

Chapter 1: a gentle introduction to systems and processes

Introduction

This chapter presents some of the major ideas in thinking about systems and processes. It does so by looking at two non-business topics – the Marble Arch, in London, and apple trees.

We take the discussion out of the business context for two reasons:

- to help you think afresh about processes and systems and how they should be managed
- to show that real systems are more complex and variable than computer specialists and software salespeople would sometimes have you believe.

Please use the chapter as a refresher if you are familiar with systems thinking. If you are not, we invite you to use it as an introduction to the subject.

Looking for processes

The first vows sworn by two creatures of flesh and blood were made at the foot of a rock that was crumbling to dust; they called as witness to their constancy a heaven which never stays the same for one moment; everything within them and around them was changing...

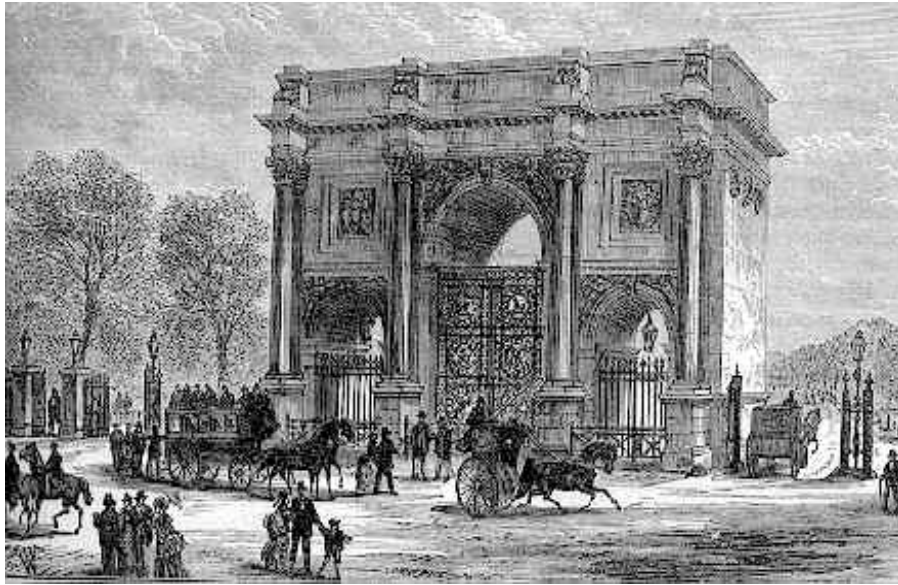
Oeuvres Romanesques, Denis Diderot (1713-84)

Much management thinking and writing is about entities – things – that are unmoving, unchanging and separate. The reality is that most of what you see around you, whether you can touch it or not, is part of some process or other¹. It is on its way to being something else.

Some entities might perhaps look permanent but this is only because the changes they are undergoing are invisible to normal view or are imperceptibly slow. As Diderot suggests, nothing in this world is unchanging.

We want to encourage you to see more of the processes that surround you and to be able to place them in a wider perspective. To get you into the swing of it, we examine two examples from outside the world of business.

Figure 1.1: Marble Arch, 1880



Our first example is Marble Arch in London. The engraving above shows it as it was over 120 years ago, when the arch was about 50 years old. The arch is still there today, as millions of visitors to London can testify. Looks permanent enough, doesn't it?

Appearances deceive. Not even the arch's position is permanent. It originally formed the main entrance to Buckingham Palace, nearly a mile away. When the palace was extended in 1851, the arch was moved to its current site at the top of Park Lane. It now causes such an obstacle to motorised traffic that there is talk of moving it again.

What you see when you look at this edifice is merely the present stage of a combination of processes.²

The longest of these is a **geological** process. The arch is made of the famous white marble from Carrara in Tuscany. This began as limestone, a sedimentary rock laid down on a seabed 150 to 200 million years ago. About 100 million years later, the same intercontinental forces as were pushing the Alps skywards subjected the limestone to intense pressure and heat. This changed the rock's internal structure, producing the soft glassy result so prized by architects and sculptors.

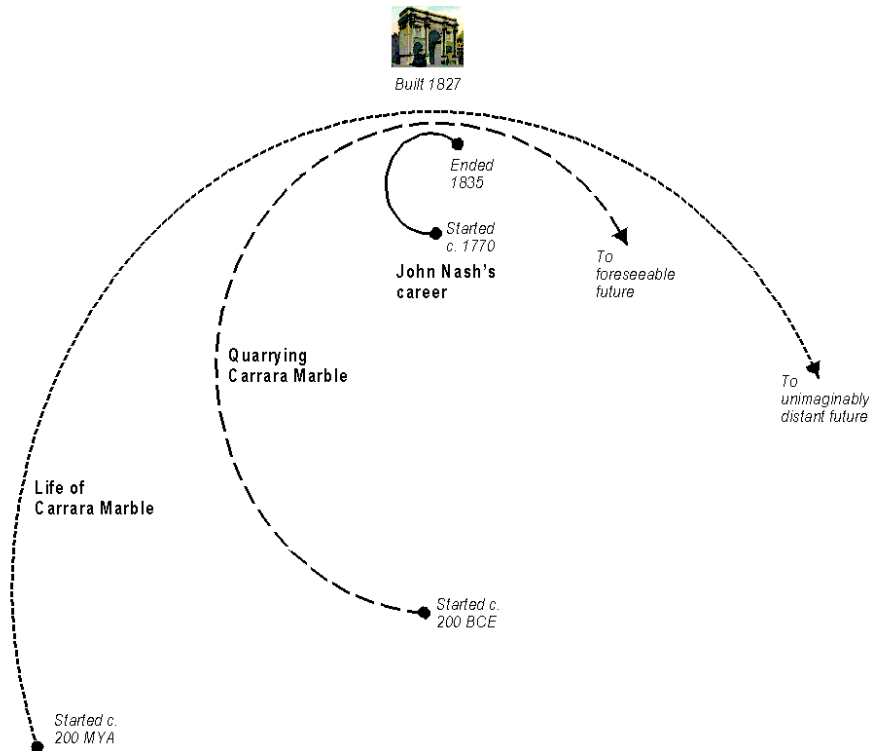
The rock's story has not ended. Wind, frost and rain are slowly wearing away the stones of the arch, as they do any rock. The acid in raindrops is speeding this erosion by reacting with the calcium of which marble mainly consists. These granules and chemicals are blown and washed away, being deposited elsewhere. There, they make a small contribution to some river or lake bed, perhaps, that after more aeons will become new rock.

The second process, many times shorter, is an **historical** one – quarrying the stone. People have been extracting marble at Carrara from before Roman times. What you also are seeing therefore, as you look at the Arch, is the output of an industrial tradition over 2,000 years old.

The third process is **human**. It is the career of its architect, John Nash. This is shorter still and lasted about 60 years. Nash lived from 1752 to 1835, beginning his architectural work in the 1770s. His career culminated in a contract from King George IV to develop the then Marylebone Park in west London. This project took 19 years and resulted in such landmarks as Regent's Park, Regent's Street, St James's Park, Buckingham Palace and, of course, Marble Arch. Nash built this in 1828, modelling it on the Arch of Constantine in Rome, which dates from 313 CE.

The diagram below, not to scale, shows Marble Arch as being at the intersection of these processes. (MYA means millions of years ago. BCE means Before Common Era and CE means Common Era, in which we live today.)

Figure 1.2: Processes at the building of Marble Arch



There are other processes under way besides these three. We have already touched on the development of road traffic management schemes in London. Another is the growth of the public arts around this time. John Nash was one among several architects whose careers flourished in the Georgian period. Others included Robert Adam, James Gibbs, Nicholas Hawksmoor, Sir John Soane and John Vanbrugh. All helped create the neo-classical style characteristic of the period. The development of 'schools' in design or music is a well-known process, as is the way they influence future generations of artists.

It is no coincidence that London was at the time the wealthiest city in the western world. Artists need patrons. There was clearly a process of vigorous economic development under way. Most of the great houses these architects designed were at the time country houses but not for long. London was also undergoing a process of urbanisation.

Selective vision

The more you think about it, the more dimensions and processes you can see intersecting during this period, as you can any period. We have touched on seven – geological, historical, biographical, transportative, artistic, economic and developmental. Deciding which of these is to be representative or definitive is difficult³. Can any single process do so? Clearly not, in this case. It is curious, then, that this question so seldom arises when looking at business.⁴

The processes people notice in any situation will depend largely on their responsibilities, background, training and inclination.⁵ The three processes we charted above are, for instance, those you might expect a geologist, an industrial archaeologist and an architectural historian to concentrate on.

There is no reason someone from any of those disciplines should not think about the other two processes as well. Surprisingly, though, people's jobs and professions often blind them to other facets of a situation, to other ways of looking. You will see examples of this as we progress through the book.

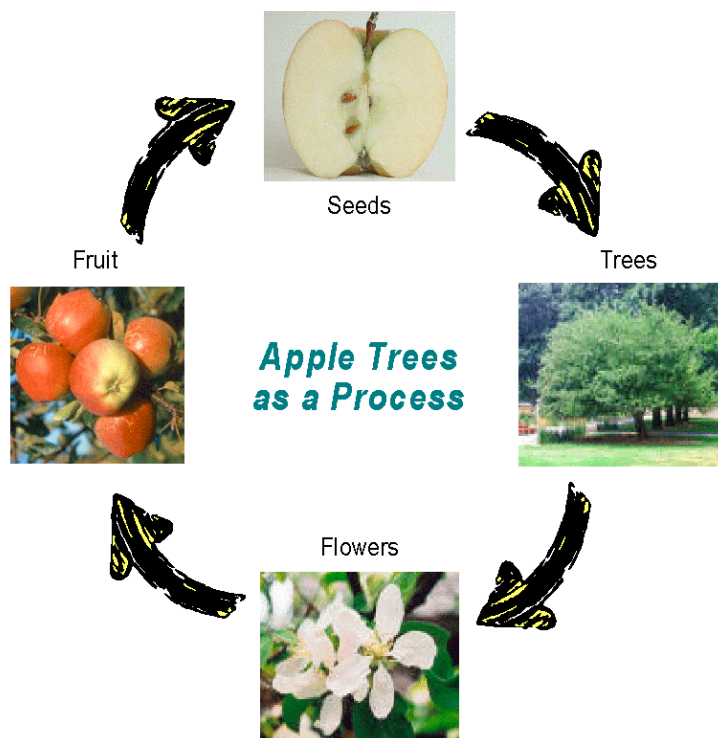
It is remarkable how often people put on these wilful blinkers when viewing the systems and processes of organizations. It is a trap we wish you to avoid. The next example should also help with this.

Core processes – a story of apples

Fritjof Capra and two Benedictine monks.... suggest that we must see things as processes rather than structures. For example: a tree is not an object, but an expression of processes such as photosynthesis, which connect the sun and the earth.⁶ The same thinking applies to our jobs, our organizations, and ourselves. *A Learning Organization*. Ronald Bleed

Or, as an evolutionary biologist might put it, a tree is a seed's way of making more seeds. The picture below shows the outline process.

Figure 1.3: Apple trees as a process



This looks simple enough. Seeds ('pips') grow into trees, which flower. The flowers turn into fruit, at the centre of each are more seeds. This is repeated indefinitely.

Where does the process start? Is it with the seed, the tree or somewhere else on the cycle? It is a chicken-and-egg riddle that has echoes in many business processes.⁷

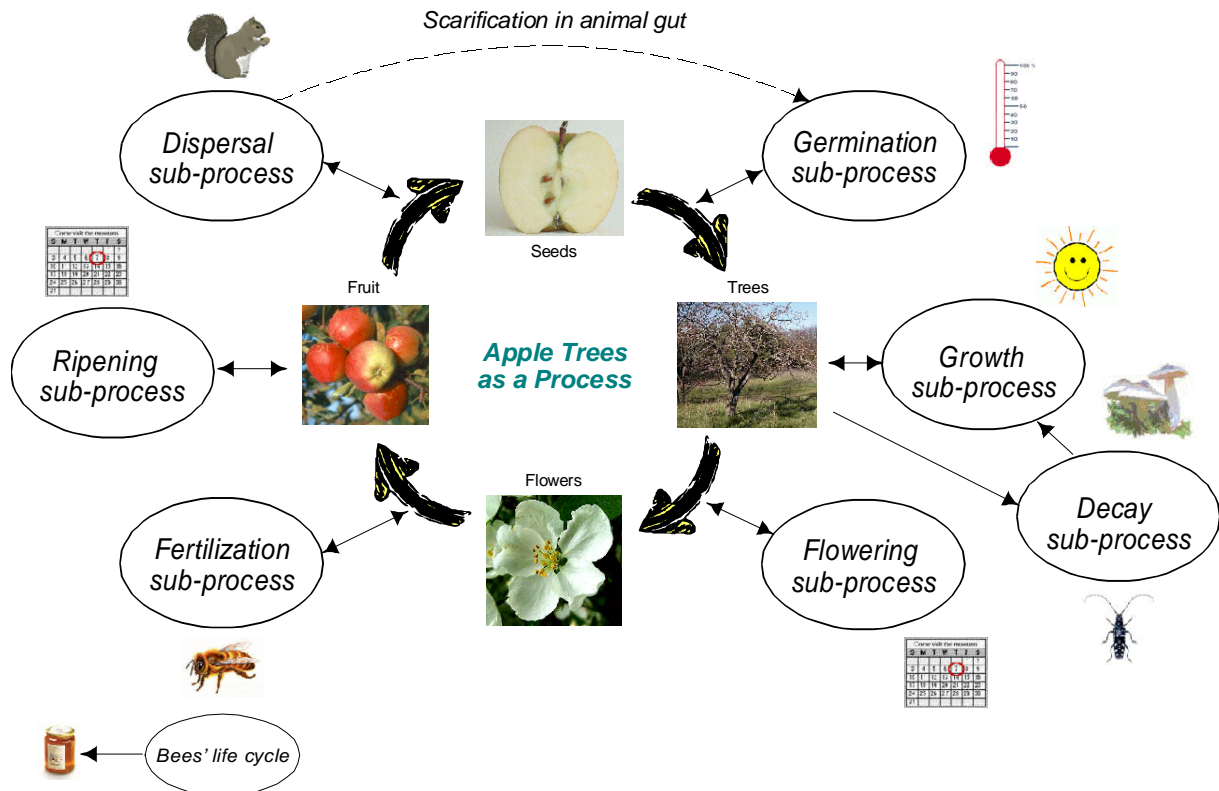
Deciding start and finish points for computer systems used to be easier than today – your organization's boundary placed a natural limit at either end. Now, as the 'Olympic' cases in the Prologue show, automated processes go into customers' and trading partners' organizations as well.

Business processes have always done this but the means to manage them with the aid of software did not exist before. This is one of the opportunities that Business Process Management offers.⁸

Getting beneath the skin

If we look closer at the apple trees process, we find that it includes several sub-processes. Most of these depend on some external condition or agent. The picture below highlights the main ones.

Figure 1.4: Sub-processes within apple tree



Here are those sub-processes shown in table form. Some of them vary in other species of tree.

Table 1.1: Sub-processes within apple trees [see Chap1Tab1_1.pdf]

Don't worry – we are not trying to turn you into an ecologist. This is greatest depth of biological detail we are going into.

The point of this table is alert you to the number and variety of the processes taking place even in apparently simple systems.⁹ It is also to make you aware of the important role that outside conditions and actors often play.¹⁰

In systems terminology, the apple tree's processes are part of an open system. This means its boundary can be crossed. Business systems are nearly always open, too.¹¹

The layout of the table might be familiar to you if you know about Six Sigma quality programmes. It is a variant of the SIPOC form that quality teams use in the measurement phase of process improvement. (SIPOC stands for the Suppliers to a process, their Inputs (the 'I'), the Process under investigation, its Outputs and the Customers for its outputs,)

Even in this simplified view, there is no single determining factor for many sub-processes. Most of them involve at least two factors; they are multivariate. This is true in business as well, although there is often a temptation to regard them as being dependent on one, especially when assessing performance.¹² (See ‘Measuring the results’, in Chapter 7.)

There is a further link between these natural processes and business activities. Much of the theoretical work on complex systems has been done by biologists trying to relate what they see in nature to other kinds of system. The results of their work lie behind most well-found modern approaches to business process design and management. We talk more about this in later chapters.

Death where is thy sting?

The decay sub-process is another important stage in a plant’s life cycle, and not only at its death. Recyclers on and in the ground, such as bacteria, fungi and worms, do their work every year on its fallen leaves, flowers and its fruit. This returns the nutrients in them to circulation, helping the tree recoup some of its outlay. The cost to it of growing leaves is high.

Decay is a useful metaphor for what also happens in organizations. Old computer systems, obsolete production lines and ‘life expired’ car fleets do not just fade away. They, too, must be disposed of, usually at a significant cost. Often the law demands that they be recycled. Material recovery is big business; as in nature, recyclers carry out a vital task, often unrecognized.

It is easy to forget to plan for the ‘death’ of a system’s components when building a system.¹³ This is especially true where those components are people.

Drawing the line

Points of view

Ask an apple tree what it thinks of bees and it might say something like: ‘Yes, very useful little creatures. They help me fertilize my flowers and swap genetic material.’

Ask a bee what it thinks of apple trees and its reply might be: ‘They’re a wonderful idea! Filling stations and supermarkets combined – and so many of them.’

Ask a worm what it thinks of apple trees and it would probably say: ‘What’s a tree?’ Explain trees’ contribution to soil ecology and it might say: ‘Oh, so that’s where all that good stuff comes from.’

Ask its opinion of bees. Be prepared for an uncomprehending look even after you’ve explained what they do. ‘Sorry, friend. I’m only concerned with real-world issues.’

The sub-processes diagram shows the difficulty of defining system boundaries¹⁴.

We show a bee and a jar of honey at bottom left of the diagram. Honey-bees visit flowers for their pollen and nectar. Pollen is food for the bees. The nectar gets turned into honey in the beehive, from where humans can extract it for their own use. Are these insects part of the tree’s system, therefore?

It takes just a small shift in viewpoint to see the supply of apple flowers as an input to the bees’ life cycle. Should we regard the tree part of the honey-bee’s system, instead? Or as well?

People often do not realise how dependent apples are on those bees. These insects are by far the most common pollinators in orchards. Without enough of them, the trees do not produce much fruit. This is why apple growers place beehives in their orchards, not for the honey but to increase the chance of a good harvest.

There are companies that rent out occupied hives for this. They get a fee, and the honey. This is equivalent, in corporate jargon, to business process outsourcing or BPO.¹⁵

Sensing and communicating

Apple trees flower roughly at the same time in the wild, usually in May in the northern hemisphere. This makes it easier for bees to find open blooms on different trees, cutting their travel costs. It is also essential for the trees' cross-fertilisation.

The trees can synchronise their blossoming because, like almost all living organisms, they can tell the time. They contain the molecular equivalent of a clock that works roughly on a 24-hour ('circadian') cycle. They correct this clock by checking its 'readings' against the daily cycle of light and dark.

While doing this, the apple tree's clock compares the length of nights to the length of days as the season progresses. When the ratio between the two is favourable, the tree releases an internal hormone that triggers the budding and, later, the opening of its flowers. Further on in the year, the shortening days are a signal for leaf drop. Timing, sequence and synchronization are important features of business processes, too.¹⁶

On being a system

Any persisting pattern of activity that can be described as a system must involve processes that hold it together; otherwise it would tend to degenerate. So, the structure and process of a system and the control of the system are two sides of the same coin.

Systems, Management and Change: A Graphic Guide, by Ruth Carter, John Martin, Bill Mayblin and Michael Munday

Making and distributing internal hormones is a tree's way of regulating its growth (size) and development (structure). It is how the tree exercises control over itself.¹⁷

This sort of responsiveness and internal communication is what distinguishes a system from an assemblage.¹⁸ A tree is a system, whereas a chest of drawers is a collection of inanimate lumps of wood. A more formal definition is that *a system is an entity that maintains its existence through the mutual interaction of its parts*.¹⁹ This is normally attributed to Ludwig von Bertalanffy, one of the biologists mentioned earlier.

Mutual interaction implies both life and communication in whatever is interacting. Dead things tend not to communicate, except perhaps through mediums.

A colony of honey-bees certainly interacts. As is well known, bees can communicate with each other symbolically as well as directly. They pass on details of the direction and distance of a suitable food source through a 'dance' they perform back at the hive.

Our apple trees can also be said to communicate with bees, through their blossom. By appealing to the bees' senses of sight and smell, the trees advertise their flowers' nourishing and tasty content.

We therefore have two separate systems – an apple tree and a colony of honey-bees. Each can by definition communicate within itself. They also communicate with each other. The point where they do so is the flower. It is the interface between those systems.²⁰

Process (re)engineering

Another external dependence, shown at the top of Figure 1.4, is on the animals and birds that eat an apple tree's fruit. Like many seeds, those of an apple will not germinate and produce a new plant until they have passed through a digestive system. The acid in an animal or bird's gut weakens the seed's hard coating. This effect, called scarification, allows the embryo inside the casing to burst through it in the spring.

One benefit of this for the tree is that by the time its scarified seeds reach the soil, they are far away from the parent. This increases their chances of survival and, thus, of the dispersal and continuation of tree's genes.

This is how it happens in nature but is too hit-and-miss a method for commercial fruit growers. In systems terminology, it is described as probabilistic. In fact, relying on nature is impossible with many cultivated varieties of apple. They would revert to their earlier, less-differentiated forms if allowed to reproduce freely. (Apple nurseries, as opposed to fruit growers, sometimes encourage this. Most popular varieties of apple arose from chance hybridisation.)

Instead of relying on nature's way, growers short-circuit the dispersal and germination sub-processes with something more certain.²¹ When they want more trees, growers take or buy cuttings from healthy trees of the required variety. They then graft them on to a different tree, called a rootstock. With tongue only slightly in cheek, you might say this disintermediates the animals and birds.

Something guaranteed to happen every time is called deterministic.²² Such systems are rarely found outside textbooks and system specifications. In real life, just about every system is probabilistic to some extent. Even grafting does not work every time. It is just more reliable than relying on the birds and the bees

The farmer's intervention in the natural cycle ensures that the genetic code of the desired apple is followed exactly in its offspring, a procedure called cloning. It is the equivalent of creating and enforcing business rules within organizational processes.²³

Cloning applies also to the rootstock. Four-fifths of the world's apples grow on a kind developed in the early 1920s at a research station in East Malling, in Kent. This has been cloned repeatedly to produce millions of genetically identical trees and is a recognised international standard.²⁴

Routes to market

Assuming our apple grower to be successful, he will need to decide how he is going to sell his crop. What will be his business model?

Figure 1.5: Routes to market for apple growers



We show four possibilities. For simplicity's sake, we have not shown despatch overseas. We have also assumed that these are dessert or cooking apples, rather than being grown for pulp, juice or cider.

Growers can choose any of these paths to the consumer, or any combination of them. We have shown path A as branching into A1 and A2. A small-volume grower – a 'boutique' farmer – could choose either at short notice. Paths B and C are mainly relevant for medium to large farms. Deciding between these would be done infrequently, probably only once.

Each flow chart shows the growing process on the left, with the subsequent actions (shown in rectangles) and the delivery and hand-over points (ellipses) to the right of it. Each rectangle or ellipse is a step or node in the flow. Each hand-over point is an interface, such as to a wholesaler's system or a consumer's.

The small pictures represent the form of transport used between each node. They give an idea of the volume transported at each stage. In each model, we have assumed that the consumer drives to the place of sale. We have also ignored importing, which is in fact a major economic activity.

The table below shows some of the factors that would possibly influence a grower's choice of how to get his crop to the consumer. The more stars there are, the better the score in that aspect.

Table 1.2: Factors influencing the choice of route to market

Path	Factor				
	Convenience to consumer	Cost to consumer	Profit for grower	Profit for retailer	Food miles
A1 (farm shop)	*	***	***	—	***
A2 (local market)	**	**	***	—	***
B (wholesaler)	***	**	**	*	**
C (large retailer)	**	**	*	***	*

The four main stakeholders in this system are the grower, the consumer, the retailer and society. (Wholesalers have a stake, too, but we are keeping the model simple.). The stars are a rough measure of what each path means to each stakeholder. The more stars the better.

We have represented society by the ‘food miles’ label. As its name suggests, this is a measure of how far a food has to travel to reach consumers. It is, indirectly, a measure of the environmental cost of getting it to their homes. Public concern and national legislation are making food producers pay more attention to such matters, so it warrants a place in the analysis.

The table is especially helpful in distinguishing path B from the similar-looking path C. Flow diagrams tell only part of the story of a process.²⁵

The table also shows that modelling can be done symbolically, using stars in this case, as well as graphically, by flowcharts. Mathematics is another common form of modelling, such as in spreadsheets.²⁶

Modelling

As with any model, the table above is a simplification of reality.²⁷ In practice, the grower’s decision would take into account many other factors, some of which would change faster than others. The varieties of apple he grows and the size of the crop, for instance, might incline him to prefer one path to the others. So, too, might contractual terms. Other contributory factors would include the quality of his apples, prevailing market conditions, government grants, fuel prices and the long-term weather forecast.

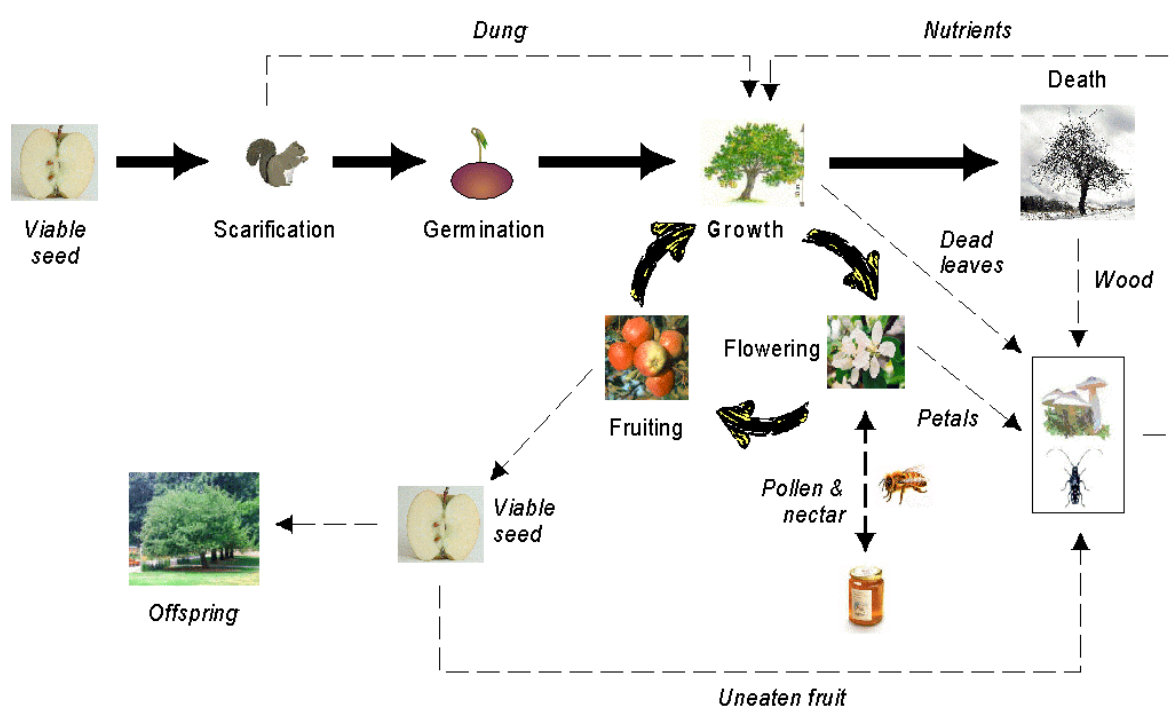
Taking due account of all these is a complex matter, which old-time growers did in their heads or on the proverbial back of an envelope. Modern growers use computer software to model the behaviour of the markets they are entering. This decision support software can guide the grower on what to do but does not direct or manage those actions.²⁸

Sometimes these programs are part of what is called a full farm package. This will typically also help the grower to plan, budget, schedule and oversee most of the activities on his farm. Inside white-collar organizations, the last of these is referred to as business intelligence (BI) or, increasingly, business activity monitoring (BAM).²⁹

Plotting more purposefully

You may have noticed that the life cycle for apple trees at Figure 3 only works if you deal with trees in the plural. Although a single apple tree can fruit and flower many times over, it germinates and dies only once. If we are interested in the life path of one specimen of an apple tree, therefore, we need to draw the process differently. The flow chart below shows how this would look for a wild apple if we include the sub-processes depicted in Figure 1.4.

Figure 1.6: Life cycle of a single apple tree



The most obvious difference from the earlier charts is that the main flow – of genetic material – is mostly linear. We start with a viable seed (that is, one capable of life), on the left. The process ends, as you would expect, with the death of the tree. The convention is to call this sort of diagram a life cycle whether it loops back on itself or not.³⁰

There is repetition at the growth stage, so we show that on a loop. Flowering and fruiting also appear on this loop. These sub-processes (called sub-routines in computer programming) can continue many times over. The original Bramley apple tree, for instance, is over 160 years old and still produces fruit. Most commercial fruit trees last 10 to 15 years before they are replaced.

In systems terminology, each new growth-flowering-fruiting cycle is an *iteration*. (To iterate is to repeat.) So, too, is each running of a process. Indeed, every apple tree could be described as an iteration of the apple tree process, which takes us back to the quotation about Fritjof Capra on page 4.³¹

Each tree is also, to introduce more jargon, an *instance* of the apple tree process. This simply means it is a single example of the process. An instance (example) can contain several iterations (repeats) of one or more sub-processes.³²

We show secondary flows in Figure 1.6 with dashed lines. These flows are typical of woodland ecology, with recyclers active wherever genetic material is discarded. There are two tangible outcomes of these secondary flows – honey and new trees. (In the wild, the

honey would stay in the nests of wild bees, to feed their young, rather than being collected for human use.)

The inward flows in the system as depicted are mainly nutrients recycled by various organisms on or near the tree. These range in size from, say, bears – which are well known for fertilizing the ground in woods – down to microscopic bacteria in the soil.

For simplicity again, we have not shown water, carbon and nitrogen. These are, of course, the major inputs to the growth processes of any plant. We also do not show sunlight, since that is an energy input. The chart is of the flows of physical material.

One of the smallest inflows in volume – but crucial – is the pollen that bees and other flying insects bring with them from other apple trees. Volume and frequency are not always reliable guides to importance.³³

Charting conventions

You may notice that some of the labels are in italics, while others are in a Roman (upright) font. The italics refer to plant matter, to objects. The labels in Roman refer to processes. This is an important distinction in plotting business processes.³⁴

You should note that this is a diagram of a *physical* flow. It does not, for instance, show how energy flows through the system or how information goes through it. Each of these would call for a different diagram (although you could argue that pollen is a source of information as much as of material). When looking at business processes, we need to be equally clear what it is we are plotting the course of.³⁵

Also, if we were plotting physical flows within a business, we would start by finding out the size of stocks and the rates of flow of the materials we were interested in. Without these, you cannot get useful information about overall inputs and outputs, throughputs, bottlenecks and so on. Simulation is impossible without these.³⁶

To keep the diagrams simple, we have not shown stocks and rates of flow in the apple tree processes. These were, anyway, not useful information for this exercise.

The apply tree supply chain

Viewed as a business, the apple tree's supply and demand chains can be thought of as containing these external participants.

Table 1.3: Participants in an apple tree's supply and demand chains

Identity	Role	What it transfers
Sun	Energy supplier	Photons (sunlight)
Atmosphere	Raw material supplier	Gases input to leaves (oxygen & carbon dioxide)
	Waste contractor	Gases output from leaves (oxygen & carbon dioxide); water (mainly as vapour)
Ground	Raw material supplier	Water to the roots
Dunger (e.g. bird; mammal, insect)	Raw material supplier	Food (mainly organic chemicals) to the roots

Recycler (fungi, worms, beetles, etc.)	Raw material supplier	Food (mainly organic chemicals) to the roots
Pollinator (e.g. honey-bee)	Piece-part supplier	Genetic material (pollen received)
	Courier service	Genetic material (pollen exported)
Scarifier	Post-process contractor	Preparation of seed for germination
	Courier service	Genetic material (transported seeds)

The input from scarifiers is, in effect, part of the factory construction process. (The recyclers of the dead tree are the demolition contractors.) The work scarifiers do on the tree's seeds is an example of 'outsourcing'.

Applying these ideas

That ends the mental aerobics for now. We hope your mind is now sufficiently warmed up to move on to thinking directly about business systems. We will continue to refer to the ideas in this chapter and to natural systems as we go through the book.

Ideas in this chapter

This list summarises the main ideas we have introduced in this chapter and where we did so.

¹ Most of what you see around you, whether you can touch it or not, is part of some process or processes.

² It is usually just the present stage of a combination of processes.

³ Deciding which of these is to be representative or definitive is difficult.

⁴ People seldom consider the existence of multiple processes when looking at business processes.

⁵ The processes people do notice depend largely on their responsibilities, background, training and inclination.

⁶ 'A tree is not an object, but an expression of processes.' (Ronald Bleed)

⁷ Deciding where a process starts is hard.

⁸ Business Process Management lets people manage processes beyond their organization's boundaries.

⁹ Even apparently simple systems can contain many different sub-processes.

¹⁰ Conditions and actors outside a system often exert an important influence on it.

¹¹ Business systems are usually open systems; their boundaries can be crossed.

¹² Many business processes and sub-processes involve at least two determining factors.

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- ¹³ Building the ‘death’ of a system’s components into the plans for it is sometimes overlooked.
- ¹⁴ Defining system boundaries is difficult.
- ¹⁵ Renting out occupied beehives to apple growers is a kind of business process outsourcing (BPO).
- ¹⁶ Timing, sequence and synchronization are important features of some systems.
- ¹⁷ Exercising control through processes is an essential feature of systems.
- ¹⁸ Internal communication and responsiveness to stimuli distinguish a system from an inert assemblage.
- ¹⁹ ‘A system is an entity that maintains its existence through the mutual interaction of its parts.’ (Ludwig von Bertalanffy.)
- ²⁰ Where systems communicate with each other is called the interface between those systems.
- ²¹ One way to make a system more reliable is to replace a probabilistic sub-process with something more certain.
- ²² The opposite of a probabilistic system is a deterministic one but these are rarely, if ever, found in real life.
- ²³ Cloning genetic material is the equivalent of creating and enforcing business rules within organizational processes.
- ²⁴ Repeated cloning is a way to create a standard.
- ²⁵ Flow diagrams tell only part of the story of a process. You need data as well.
- ²⁶ Processes can be modelled symbolically and by using mathematics, as well as graphically.
- ²⁷ Any model is a simplification of reality.
- ²⁸ Processes can be modelled using computer software. This ‘decision support’ software can guide the user on what to do but does not direct or manage those actions.
- ²⁹ Inside white-collar organizations, overseeing a process is referred to as business intelligence (BI) or business activity monitoring (BAM).
- ³⁰ Life cycle diagrams do not always loop back on themselves.
- ³¹ Each running of a cycle or process is called an iteration.
- ³² An instance is a real example of a process.
- ³³ Volume and frequency do not always indicate the importance of a process or flow.
- ³⁴ It is important to distinguish between objects and processes when plotting business processes.
- ³⁵ You need to be clear what it is you are plotting the course of when drawing a process diagram.
- ³⁶ Process analysis should include details of stocks and flows, if only to allow simulation.