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A Mathematical Model for Process Training

Or, go immediately to:

A Practical Example, with Excel (p. 4)

Many companies would like to improve the quality and productivity of their processes by providing good process training, but are overwhelmed by the thought that "their processes" are so complicated and varied that it is an impossible task.

Fortunately, this is rarely the case. This discussion will attempt to cast some light on the situation and show a way to conquer this seemingly intractable situation.

We will apply the concept of a Normed Vector Space to illustrate some points about process training. This mathematical model is not perfect by any means, but it will serve to illustrate some important points to those who are theoretically minded. Or, just go directly to the Practical Example with Excel on page 4.

Let P represent a process. In general, P will be comprised of two or more sub-processes, P1 and P2. We'll denote this as P = P1 + P2 assuming the order won't matter, which of course it would in most cases, thus an imperfect model.

We'll call a process an "atomic process" if it has no sub-processes.

It then follows that any process P can be thought of as the composite sequence of one or more atomic processes.

Let **V** be the space of all processes, P. We will define P1 + P2 to be P1 followed by P2, or P2 followed by P1. We will assume they are the same for this model, so + is commutative. If A is a number then AP will mean the Process P applied A times. In this way, **V** will be considered a Vector space. Note this means –P just undoes P, and 0 is the null process (see Excel example).

We'll suppose {P1, . . ., Pn} is a set of atomic processes which forms a basis for **V** = Span { P1, . . ., Pn }. This means any P in V can be written as: P = **Σ** AiPi

Note that a relatively small set of atomic processes will yield a much larger number of complex processes. For example, suppose n = 10. How many complex processes consisting of up to six atomic processes would there be?

Well, for the first atomic process we have ten choices. For the second atomic process we also have ten choices, and so on. So there are all together about 10^6 = 1,000,000 different complex processes possible. You may create training on any one of these complex processes by simply chaining together the appropriate atomic process training modules.

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Thus, all we must do is create training for the n atomic processes. We can then put together sequences of these atomic processes to create training on a large number of complex processes.

What about Education?

Of course, you may also wish to deliver some educational materials to explain the concepts involved and teach the process worker things that might help the worker understand the "why" of what they are engaged in, as well as the "how".

Education is usually delivered in a linear format with little feedback or interaction. Think of a lecturer in a classroom with a large group of students. Or think of a linear "movie" or video tape. Or think of a book or PDF document.

Education is good. But, education <u>is not</u> good <u>process training</u>.

Each company must decide how much education its workers need and the subsequent benefits. It can be difficult to do an ROI analysis on investments in education. Many companies already do a pretty good job of education. Many training departments and training companies deliver education. Very few deliver good process training.

The "Cost" of a Process, a Normed Vector Space Model.

We will assume each process ("vector"), P, has a Norm, [P], or "size", ([P] could represent time consumed, or process cost, for example). Thus, **V** becomes a normed vector space with norm [ ].

And we define [**Σ** AiPi] = **Σ** Ai[Pi] where Ai ≥ 0.

So, any process will have a calculable norm, or size, or cost.

An Important Principle for optimizing productivity.

There are usually several different processes that could be utilized to achieve a particular desired objective or output.

If a process P is selected to achieve an objective, then one wants [P] ≤ [Q] for any other process Q which could achieve the same objective.

Now suppose we have a set of atomic processes, {P1, . . .,Pm, Pm+1. . . ., Pn} which form a basis for **V,** i.e. **V** = Span { P1, . . ., Pn } Then, we see that {P1, . . ., Pm} will be the basis of a proper subspace **W** = Span { P1, . . . , Pm }

And we see **W** < **V**. (i.e. **W** is a proper subspace of **V**)

Now, suppose that the only atomic processes we have mastered are (P1, . . ., Pm} Then, we will have to rely on processes in **W** to achieve our objectives.

Also, suppose there is an optimal process P for a given objective that is in **V**, but is not contained in **W**, then we will have to settle for the best process Q contained in **W**. And, it will probably be the case that [Q] > [P]. (i.e. the "cost" of Q is greater than the cost of P).

So we are operating at less than optimal productivity. Ironically, less choice is more expensive.

It is not uncommon to be able find a better process to achieve an objective when one has more atomic processes to utilize in creating the process. So one always wants to have as many atomic processes as possible available in order to maximize productivity. See the Excel example below.

Having atomic processes available implies that the workers have been trained to carry out these atomic processes. Worker process training is just as necessary as any hardware or software to optimize productivity, and quality.

It is common to have workers who have mastered too small a subset of the atomic processes, and, thus, can not carry out optimal processes. Consequently, this causes productivity and quality to suffer.

The larger the set of atomic processes one has available the larger the space of available processes and, thus, the more optimal productivity processes we have. One can achieve Kaizen (Never Ending Continual Improvement) by continually expanding the size of **V** by adding more and more atomic processes, and, thus improving the complex processes for our objectives.

Be sure your process training includes training on an adequate number of atomic processes so you can be sure the most optimal complex processes are being utilized by your workers. This will pay off handsomely with higher productivity.

We will demonstrate this with a practical example on the next page.

You might want to try to think up examples with your own work flow processes.

This is one good way to Never Ending Improvement.

A Practical Example with Excel to illustrate the value of knowing more atomic processes.

This is an Example that demonstrates where more atomic processes yield more efficient processes.

The objective of the process is to add up the forty numbers in the Table with two columns (B and C) and twenty rows (1 thru 20). The answer is 3710.

There are many processes that will achieve this objective. Some processes will be more efficient than others and will depend on which atomic processes they are composed of. You will see that more atomic processes yields a more optimal process to achieve the objective.

We will see how the efficiency and accuracy of the ultimate process you choose will depend on which atomic processes you build the ultimate process out of.

A	B	C	D
1	2	250	
2	5	240	
3	8	230	
4	11	220	
5	14	210	
6	17	200	
7	20	190	
8	23	180	
9	26	170	
10	29	160	
11	32	150	
12	35	140	
13	38	130	
14	41	120	
15	44	110	
16	47	100	
17	50	90	
18	53	80	
19	56	70	
20	59	60	
21			
22	610	3100	3710
23			3710
24	610		

If you use Excel, you might figure how you would “solve” this problem.

What process would you use? What atomic processes would you need?

It’s sometimes amazing what we don’t know, that we don’t know.

I. No real Excel atomic processes **V** = Span { 0 }

I once asked the president of a company to do a similar problem and he gave me the Excel spreadsheet with the total 3710 displayed correctly. However, when I looked at the formula to be sure he had it right I was surprised to see no formula at all, just the number. When I asked him how he did it he told me he used a calculator and entered the answer! Well, at least he used a calculator. I suppose he could have done it by old fashioned addition with paper and pencil.

I asked him how he knew it was right, and he said he was careful. He also said that if it was really critical he would check it by adding it up twice or by having someone else check his work. (He didn't have a tape for his calculator).

I asked him what he would do if we changed some of the numbers. He said obviously he would have to do it again.

How much do you think this process cost? How accurate was it? What do you think the Productivity and Quality were? Obviously, both were quite low. Would you be surprised to learn his company eventually failed?

I insisted he learn to use some Excel's formulas so I could check his work.

This was his next answer.

II. Two simple atomic processes, = and + **V** = Span { =, + }

He came back with an Excel formula for the sum in cell B22 as follows:

=B1+B2+B3+B4+B5+B6+B7+B8+B9+B10+B11+B12+B13+B14+B15+B16+B17+
B18+B19+B20

He had similar formulas for cells C22 and D22 I won't torture you with.

Well, they worked, and were a big improvement over the calculator. But, it is hard to check them and takes quite a while to enter them, and a lot of work to modify them if one changes the dimensions of the table.

So, I showed him how to use the Sum formula. This was his next effort.

III. One more atomic process, SUM **V** = Span { =, +, SUM }

=SUM(B1:B20) in cell B22 works a lot better. Similar formulas for C22 and D22. It is easier to check. But, he entered it pretty clumsily and so I told him about the Autosum atomic process.

He then computed the sums as follows in IV:

IV. Another atomic process, Autosum **V** = Span { =, +, SUM, Autosum }

=SUM(B1:B21) for cell B22.
=SUM(C1:C21) for cell C22.

And then, =SUM(B22:C22) for the final answer in cell D22.

This was certainly easier to create the formulas, but it did involve three formulas in three cells. So, it was still a little hard to check.

I told him how to use the Sum function and simply drag the cursor over the entire table to get the result from process V. as follows:

V. An additional atomic process, Create a Fill,

V = Span { =, +, SUM, Autosum, Create a Fill }

=SUM(B1:C20) for the answer in cell D23 (Note: now we didn't use Autosum).

This was much easier to create, and to modify if one changed the dimensions of the table. It only takes about ten seconds to create this formula this way.

Just think about the productivity and quality of these various processes and their effect on the bottom line if this was a process to be used frequently in a workflow. There could be orders of magnitude differences in the cost of the processes.

Conclusions:

The productivity will be greater for V. than IV., which is greater than III., etc.

This would become significant if one is adding up numbers in many large multi-column, multi-row tables of numbers. Just calculate the percentage in labor costs alone of executing the processes I. thru V. Clearly, the costs go down dramatically as the processes improve. V. is less expensive than IV, etc.

Additional atomic processes usually make more efficient processes possible.

Lesson Learned.

More atomic processes usually facilitate the creation of more efficient processes.