



## Chaos Theory

Dave King argues that Chaos theory may help to explain the unpredictable events which managers routinely meet. The Plan Do Study Act cycle is a tool which can help managers deal with the unpredictability. However, the barriers to using this deceptively simple tool should not be underestimated.

### Introduction

"It has become increasingly clear that both top-down and bottom-up strategies for educational reform fail. As the pressures for reform mount we must ask the question if a different more fundamental strategy is needed." (p187 Fullen)

**The introduction of cheaper and better photocopiers leads to a rise in advertising expenditure!**

Let me tell you a story,

I work for a privately owned group of EFL schools and one of my jobs is as Director of the teacher training department. One of the courses that we run is the Cambridge CTEFLA. Recently, the head of the accountants department discovered that he could get cheaper, and better photocopiers from a new supplier. Therefore he arranged for these new and better photocopiers to be placed in each building to replace the existing ones. The photocopiers arrived, shiny and new and packed with exciting and useful features. In the Teacher Training department we were very pleased to have one of these wonderful new machines. The problem began when the machine ran out of toner,

being a new and different type of machine we didn't have a reserve supply.

The trainees and trainers on the CTEFLA course were forced to use the photocopier in the Teaching department. This led to queues for the photocopier and to putting extra strain on this machine which of course started to breakdown leading to even longer queues of teachers, trainees and

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teacher trainers. This situation went on for a considerable length of time. The photocopier suppliers had trouble locating the toner. The machines were new and their warehouse first sent the wrong toner and then discovered that they didn't have any in stock. They would have to contact the

manufacturer.

The result of this being that the chain of cause and effect led to the teachers resenting the presence of the trainees. Unfortunately this frustration and resentment was emerging especially when the trainees were doing their observations of the teachers' classes and trying to discuss what they have seen with the teachers. Approximately 20% of the trainees that come on our CTEFLA courses come because of recommendations from ex-trainees. A friendly and helpful atmosphere being frequently cited as a characteristic of the school. The decline in enjoyment and learning caused by the resentment would certainly have led to a drop in those recommendations and would have been followed by a rise in the expenditure on advertising so as to fill the courses.

### Using Chaos Theory to describe the phenomena

I would say I have observed and participated in many such situations where decisions and consequent actions lead onwards to effects that were not predicted. This I would generalise is the experience of most managers. So, I need to make sense of data such as detailed in the story of the new photocopiers.

What may help managers to understand

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such phenomena is "Chaos Theory". Chaos theory makes various claims about complex dynamic systems such as the world that we live in.

- Firstly, that we can not predict what the exact effects of our decisions will be because everything is connected, directly or indirectly, and affects everything else.
- Secondly, that the world does not consist of a uniform randomness - patterns will emerge.

All aspects of life can be seen as parts of a dynamically complex system where everything is connected and affects, to some extent, everything else. The sheer number of the interactions makes exact prediction of future events in the real world an impossibility. This works against the view of Newtonian physics that anything can be analysed in isolation. "The basic idea of Western science is that you don't have to take into account the falling of a leaf on some planet in another galaxy when you're trying to account for the motion of a billiard ball on a pool table on Earth. Very small influences can be neglected. There's a convergence in the way that things work, and arbitrary small influences don't blow up to have arbitrary large effects". p15ct However, "In science as in life, it is well known that a chain of events can have point of crisis that could magnify small changes. But chaos means that such points were everywhere. They were pervasive." (p23 Gleick)

Chaos theory proposes that in the general sea of unpredictability "islands of structure" will appear. I take this to mean that though we can not predict what we may find, as we gather information about a situation, it may be that strong trends may emerge and that it is by looking for those trends

and then working from an understanding of those trends that we can better manage change and achieve our aims.

"Chaos theory is attractive to educators because much of what happens in the life of a school just doesn't seem to fit the current frame of "what ought to be happening". Little change ever occurs as it is planned. The objective or goal may eventually be realised, but almost never in the predictable way in which it was designed. It may be time to set aside the assumptions about regularity and controllability in changing organisations. Perhaps the best chance that exists for transforming fundamental schooling traditions is to embrace irregularity as a norm, while looking for patterns that can be guided in a certain direction." (p7 Snyder)

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It is necessary to avoid being too extreme when looking at unpredictability. Though you can not predict, to the minute, when you will arrive at work every day you can predict that you will arrive and that it will be, on most days, within a certain time frame. This I would term as "good enough prediction". Though you can not predict exactly what will happen, the approximation is usually good enough to be satisfactory.

## Developing the Mental Model

Our mental models or mental maps "are deeply ingrained assumptions, generalisations, or even pictures or images that influence how we understand the world and how we take action." (p8 Senge) This leads us to the interesting relationship between thought and language. Hayakawa sees them as interdependently forming each other and quotes Anuerin Bevin, "It is inherent in our intellectual activity that we seek to imprison reality in our description of it. Soon, long before we realise it, it is we who become prisoners of the description." (p92 Hayakawa) Hayakawa also warns "To understand the symbolic process is to be able to use it to your advantage; not to understand it is to remain forever its victim" (p16 Hayakawa)

As a manager I find that my mental maps have been dominated and shaped by machine metaphors. "The universe that Sir Isaac Newton described was a seductive place. As the great clock ticked, we grew smart and designed the age of machines..... we grew assured of the role of determinism and prediction" (p26 Wheatley)

"The machine imagery of the spheres was captured by organisations in an emphasis on structure and parts. Responsibilities have been organised into functions. People have been organised into roles. Page after page of organisational charts depict the workings of the machine: the number of pieces, what fits where, who the big pieces are." (P27 Wheatley) The machine metaphor fits well with a universe that is predictable. Even unpredictability can be seen in machine terms, malfunctioning or

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...broken parts, be those broken parts people or organisational structures, lead to breakdowns.

Personally, I found it very difficult to switch to another form of metaphor. Eventually I realised that the metaphors that I need to describe the world when using the lens of chaos theory can be provided by the natural world. So I needed a metaphor from the natural world which would show a single cause that leads to lots of effects - effects which can be distant in time and space. My first thought was of what I would consider a common metaphor, "the manager's decision as a pebble thrown in a pool and the effects as the ever widening ripples". However I reject this on the basis that it separated me from the effects and I know that I am as much affected by the ripples as anyone else in an organisation.

***The PDSA Cycle guides you to certain questions and actions beyond the usual who, where and how.***

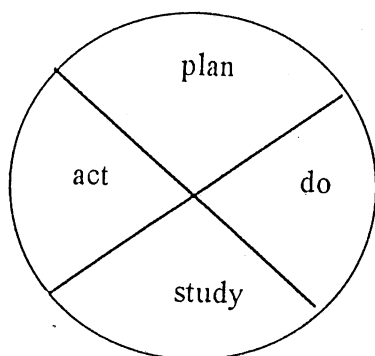
So, now I am a fish. A fish in an ocean. The ripples caused by the decisions of myself and others spreading far and wide, leading to effects distant in time and space from the causes and as they interact with other ripples from other decisions the effects becoming more and more unpredictable!

## The PDSA Cycle

The PDSA cycle or "Deming cycle guides us towards improvement" (p139 Neave) It is a management tool described by Walter Shewart in the 1939

and brought into common use by Deming. The letters stand for Plan Do Study Act. They are usually shown in a circle.

### The PDSA Cycle



This tool is used as:

- an action plan
- a planning tool

As an action plan it shows that you need to deal with four stages; the Planning of the change, the Doing of the change, the Studying (also referred to as measuring) of the results of the change and then Acts that you will carry out based on study of how successful have been the changes.

As a planning tool it guides you to certain questions and actions beyond the usual who, where and how. It proposes that PDSA's are used in iterative cycles and for the first cycle managers use pilots "carried out on a small scale-large enough to gain useful information, but no larger than necessary in case things go wrong" (p142 Neave)

Your plans for the Study phase should not only include a collection of data at the end of a project or process, there should also be in-process measurement. "Fundamental in Deming's and some others teachings

of the old was the change of emphasis from sorting finished product by inspection, i.e. downstream action on output, to upstream action on processes, i.e. to improvement of efficiency and quality so that end inspection is less necessary" (p203 Neave). Deming taught that end inspection was too late. The proposed chaotic nature of complex dynamic systems also says that end inspection will be too late to deal with the problems of unpredictability and too late to gain advantage from the "islands of structure" or strong trends which in-process measurement may detect.

An example of an in process measurement is the weekly feedback session on the CTEFLA course, which picked up the trainees reactions to the teachers following the arrival of the new photocopiers. Because the feedback was being collected and considered on a weekly basis the Teacher Training department were able to react quickly and take steps to avoid the problem becoming serious. Quality improvement, at least in the version proposed by Deming, claims to lower cost. The use of pilots and in-process measurement have provided evidence that this claim is true.

PDSA's can be run at all levels of activity, they can also be used when building space ships and other projects on a huge scale. Yet the value of the PDSA tool is optimised when all staff understand all work can be viewed as processes which can be improved and that the PDSA method can be used for all activities, no matter how small. To make the point with an extreme example, the process of making a cup of tea can be seen as an opportunity to use the PDSA method while on a lower level even the sub-process of putting sugar into the tea can involve an end measurement of how sugary it tastes and in-process studies of the size and depth

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of the teaspoon, the volume of the cup and the depth of the liquid. PDSA's can be infinitely "nested inside of each other" each PDSA helping to improve the quality of the product and achieve the aim of the project.

The optimal use of in-process measurement demands the involvement of all staff. Chaos theory points out "it is well known that a chain of events can have a point of crisis that could magnify small changes. But chaos meant that such points were everywhere." (p 23 Gleick). The manager needs in-process measurements running on his or her own work processes and also the understanding and involvement of all the staff. This involvement of all the staff in the in-process measurement of their work processes is one of the crucial factors in the growth of continuous quality improvement.

## The Barriers to Learning

The collection of information and the concepts that underlie the collection of information in an organisation can be seen as aspects of what Senge referred to as "the learning organisation". Yet, it is no accident that most organisations learn poorly. The way that they are designed and managed, the way peoples jobs are defined and most importantly the way that we have been taught to think and interact (not only in organisations but more broadly) create fundamental learning difficulties" (p18 Senge)

As well as the aforementioned problem of developing new mental models I would add;

### 1. Organisational culture

PDSA was neatly described by one participant when I first gave this paper as a "think do, think do cycle" If you are working with in a culture that requires lots of "Do" and not much "think", then it will be difficult to use PDSA as a method.

Also, if the power to change and

improve the processes of work is not the hands of those doing the work it can be very frustrating and will often seem pointless for them to collect and study the data produced by their own work processes.

### 2. Ego investment

For many managers the concept of the Study phase of PDSA is easy to accept as a theory but becomes difficult to carry out in practice. Studying the changes they themselves are managing may mean that they find evidence that they made decisions which were *wrong*. For many managers it is difficult to accept that they should be working to find evidence that they were wrong, especially if they see themselves in the role of "controlling", "driving" or "pushing" their organisations and the loss of "face" would be, according to their mental model, dangerous to this assumed role of a manager.

### 3. Habit

It is difficult to break habits and to build new ones. Reflection upon my own experience and of other managers that I have observed and mentored leads me to see this as a major and for me an unexpected obstacle. Logic and intellect may lead us in one direction - habits built up over years are often more powerful and it may take a long and sustained effort to build - or grow - new one.

## Conclusion

The manager, and I include teachers as co-managers in the learning and teaching environment, have three new interdependent and often overlapping features they might to incorporate into their mental models; "quality improvement", "the learning organisation" and "the new science" including chaos theory. At the beginning of this paper I quoted Fullen, I will return to him for an end quote. "The purpose of the partnership is the establishment of approaches to

teacher development at all stages of the teaching continuum, by transforming schools, districts and faculties of education to environments for continuous learning" (p187 Fullen).

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