

**Why Vectors for Managers and Analysts?** *Because the final responsibility for a decision falls on their shoulders and any help to make that task easier and more effective is good for all concerned.*

## 1. Introduction

### The Problem

It is imperative in these days of executive and board director responsibilities being more scrutinized, that those accountable be fully aware of what lies beneath executive and board presentations, stock holder reports, employee policy changes and strategic corporate decisions. The challenge is that most executives and directors have lots of experience - but not always in the subject matter or discipline required for decision action.

This makes the need to "see" the decision logic that much more important from a fiduciary responsibility view. To make a bold decision takes more than fortitude; it takes a full understanding of all the cards on the table. Any significant decision today is also likely to be complex AND risky. Eventually, even the most complex decisions are reduced to a set of options.

If closure is to be accomplished, then oversights must be eliminated, people who are not fluent in the decision content must eventually be comfortable with the facts and the rationale for the final decision must not be lost in antiquity. Henceforth, decision audit trails are a must.

### The Procedure

When a significant decision is to be made, all the feasible "Decision Options" must be listed along with the criteria that they should be tested against. The criteria must be organized properly and logical in structure, particularly in how levels of priority are established. The recommended procedure by most decision theorists is to build the criteria tests in the form of a hierarchical outline which can cascade down many levels of detail and priority.

A Voting Matrix of Criteria Scores vs Decision Options is needed which must also include importance weighting. Room should be provided to accommodate the various contributors' evaluations. The contributors should be advised to vote/score only on those criteria in which they are competent. It is imperative that a formal Voting Matrix be retained with names and recorded votes including space for individual contributors' comments.

### The V(ma) Advantage

Thus far, what has been described is standard operating procedures for decision and comparative analysis. What V(ma) also brings to the table, addresses the complexity of the comparative analysis and produces substantial information about each Decision Option which will enable the managers to review the results and make the Decision.

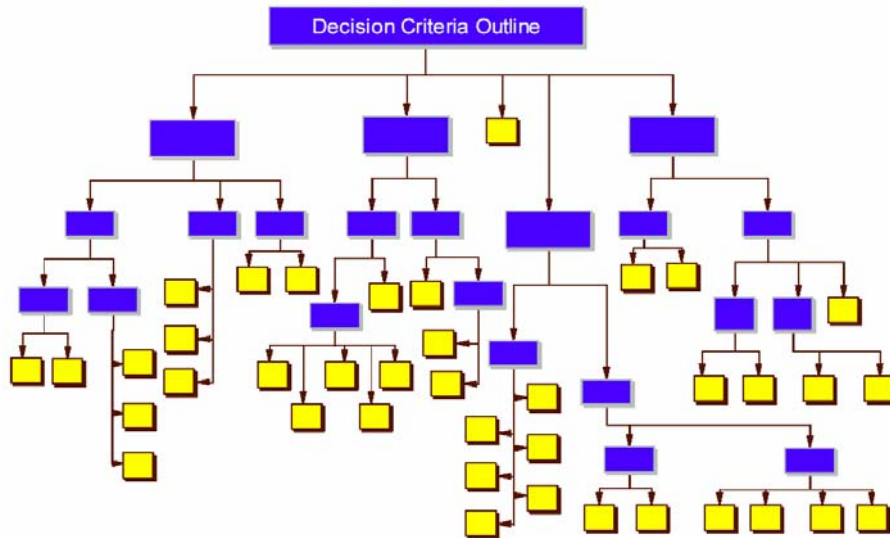
**V(ma) is a Decision Analysis Software System** created by **Comparative Visual Assessments Incorporated, "CVA"** and is based on CVA's patented decision tool methodology which utilizes statistics and vector analysis to provide managers and analysts with a hierarchical graphic database of "Vectorgrams<sup>SM</sup>" for more effective access, evaluation and decisions.

In addition to the standard numerical analytic data, V(ma) provides a graphic viewing process, that is unique, patented and more important, designed by a former CEO with over 30 years experience in making complex product functionality and development tradeoff decisions. The essence of the graphic viewing process is not just a few clever diagrams but rather a database of graphic views for page turning browsing. Providing such a decision tool enables business managers to understand more fully, the nuances of a decision analysis effort by being able to probe from the top summaries to the smallest detail with the click of a mouse at their consoles or laptops.

The V(ma) goal is to assist management in obtaining a full understanding of the Decision Options and to be comfortable with the facts, thus ensuring a more confident decision and the ability to defend that decision later. V(ma)'s graphic presentations are called Vectorgrams. They provide an graphical chart viewing of the results coupled with a linking capability that allows one to migrate throughout the analysis workbook to whatever detail they need in order to be comfortable with the facts.

The technique enables the manager to see why and where each Decision Option excelled or failed and which criteria evaluations would have to be improved by each Decision Option - in what order of priority - and by how much - in order to match the Decision Option that met the criteria tests most successfully.

*The V(ma) Vision and Metaphor*



**Vision**

*Our vision is to make V(ma) a tool for the Decision Analyst and an Interactive Reader for inquisitive Managers that they may better understand the results of the Analyst's work.*

**Metaphor**

*The hierarchy of a domain can be likened to that of a circuit and just as an engineer can examine a specific circuit position with a probe*

*so now can the manager examine a specific (blue) Node of the Decision Criteria Outline to determine how well the Decision Options performed for those criteria...*

*and just as the circuit engineer has an oscilloscope for better graphic visualization so now does the manager and analyst with Vectorgrams for each Node in the Criteria Outline.*

**The Future's Mangers**

*Tomorrow's management will be computer literate and will demand access to details far beyond what those in the past required. Just as they can now read the news on a Web page and click and drill down as far as they need to be comfortable with the facts, so will they want project plans that reflect competitive biases, as well as seasonal, geographical and economic biases included as weights of importance. And they will want product projections to reflect their effect on their products to be conveyed as part of a graphics language that will enable them to move easily through the details simply by clicking and drilling throughout the hierarchical domain of the entire project.*

*The following pages contain a set of topics 2 through 6 which describe the approach V(ma) has taken to assist the analyst and manager, in their effort to choose the most qualified alternative, by probing the results of hierarchical criteria tests.*

## 2. Understanding the Weighted Average Process

The score for each of the Alternative Candidates for a given Node is the weighted average of their scores ( $f_i$ ) for each of the Node's subcomponents and the corresponding importance weights ( $W_i$ ) of each of the subcomponents. It is denoted by the equation

$$\text{Node 's Weighted Average Score} \quad \bar{f} = \frac{\sum_i W_i f_i}{\sum_i W_i}$$

Herein lies the beauty and the mystery of the process. Before the weights of importance are determined, they can be considered as all being equal to one another. That means that for an unweighted node, a candidate's weighted average score merely becomes the average of its subcomponent's scores. But when the weights are included, they can become **multiplying weight ratios** based on how the distribution of importance was applied. To summarize, if an important feature has a large score, its weighted score is going to become extremely large while an unimportant feature's large score is going to be reduced considerably. *i.e. big scores will either win big or suffer big. Conversely, weak scores, important or unimportant, will still be relatively weak weighted scores.*

Let us consider a category node whose name might be "House Criteria" and let its subcomponent features be "Price", "Condition", "Size", and "Location".

As an example, let one of the alternative candidates be a house called "Alpha" whose **Price** has a score of 8 out of 10 indicating that it is a very reasonable price; its **Condition**, with a score of 4, indicating it is well below average; its **Size** with a score of 6 indicating its size is slightly above average; and finally its **Location** with a score of 10 indicating that its location is one of the best.

Let the customer weights of importance for the be a 10 for **Price** indicating that price is very important; its weight for **Condition** be 4 which is not a major issue, its weight for **Size** be 6 indicating that size is relatively important; and finally the weight for **Location** be 8 indicating that it is key to this customer requirements. *i.e.*

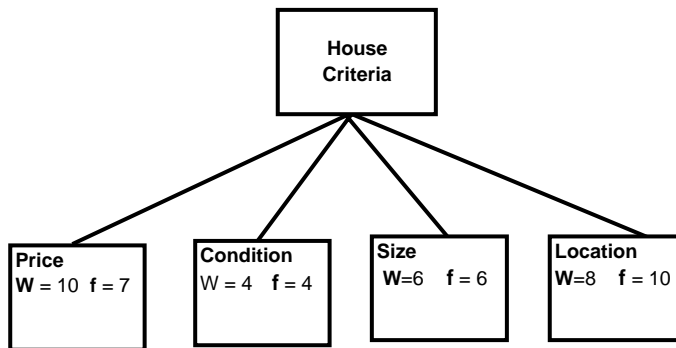
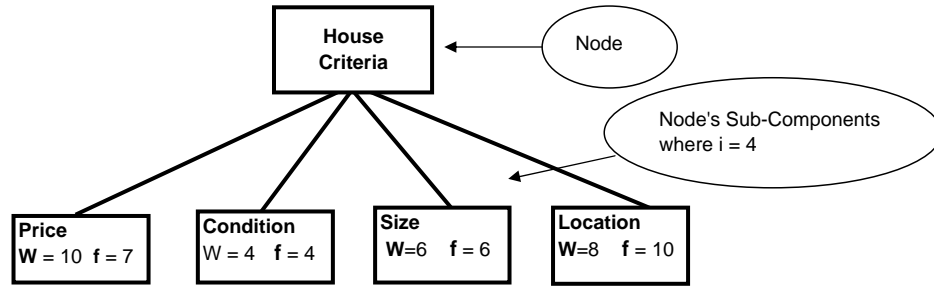


Figure 1



Again the equation for a category's node score is

$$\text{Node's Weighted Average Score } f = \frac{\sum_i W_i f_i}{\sum_i W_i}$$

Now let us review the score for the "Alpha House" before and after the weighting has been applied. With no weights applied all four of the weights are equal to 1.

The sum of the "no" weights then is 4.  
 The unweighted score for "Alpha" is  
 $1/4(7)+1/4(4)+1/4(6)+1/4(10) =$   
 $25\%(7)+25\%(4)+25\%(6)+25\%(10)=$   
 $1.75 + 1.0 + 1.5 + 2.5 = 6.75 = \text{Unweighted score of the Node}$

The sum of the assigned weights is  $10 + 4 + 6 + 8 = 28$   
 The weighted score for "Alpha" is

$(10/28)(7)+(4/28)(4)+(6/28)(6)+(8/28)(10) =$   
 $(35.71\%)(7)+(14.29\%)(4)+(21.43\%)(6)+(28.57\%)(10)=$   
 $2.5 + 0.571429 + 1.285714 + 2.857143 = 7.214286 \text{ or } 7.21 = \text{Wgt'd Score of the node}$

Now let's define the weighted ratio for each subcomponent

	% Contributions	Wgt Ratio	x	unWgt'd Scr	Wgt'd Scrs
Price	25% => 35.71%	1 => 1.4286	x	7 =>	10.00
Condition	25% => 14.29%	1 => 0.5714	x	4 =>	2.285714
Size	25% => 21.43%	1 => 0.8571	x	6 =>	5.142857
Location	25% => 28.57%	1 => 1.1429	x	10 =>	11.42857

Using the weighted ratios as effective weights, the sum of the wgt's = 4 and the weighted average score is calculated to be:

$(1.4286/4)(7)+(0.5714/4)(4)+(0.8571/4)(6)+(1.1429/4)(10) =$   
 $10+ 2.285714 + 5.142857 + 11.42857 = 28.85714/4 = 7.214286 = 7.21 = \text{Wgt'd Score of the node}$

Notice what has transpired from the weighted average process. The values, of the four "unweighted" weights of 1.0 each (adding up to 4), have been redistributed to become four "real" weights 1.43, 0.57, 0.86 and 1.14 which still have a sum of 4 and their percentages of contribution are now 35.7%, 14.3%, 21.4% and 28.6% adding up to 100%.

*(Pages 13 and 14 contain the Analyst and Manager Vectorgrams for this Node.)*

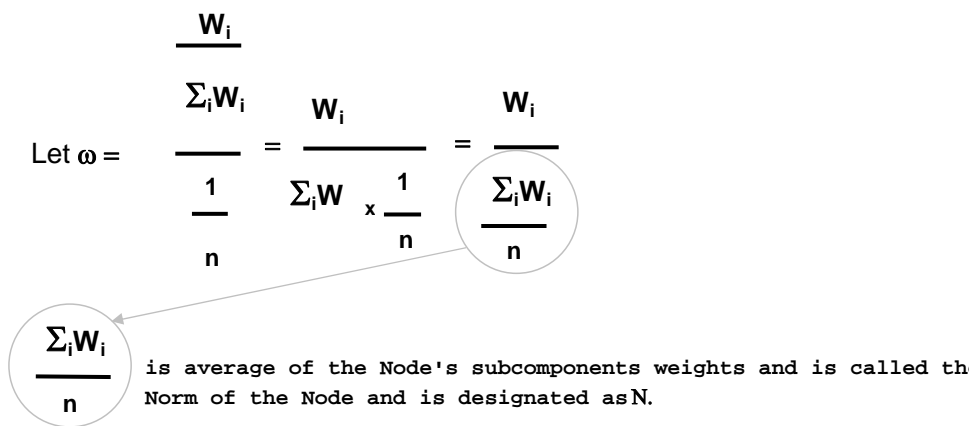
There is more to be learned about the weighted ratio of a subcomponent. (Bare with the mathematical equations; what will be shown is the derivation of an easy formula for calculating the real weights and then one for calculating the increase or decrease caused by the weighting.) Let us review the following: The percent of contribution of a subcomponent of a Node is defined as the weight of the subcomponent divided by the sum of the weights of all n of the Node's subcomponents.

The unbiased weights of a Node are all equal to 1 so the percent of contribution of each one of the subcomponents is 1/n.

The percent of contribution of a subcomponent of a Node whose i subcomponents have been assigned biased weights, is expressed as  $W_i$  divided by the sum of the weights  $\sum_i W_i$ .

The ratio between the biased weighted percent of contribution and its unbiased percent of contribution is what we define as the weighted ratio of a subcomponent and is designated by the symbol  $\omega$  in the following equation.

$$\text{Let } \omega = \frac{\frac{W_i}{\sum_i W_i}}{\frac{1}{n}} = \frac{W_i}{\sum_i W_i} \times \frac{1}{n} = \frac{W_i}{\frac{\sum_i W_i}{n}}$$



$\frac{\sum_i W_i}{n}$  is average of the Node's subcomponents weights and is called the Norm of the Node and is designated as  $N$ .

Therefore  $\omega = \frac{W_i}{N}$  The weighted ratio of a subcomponent (i.e. its real weight) can be obtained by dividing its assigned weight by the Norm of the Node,  $N$ .

The Norm of the Node is quite significant because the weights which are greater than  $N$  will be enhanced and those that are less than  $N$  will be diminished.

### 3. Defining the weighted score of a component as a vector

Let's apply the equation of the Norm of the Node to the equation for the weighted average of a Node for a given candidate by dividing both the numerator and denominator by its equation.

$$\bar{f} = \frac{\sum_i w_i f_i}{\sum_i w_i} = \frac{\frac{\sum_i w_i f_i}{N}}{\frac{\sum_i w_i}{N}} = \frac{\sum_i (w_i/N) f_i}{n} = \frac{\sum_i \omega_i f_i}{n}$$

and if we define  $\Delta f_i$  to be  $= \omega_i f_i - f_i$

then  $\omega_i f_i = f_i + \Delta f_i$

and  $\bar{f} = \frac{\sum_i (f_i + \Delta f_i)}{n}$  The numerator of the equation defines the weighted score of each ith (f and Δf) and the denominator n defines the scale to produce the resultant weighted score for a given alternative candidate for that Node

To explain how a vector is constructed, we begin with of an alternative candidate's subcomponent whose unweighted criteria score f is represented as a vector

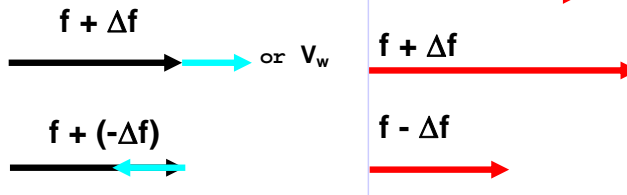
by



Next, we introduce its value Δf as a vector by



and then f + Δf would be represented as a vector V<sub>w</sub> by and should Δf be negative as by



The use of vectors with their delta values is restricted visually, but especially in the latter case because of the overlap of the negative delta. V(ma) has developed a scheme to correct it by defining the impact of the importance bias as a "Square Vector" V<sub>b</sub> whose horizontal and vertical components are both equal to Δf thereby producing

$$V_w = V_{wx} + V_{wy} \text{ with } V_{wx} = f + \Delta f \text{ and } V_{wy} = \Delta f.$$

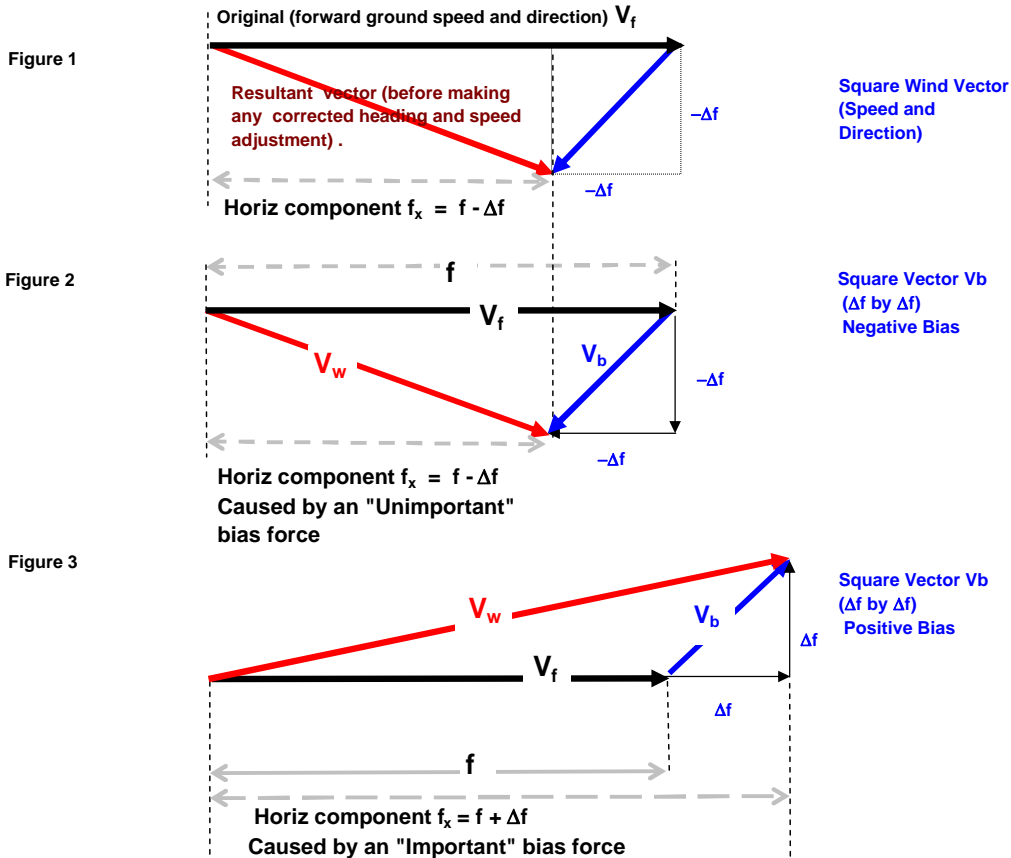
This will utilize a second dimension y, to show the positive or negative value of the vertical component of the vector V<sub>w</sub> = Δf enabling the reader to easily perceive the importance or lack of it for each vector.

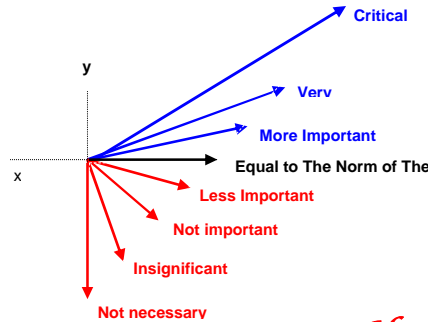
The x dimension will show the horizontal component of the vector V<sub>w</sub> which is the weighted score equal to f<sub>x</sub> = f + Δf. See the examples in Figures 1, 2, and 3 on the next page.

**Figure 1** describes what a pilot faces when flying a plane in a cross wind 45 degrees off his nose. This cross wind is a "Square Vector" by definition: **The diagonal of a parallelogram, all of whose sides are orthogonal and equal.** The wind is going to blow the plane off course and at the same time decrease the forward ground speed of the plane. The forward ground speed is the original score  $f$  modified to  $f_x$  or  $f \pm \Delta f$  in the next two figures.

**Figure 2** is the same example with the vector  $V_f$  experiencing an "Unimportant" Square Vector bias force  $V_b$  producing  $V_w$  causing  $f_x$  (the horizontal component) to become  $f - \Delta f$  and  $f_y$  to be  $-\Delta f$ . And conversely, **Figure 3** is an example of the vector  $V_f$  experiencing an "Important" Square Vector bias force  $V_b$  producing  $V_w$  causing  $f_x$  to become  $f + \Delta f$  and  $f_y$  to be  $+\Delta f$ .

In a typical Vectorgram only the resultant vectors (shaded red for this example) will be displayed. Thus a vector pointing down indicates a subcomponent that has been weighted below the Norm average and as such its horizontal length has been reduced by  $\Delta f$ . i.e.  $V_w$ 's angle pointing down shows negative bias and  $V_w$ 's angle pointing up shows positive bias.





*Vector Angle of Importance*

*Horizontal Length of a Vector*

The angle of each Criteria Vector shows how important it is with respect to the importance of all the vectors within the Node.

The average of the weights of all the vectors is called  
**The Norm of the Node.**

The vector whose importance weight is equal to **the Norm of the Node** has an angle of zero degrees.

Those vectors whose importance weights are greater than the Norm have angles greater than zero degrees (above the horizontal).

Those vectors whose important weights are less than the weighted Norm have angles less than zero degrees (below the horizontal).

The Horizontal Length of a Criteria Vector is equal to its vector's original score multiplied by the ratio of the vector's weight of importance to that of **the Norm of the Node.**

e.g.  
 The horizontal length of a vector whose importance is greater than the Norm of the Node will be longer than its original criteria score.

The vectors in the diagram above, whose angles are above and below the horizontal, show how the size of the black vector, (which has the same weight of importance as the Norm of the Node), would expand or contract if its importance weight were changed to one of the other weight settings.

#### 4. Definition of a Vector String

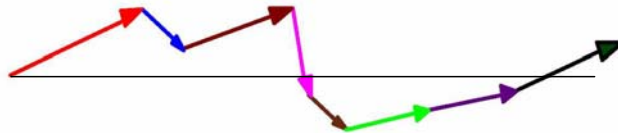
As stated on page 5, the result of a weighted average of a group of subcomponents is only a one dimensional piece of information. i.e. the value  $x$  for each of the components either gets larger or smaller. By introducing the concept of each subcomponent's weight being represented as a bias force in the form of a **Square Vector**, (whose  $x$  and  $y$  components are both equal to  $\Delta f$ , which when applied to a vector whose value is  $f$ , produces ...

A resultant vector, for each subcomponent, as a two dimensional figure that conveys the following information about the weighting process

- a. Each vector's horizontal component  $x$ , equal to  $f + \Delta f$ , is the value of the weighted score for that subcomponent .
- b. Each vector's vertical component  $y$ , is equal to the dividend or debit value  $\Delta f$ , graphically describing the magnitude of its subcomponent's importance or lack of it.

When the resultant vectors of all the subcomponents involved in the weighting process, are added together, the result is a **Vector String** which graphically shows:

- a. The horizontal length of the vector string is the size of the combined set of subcomponents' weighted score.
- b. Should the end point of the vector string's  $y$  value be greater than the  $y$  value of the vector string's initial point,(i.e above the string's horizontal axis) then the resultant weighted score will be greater than the vector string's original unweighted score.
- c. Should it be equal, the result will be equal to the vector string's original unweighted score and should it be below, the result will be less than the vector string's original unweighted score.
- c. And finally, the average of all the positive and negative vertical components'  $y$  values will be the positive or negative incremental value that represents the bias force that was applied to the original unweighted vector string's score.



For each Node in the Hierarchy of Nodes and Endpoints, there will be a V(ma) Matrix Vectorgram containing a Vector String for each Decision Option, a Vector String for the Node's "Best in Class Benchmark" and a Vector String for the Node's "Standard Benchmark."

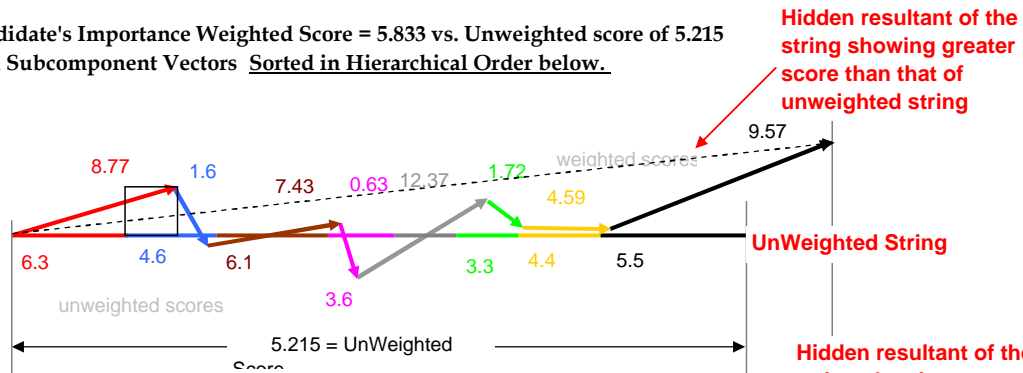
The horizontal length of each Vector String will show how well its Decision Option or Benchmark scored for that set of criteria.

*Construction of a Vector String*

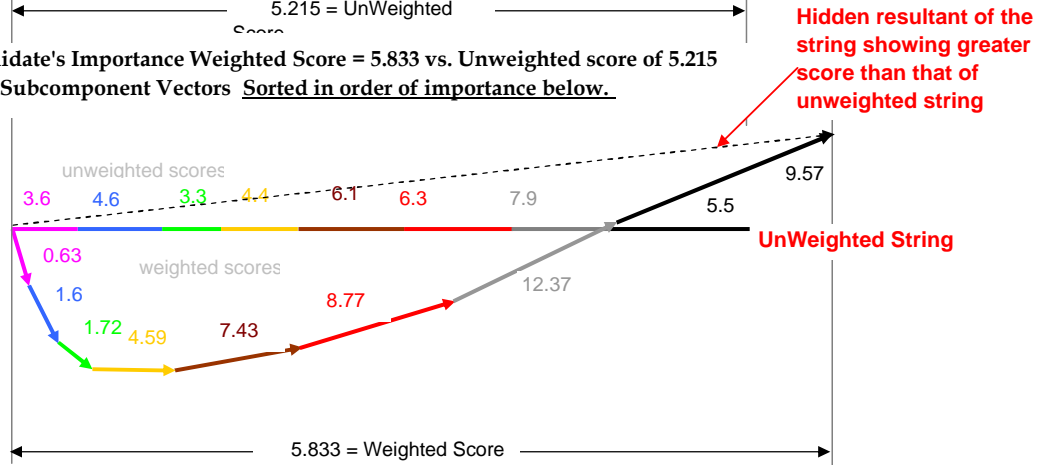
Merging the two vector strings, one unweighted and the other weighted, gives a better visualization of the effect of weighting the subcomponent criteria of a Node.

In the diagrams below, the unweighted vectors are all horizontal (by definition). Notice that the Pink, Blue and Green wgt'd vectors have negative vectors, that the Yellow is barely positive and the Brown, Red, Gray and Black wgt'd vectors are positive with significant gains in horizontal length, causing the weighted vector string to have a longer horizontal length of 5.833 from its unweighted counterpart of 5.215.

Candidate's Importance Weighted Score = 5.833 vs. Unweighted score of 5.215 with Subcomponent Vectors Sorted in Hierarchical Order below.



Candidate's Importance Weighted Score = 5.833 vs. Unweighted score of 5.215 with Subcomponent Vectors Sorted in order of importance below.



$W/N = 1 + \Delta$

W	W/N	1 + Δ	Δ	Δf	f	f + Δf
1.00	0.17	0.17	-0.83	-2.97	3.60	0.63
2.00	0.35	0.35	-0.65	-3.00	4.60	1.60
3.00	0.52	0.52	-0.48	-1.58	3.30	1.72
6.00	1.04	1.04	0.04	0.19	4.40	4.59
7.00	1.22	1.22	0.22	1.33	6.10	7.43
8.00	1.39	1.39	0.39	2.47	6.30	8.77
9.00	1.57	1.57	0.57	4.47	7.90	12.37
10.00	1.74	1.74	0.74	4.07	5.50	9.57
Sum	5.75	0.00	4.96	5.21	0.62	5.83
N= Norm of Node		Average		Δf average		
		0.00		Unweighted Score		Weighted Score

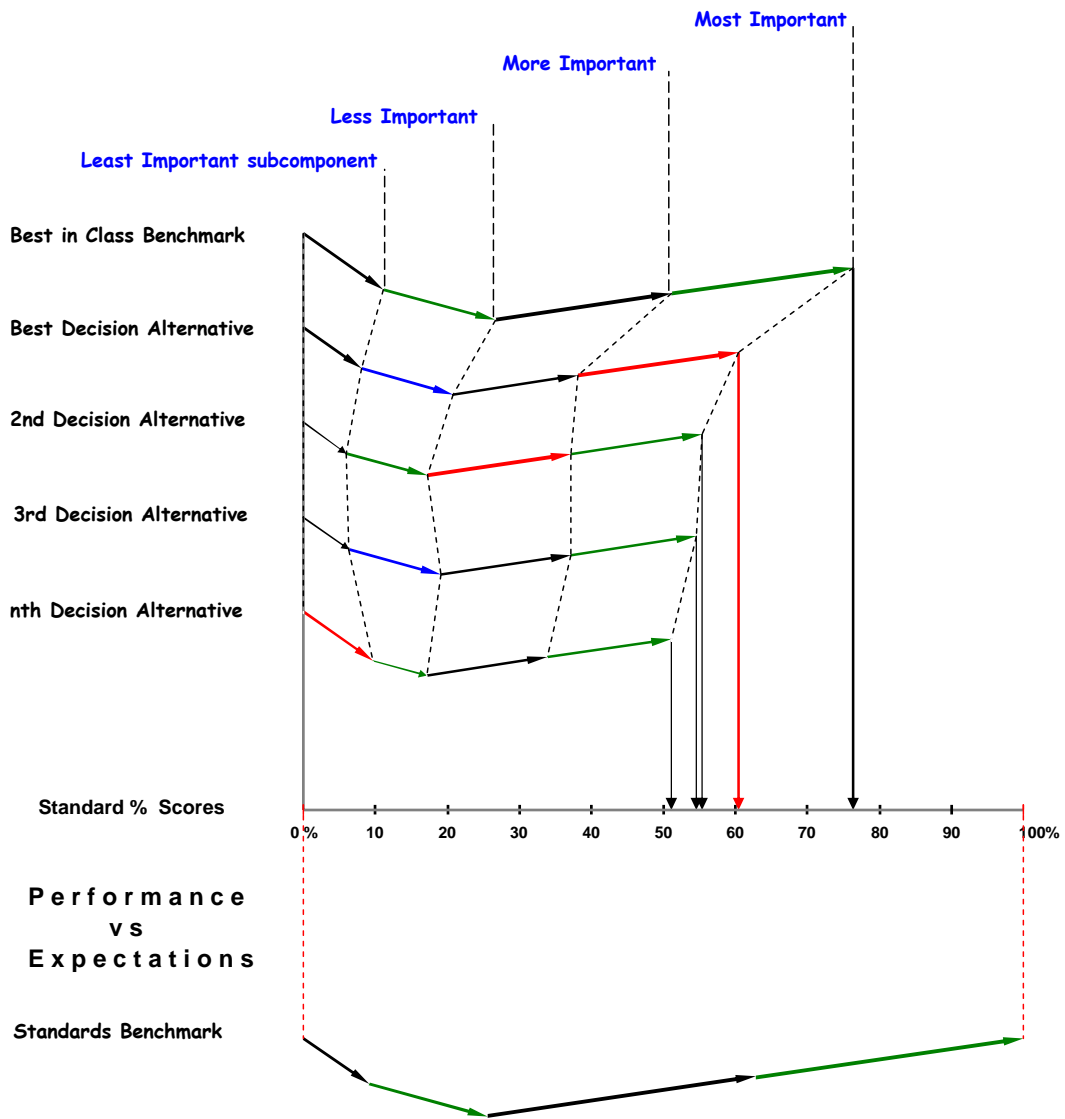
5. Definition of a Vectorgram



Matrix  
Vectorgram

*This is the basic structure of a  
V(ma) Matrix Vectorgram*

Decision Hierarchy Node Criteria





Matrix  
Vectorgram

*This is the basic structure  
of a V(ma) Matrix  
Vectorgram  
with explanations*

**Decision Hierarchy Node**

In each one of the node's subcomponents' corridors one can select that each one of the vectors be displayed with either: rankings, initial scores, weighted scores, or standard deviation data. and unweighted scores

Least Important  
More Important  
Most Important

The Best in Class Benchmark is a hypothetical option whose endpoint scores consist of the best of all the real decision options' endpoint scores. It is sometime referred to as the "Criteria State of the Art" of the options being evaluated.

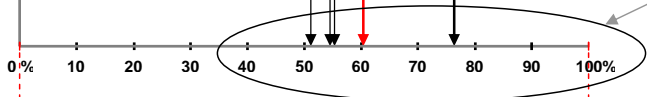
Decision Alternatives Sorted by total performance scores or a specific customized order

Best Decision Alternative  
2nd Decision Alternative  
3rd Decision Alternative  
nth Decision Alternative

This section within the ellipse is the first thing one should examine upon opening a Vectorgram.  
  
In this example none of the decision options have scored even close to the standard goal. The reason is that these are 1991 scores and the standards were based on the ultimate needs of the customers. Today's scores would be much closer to the standard.

The decision option can be related by % to either of the two benchmarks or any one of the individual decision options.

Standard % Scores  
**Performance vs Expectation**  
Standards Benchmark



The "Standard" benchmark is a hyperthetical option whose scores are the same value as their corresponding assigned standard weights.

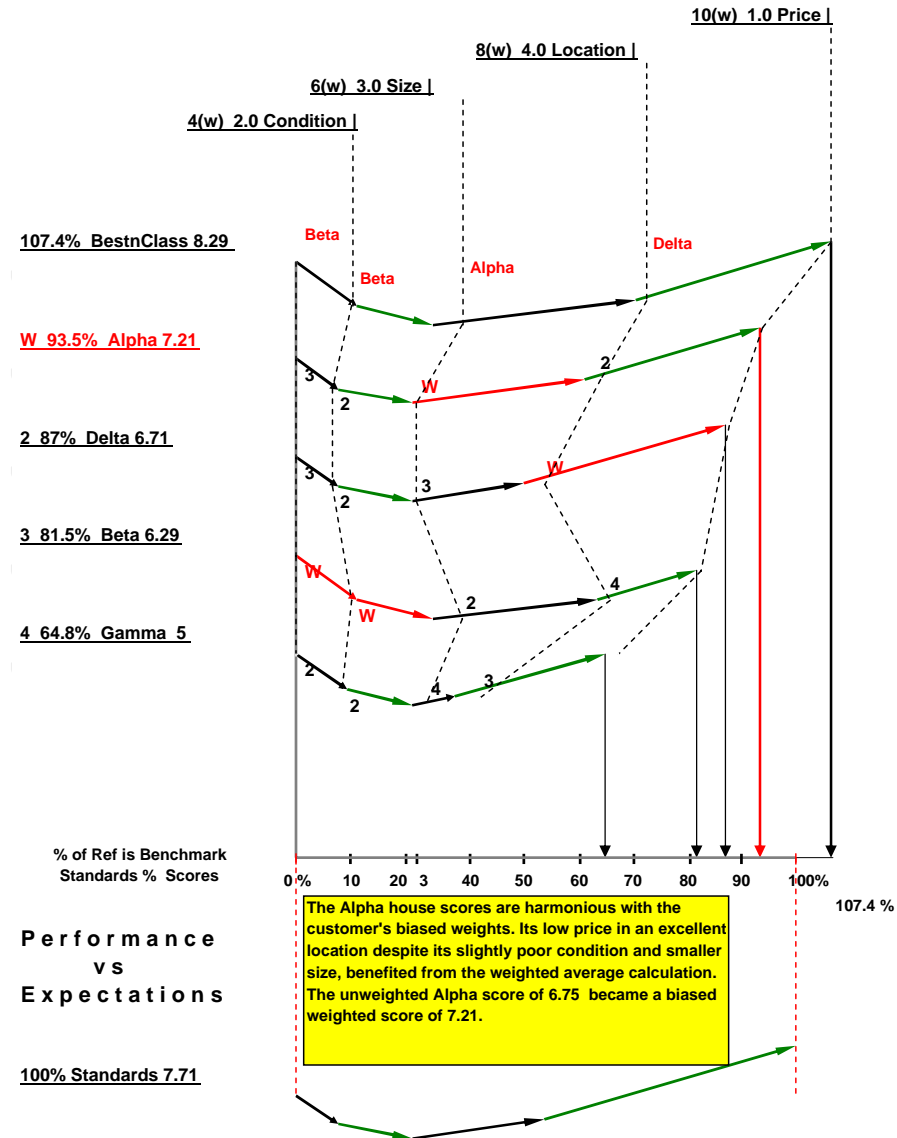
Project Name :  
House Criteria

**Analyst Vectorgram**

Winner 93.5%  
Alpha  
7.21

5/5/03  
9:47 PM

Node's Subcomponent Criteria with the Norm of their wgts = 7 on a scale of 10.



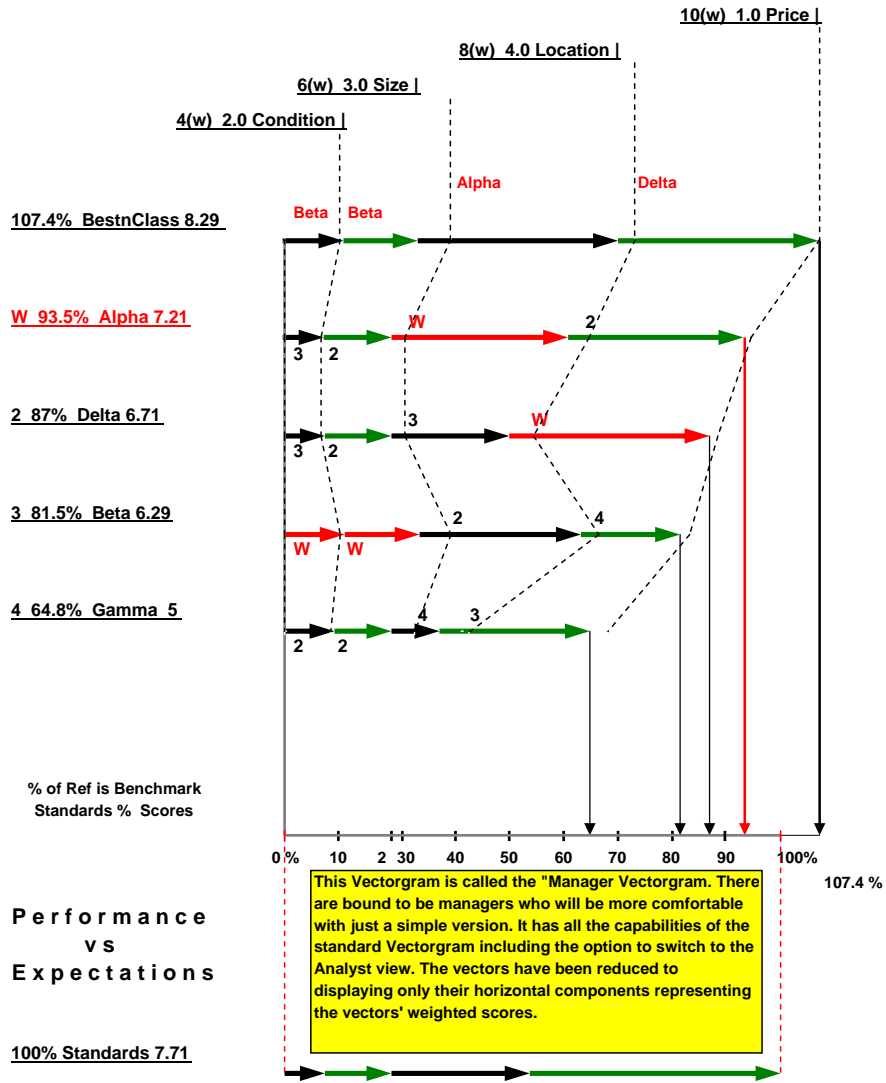
Project Name :  
House Criteria

**Manager Vectorgram**

Winner 93.5%  
Alpha  
7.21

5/5/03  
9:42 PM

Node's Subcomponent Criteria with the Norm of their wgts = 7 on a scale of 10.



Performance  
vs  
Expectations

100% Standards 7.71

6. References

*References:*

*Comments*

Dan Reddy  
Solutions Architect Consultant - Information Assurance Corporate Information Technologie  
EMC Corp. (508) 89B-5647

First Client (while at National Grid and subsequently at EMC) Approximately 12 projects - including Storage Systems which can be found in the V(ma) Help file. Client since 1991

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(847) 582 7001

Approximately 12 Projects - including Energy Systems and On Line Financial Systems  
Client since 1995

Paul Feener  
Senior Director Principal Consultant Almnet Solutions Inc  
(508) 389 3675

Approximately 6 Projects - including Self Evaluation of Network by Customers, Firewall Systems and Computer Operating Systems  
Client since 1996

Jim Oliver  
Principal Consultant  
Aimnet Solutions Inc  
(508) 893 8117  
Cell (617) 901 3652

Approximately 6 Projects -including  
Project leader of Self Evaluation of Network  
Client engineer

Eric Paul  
Senior Systems Engineer  
EMC Corp.  
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Client Project leader of Computer Operating Systems  
(Eric was Network Service Lead Engineer for National Grid for this project) Client engineer

Robert C Mccray, (603) 673-8654, General Amherst Rd, Amherst, NH 03031, former owner and Manager of Simple Process Control LLC

Chemical and Refinery Intelligent Valves  
One Project 1994  
This project was unique in that it utilized performance data from public documents to score all the competitors.

Geof Bock  
Senior Vice President Patricia Seybold Group (617) 742 5200 3102

Geof worked for Jack at Digital while Jack was Director of Comparative Analysis and as such was familiar with some of the projects using Vector Comparisons at Digital. The Office Systems CVA Case history was one of them and the consulting firm who provided the competitive scoring was the Patricia Seybold Group.

Beverly Shultz  
Technical Executive Consultant  
(978) 486 0947

Jack reported to Bev wQile he was Director of Comparative Analysis at Digital. It was she who recommended Jack for the Digital Outstanding Achievement Award for Comparative Analysis Research. During that same time period Jack gave a paper titled,  
A Quantitative Comparative Analysis Technique for Benchmarking Product Functionality and Customer Requirementsat the  
DSS-91 Information Technology for Executives and Managers  
Eleventh International Conference on Dedsion Support Systems  
Manhattan Beach, California June 3-51991  
Digital submitted a U.S. Patent application during this period which named Jack as the sole inventor. It was awarded in 1996.  
CVA Inc. was awarded another independent patent on the same subject In 1999 and again named Jack as the sole inventor.

Bob Everett  
(508) 477 8937  
Executive Consultant, Former President and Honorary Trustee Mitre Corporation

Mentor and former boss's boss of Jack at M.I.T. Whirlwind Project and M.I.T. Lincoln Lab and an adviser re Jack's development of Vector Comparative Analysis in 1989 while a Director on the Board of Digital Equipment Corporation.

## 7. CVA Founder

**Jack Gilmore** is the founder of Comparative Visual Assessments Inc., a management-consulting firm that specializes in comparative analysis. He is the sole inventor of a patented methodology<sup>1</sup> for utilizing vector analysis to produce graphic diagrams ("Vectorgrams"<sup>TM</sup>) to depict the strengths and weaknesses of comparative candidate products, subjects or people. He designed and wrote the comparative analysis software system, which is an integral part of the consulting services. It is written in "Visual Basic for Applications" and is an "Add-in" to Microsoft's Excel spreadsheet program thereby providing a link to other tools and functions.

<sup>1</sup> U.S. Patent Number 6,008,817 Comparative Visual Assessment System and Method, December 28, 1999

**M.I.T. Project Whirlwind:** After a degree in Physics at Boston College, he started his software career in 1950 as a systems programmer at the M.I.T. Whirlwind Computer Project where he wrote its first symbolic assembly program, helped develop the procedures and use of subroutines from a paper tape library of subroutines and wrote the debugging utilities for an interpretive programming language developed by his group leader, Charles Adams<sup>2</sup>. He remained on the M.I.T. Research Staff for nine years with time off for a tour of duty as a U.S. Navy night ASW Carrier Pilot in Squadron VS 39.

<sup>2</sup> "At the 1952 Association of Computing Machinery meeting Charles Adams expressed the aim of programmers - at least of that period. he said, 'Ideally, one would like a procedure in which the mathematical formulation together with the initial conditions can simply be set down in words and symbols and then solved directly by a computer without further programming.'

At the same meeting John Carr described the programming work at the Massachusetts Institute of Technology. It is clear that the Whirlwind group there was very alive to the needs of the programmer. Adams and J. T. Gilmore extended the ideas of Wilkes, Wheeler, and Gill, and there evolved from this a symbolic address procedure, an idea that seems to have been independently created by Rochester and his colleagues at IBM. The Whirlwind group also pioneered in the development of a so-called interpretive algebraic coding system. ...". The discussion concludes by stating that the entire Whirlwind programming activity was excellent and Sammet (in Sammet's, "Programming Languages", p 132.) says it was "probably the most significant of all the early work". *The Computer from Pascal to Von Neuman* by Herman H. Goldstine, Pages 338-340.

The following Whirlwind reports were prepared by Jack while he was at Whirlwind:

- ~ Interim Paper-Tape Conversion and Input Programs by Jack Gilmore, March 9, 1951
- ~ Photoelectric Conversion Program by Jack Gilmore, June 22, 1951
- ~ Requests for Computer Time by Jack Gilmore, June 22, 1951
- ~ Methods of Preparing Subroutines for the Sub-Routine Library by Jack Gilmore and John Carr III, September 24, 1951
- ~ Traffic System of Photographs Taken by Fairchild Camera by Jack Gilmore, November 21, 1951
- ~ Operational Procedure on the Whirlwind Computer by Jack Gilmore, December 10, 1951
- ~ Procedure for Requesting Tape Preparation by Jack Gilmore, December 11, 1951
- ~ Utility Programs Available to WWI Operators by Jack Gilmore, June 17, 1952

*CVA's Founder continued*

**M.I.T. Lincoln Laboratory:** He returned from the Navy in 1956, and joined the staff of the Advanced Computer Research Group at M.I.T. Lincoln Laboratory as a Research Engineer. During that time, he wrote an on-line operating system for the first transistor computer, called, the "TX-0"<sup>4</sup>, which had just been built by the research group. The operating system<sup>5</sup>, "The TX-0 Direct Input Utility System" was oriented toward serving programmers and engineers who wanted to write and debug their programs from the console. (This concept was not popular at the time. Jack gave a talk about his work at a computer staff meeting at the University of Toronto in 1958 and in the middle of the talk, he was asked to leave by Prof. Gotlieb who was an avid "Batch Processing" believer and considered the concept to be ludicrous.) The TX-0 desk/console had an on line input/output typewriter, a display scope with a light pen, an analog to digital conversion input device, a prototype Xerox laser printer and a core memory of 65,536 18 bit words of storage. The operating system also provided debugging aids, which included a flow chart display routine with logical interrupt switches controlled by toggle switches from the console panel .

During this period he also worked with a team of researchers from his group and the M.I.T. Research Laboratory of Electronics on a project that was attempting to develop a pattern recognition algorithm to recognize the "Sleeping Spindle" waveform, which appears in EEG brain wave recordings. Jack's contribution was the development of a moving window display program on the TX-0 that simulated a laboratory oscilloscope that provided the researchers with the ability to scan, view and save the brain data along with information generated by the computer to indicate what the algorithm had "recognized" as sleeping spindles. The results were reported in a Lincoln Lab report in 1957 and in the IRA transactions on Bio Medical Electronics in 1962<sup>6</sup>.

In 1958 the group took on the task of building a workstation called, "The Lincoln Writer"<sup>7</sup> that would be on-line with the group's new computer, the "TX-2" which was almost completed. Jack was assigned the job of logical designer and Robert L. Savell was the engineer. During the workstation's development he wrote a program called, "The Scopewriter" to simulate a scientific oriented typewriter. It was one of the first on-line text and graphic editors. He also was part of the team that designed the instruction set for the TX-2 and wrote its first symbolic assembly program called the Mark II Conversion Program.<sup>8</sup> He retired from the Lincoln Laboratory staff in October of 1959 to co-found one of the early consulting/software houses,

<sup>4</sup> *A Functional Description of the TX-0 Computer*,  
John T. Gilmore Jr. and H. Phillip Peterson  
M.I.T. Lincoln Laboratory Memorandum 6M-4789 November 10, 1956

<sup>5</sup> *TX-0 Direct Input Utility System*,  
John T. Gilmore Jr.  
M.I.T. Lincoln Laboratory Memorandum 6M-5097 April 10, 1957

<sup>6</sup> *Computer Techniques for The Study of Patterns in The Electroencephalogram*,  
Belmont Farley, L.S Frishkopf, W.A. Clark, John T. Gilmore Jr.  
M.I.T. Lincoln Laboratory Technical Report No. 165 November 6, 1957  
*IRE Transactions on Bio Medical Electronics* January, 1962  
*Computer Techniques for the Study of Patterns in the Electroencephalogram*.  
B.G.Farley, L.S Frishkopf, W.A.Clark, Jr. and J.T. Gilmore Jr.

<sup>7</sup> *The Lincoln Writer*,  
John T. Gilmore Jr., Robert L. Savell  
M.I.T. Lincoln Laboratory Group Report 51-8, October 6, 1959

<sup>8</sup> *Programming Language for Mark II Conversion Program*,  
John T Gilmore Jr.  
M.I.T. Lincoln Laboratory Group Report 51-1, Feb 3 1959, Reissued July 30 1959

*CVA's Founder continued*

**Charles W. Adams Associates and Keydata Corporation:** In October of 1959 he co-founded one of the early consulting/software houses, Charles W. Adams Associates Inc.. (later called Keydata Corporation) as Vic President and then in 1967, as President. The firm specialized in On-Line in Real Time computer applications. Five major accomplishments there include:

1. The development of an electronic drafting machine graphics system called the "EDM" on the PDP-1 in 1961 for Itek Corporation which was reported on in Time Magazine, March 2, 1962<sup>9</sup> under "Technology: ..... to beat the language barrier between man and machine, ITEK has, in effect hitched the digital computer to the draftsman's stylus. With a photoelectric light pen, the operator can formulate engineering problem's graphically instead of reducing them to equations ....". Itek marketed it as the EDM machine and it was later sold by Itek to Control Data. It was marketed as "The CDC Digigraphics System" and aircraft firms like Lockheed and Martin Marietta were early customers. A similar system was developed for the Air Force by Adams Associates. That project was reported by Jack in a Digital Equipment Decus meeting in November of 1963<sup>10</sup> at Lawrence Radiation Laboratory. In 1989, Jack was acknowledged as a computer graphics pioneer along with five others at a SIGGRAPH conference in Boston in a special session on early graphics projects.<sup>11</sup>
2. The automation of an oil refinery using display equipment and light pens as part of the control processing computer system in 1964,
3. The development of the first on-line commercial time-sharing system, called Keydata in 1965. By 1974, it was serving customers in 25 states and two provinces of Canada via 15 server nodes and 350 GE Terminals.
4. The development of the original INSTINET stock trading system on the Keydata system starting in the late 1960's. It is still going strong on its own system now. (It traded 31.5 billion U.S. equity shares recently in one quarter alone).
5. The development of an early intelligent database system on the Keydata system, called PAR, for the planning, analysis and reporting of financial information in 1973. It was based on set theory and enabled users, on line, to create subsets from the chart of accounts, as well as other already defined subsets. This provided the ability to create accounting "trees" and analyses such as profits by products, regions, etc. Keydata was the first user and it helped management to analyze the company in a much more efficient and effective manner.

<sup>9</sup> *The March 2, 1962 issue of Time on page 74 under Technology was titled "Breaking the Language Barrier". The article referred to the Itek's EDM Electronic Drafting Machine and the language barrier between man and the computer.*

<sup>10</sup> *A version of the EDM was also done for the Air Force and reported in a Digital Equipment Decus Meeting at Lawrence Radiation Laboratory titled, The Digigraphic Display Program for the DX-1 Computer System, November 1963 by John T. Gilmore Jr.*

<sup>11</sup> *SIGGRAPH 89 Panel Proceedings, Special Session, Retrospectives I and II: The Early Years in Computer Graphics at MIT, Lincoln Lab and Harvard Chair, Jan Hurst. EJM Associates, Moderator, Michael S. Mahoney, Princeton University, Retrospectives I: Speakers, Norman H. Taylor, Androx, Inc., Douglas T. Ross, SofTech, Inc., Robert M Fano, MIT Retrospectives II Speakers, John T. Gilmore, Digital Equipment Corporation, Lawrence G. Roberts, NetExpress, Inc. Robin Forest, University of East Anglia, UK. (Jack's paper is on pages 39 through 55. He and the other speakers were acknowledged as computer graphics pioneers.*

*CVA's Founder continued*

**Digital Equipment Corporation:** In 1974, he was hired by Digital Equipment as a consultant to initiate the design of their Word Processing System and then joined them in various managerial and technical roles in their Office Automation efforts. He designed Digital's Gold Key Word Processing user interface in 1975 and became Product Group Manager for Word Processing Systems. Later, he served as Technical Manager for the Engineering Group, which produced Digital's Electronic Mail and All-in-One Office Automation System. His last assignment at Digital was Director of Comparative Analysis during which time he initiated the use of vectors in Decision Analysis<sup>12</sup> before his retirement in 1992 to return to the consulting field.

<sup>12</sup> *A Quantitative Comparative Analysis Technique for Benchmarking Product Functionality and Customer Requirements* by John T. Gilmore Jr., Digital Equipment Corporation.  
*DSS-91 Information Technology for Executives and Managers Eleventh International Conference on Decision Support Systems Manhattan Beach, California June 3-5 1991*

**Comparative Visual Assessments Inc.:** His primary interest today is management consulting and encouraging managers to embrace the use of vectors in their analyses in order to achieve more effective and efficient decisions.



*Comparative Visual Assessments  
 Incorporated*

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