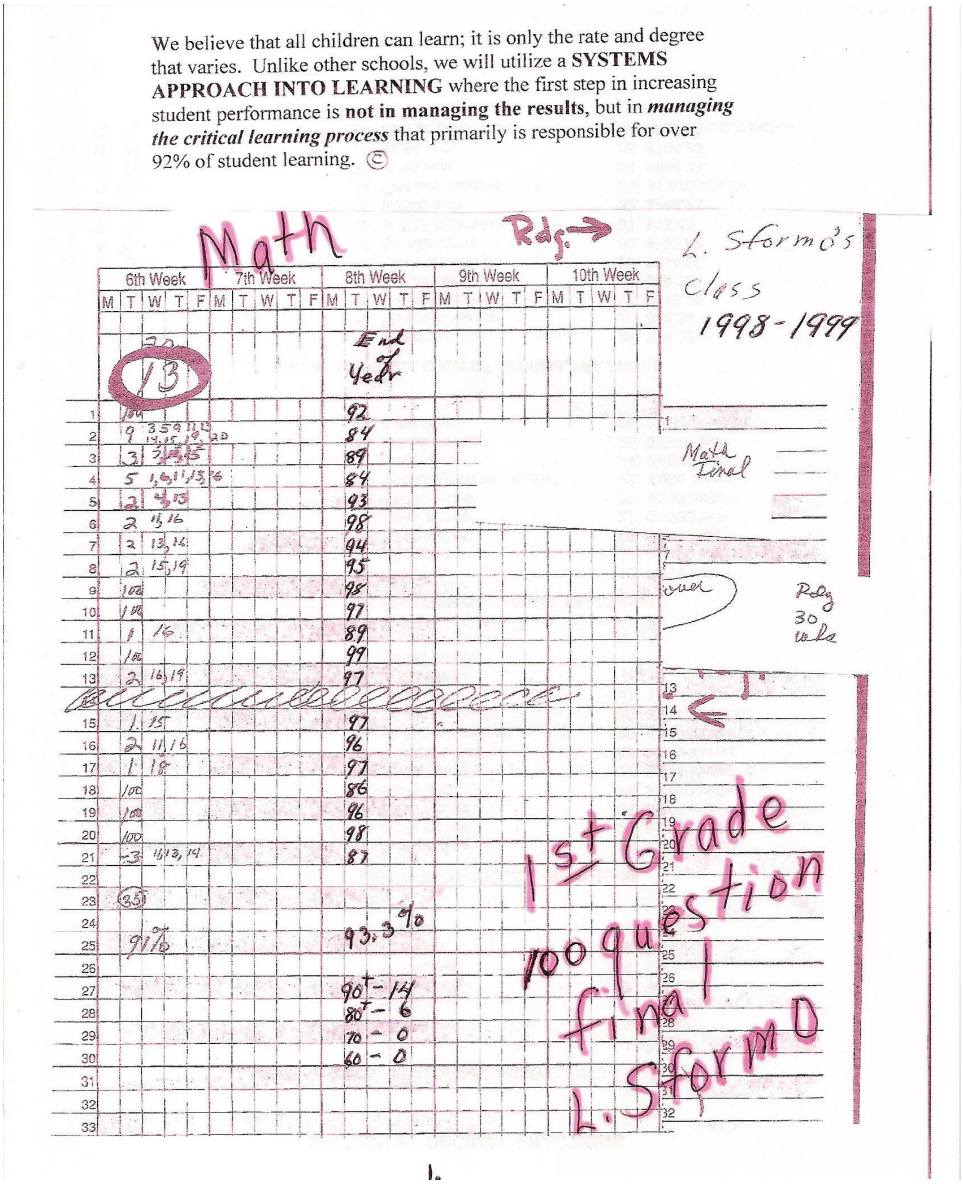

Larry Sforzo (50) Unit 7- Mr. Traditional

4-6-01 Larry, You got hard ones like 8, 17, 18, 19.

Try harder – you can do it!

1. 60 × 4 = 280

2. 10 × 7 = 70

3. 5241 × 4 = 21,004

4. 5317 × 4 = 21,266

5. 721 × 4 = 3,284

6. 230 × 4 = 920

7. 24 × 10 = 240 (00, 24)

8. 631 × 10 = 6,310 (000, 631)

9. 940 − 728 = 212

10. 8) 56 = 56

11. 19 × 4 = 76

12. 73 × 8 = 664

13. 6 × 74 = 74 × 6 = 388

14. 308 × 3 = 924

15. 409 × 9 = 3681

2.

16. 4 X 303

$$\begin{array}{r} 303 \\ \times\ 4 \\ \hline 1{,}212 \end{array}$$

17. 1804

$$\begin{array}{r} \times\ 9 \\ \hline 16{,}236 \end{array}$$

18. 2 x 4825

$$\begin{array}{r} 4825 \\ \times\ 2 \\ \hline 9{,}650 \end{array}$$

19.

$$\begin{array}{r} 92 \\ \times\ 30 \\ \hline 00 \\ 276 \\ \hline 2{,}760 \end{array}$$

20.

$$\begin{array}{r} 73 \\ \times\ 40 \\ \hline 00 \\ 292 \\ \hline 2{,}920 \end{array}$$

21.

$$\begin{array}{r} 186 \\ \times 40 \\ \hline 000 \\ 796 \\ \hline 7{,}960 \end{array}$$

22. Write the factors for 16. - (1,16), (2, 8) (4,5)
23. Write the first 4 multiples for 8: 8, 16, (24,3)
24. 8 boys have 9 marbles each. How many marbles do they have between them? (72)

25. The maple tree can have 2,783 leaves. How many leaves would be on 6 identical trees?

$$\begin{array}{r} 2{,}783 \\ \times\ 6 \\ \hline 16{,}878 \end{array}$$

3.

th.	Tests	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	
1	Tom																84
2	Sue																96
3	John																100
4	Larry																56
5	Scott																76
6	Linda																92
7	Bill																72
8	Joe																60
9	Judy																84
10	Val																92
11	Stephanie																68
12	Mike S.																96
13	Ivan																88
14	Todd																80
15	Peter																76
16	Michael																88
17	Emma																96
18	Carley																100
19	John																100
20	Chris																92
21	Sharon																84
22	Jodi																96
23	Bob																88
24	Kathy																68
25	Rita																96
26	Jeff																92

ave. 85 %

All other test notes

Ex. Dil. gov. average tool

Mr. Traditional's Class Record - 4th Math

4.

NO: 15 BARDEEN'S INC., E. SYRACUSE, N.Y.

A parallel test evaluates the same objectives using different numbers or facts.

Name: Larry Sformo Mr. SAIL

Date: 4-6-01 Rm. 101

UNIT 7: MULTIPLICATION B

* **Pretest** (Formative Assessment)

DIRECTIONS: Write your answers in the answer column.

I. Multiply a 2 digit number by a 1 digit number.

1) 60 x 4 = 280

2) 10 x 7 = 70

3) 19 x 4 = 76

4) 73 x 8 = 664

5) 6 x 74 = 388

74 x 6 = 388

****

II. Multiply a 3 digit number by a 1 digit number.

6) 721 x 4 = 3,284

7) 230 x 4 = 920

8) 308 x 3 = 904

9) 409 x 9 = 3,681

10) 4 x 303 = 1212

303 x 4 = 1,212

****

III. Multiply a 4 digit number by a 1 digit number.

11) 5241 x 4 = 21,004

12) 5317 x 4 = 21,266

13) 1804 x 9 = 16,236

14) 2 x 4825 = 9,650

4825 x 2 = 9,650

15) The maple tree can have 2,783 leaves. How many leaves would be on 6 identical trees?

2,783 x 6 = 16,878

ANSWERS

1. 280 ✓
2. 70
3. 76
4. 664 ✓
*5. 388 ✓
6. 3,284 ✓
7. 920
8. 904
9. 3,681
*10. 1,212
11. 21,004 ✓
12. 21,266 ✓
13. 16,236
14. 9,650
*15. 16,878 ✓

SCORE

I.	100	80	INC
II.	100	80	INC
III.	100	80	INC
IV.	100	80	INC
V.	100	80	INC

7

5.