Chapter 4
Time-Based Criteria

Does anyone know where the love of God goes when the waves turn minutes to hours?
Gordon Lightfoot—The Wreck of the Edmund Fitzgerald. 1975

Abstract When we think about uncertainty we tend to think about future uncertainty. In essence the degree of uncertainty makes it difficult to forecast or predict the future. This perception may be erroneous. Many forecasting and foresight processes use the past, especially the recent past, as a starting point, for their projections. That being said there is nothing to say that our assessment of the past is free from uncertainty, and more importantly bias, or that data from the past should be blindly accepted as being true. How should we treat time. Different criteria for addressing time are examined including time frames, time paths ranging from the linear to exponential, manifestations of underlying influences such as cycles and trends, and finally visibility, including weak signals and outliers.

Keywords Times frames · Time paths · Linear · Non-linear · Exponential · Cycles · Trends · Megatrends · Emerging issues · Weak signals · Outliers

4.1 Introduction

Part of the conundrum when dealing with time is that time is flexible and often seen in subjective terms. Thus, for a financial markets analyst, 6 months may be a long time whereas for an astrophysicist or an archaeologist 6 months is almost not worth bothering about as a period of interest or investigation. How should we treat time and, to mix metaphors, how long is a piece of string?

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4.2 Time Frames

Indeed, the further away the time horizon in which we have to assess uncertainty consists of a spectrum made up of three flexible time frames, *past time, now, and future time*, further complicated by reference to the more commonly used subjective expressions short term, medium term, and long term. In turn each of these categories can be broken down into a myriad of sub-periods or time frames.

4.2.1 Past Time

Past time (or history) can be divided into a number of different time frames such as (for example):

- Very recent—usually less than 1 year and relating to events that took place yesterday, last week, last month, earlier months in the last 12-month year.
- Individual years over the previous 2–10 years
- Previous nine decades
- Previous ten centuries
- Previous millennia and beyond

And as identified above, time frames are highly subjective from the standpoint of the person trying to determine how long a time frame should be in relation to forming a projection.

4.2.2 Now

Now—is where we are at this instance but this "instance" can be stretched to possibly mean today, this week or month, or longer—again depending on the perspective of the subject—it still is all rather beautifully (or annoyingly) fuzzy.

4.2.3 Future Time

How long do you want your string to be? Again, very subjective but here are some common time frames.

- *Short term:* usually less than 1 year and relating to events that are forecast to happen tomorrow, next week, next month, next quarter, rest of year (remaining three quarters for a rolling forecast)? For the purposes of this chapter "short term" is defined as being within the usual annual planning cycle of 12 months with by far the greater emphasis on the forthcoming quarter. Such forecasts will often include a quarterly breakdown for the second year of the plan.

- *Long term:* This expression is a somewhat movable feast. Many organisations use the term to cover the 3- to 5-year period, others up to 10 years, a few to 20 or even 30 years out. Perceptions of what exactly is the long term are very often dictated by the nature of the business sector. The financial sector largely operates within a much shorter time horizon with anecdotal evidence claiming that 1–3 months is short term and anything beyond that is long term. On the other hand, in sectors such as the life sciences, extractive industries, and aerospace/defence, characterised by long product discovery and development times, short to medium term is seen as extending up to 5 years out with the long term defined as any period beyond this. "Confusing, isn't it?"
- Years 2 through to 5 (sometimes called medium term)[1]
- Years 6–10 (often referred to as long term)
- Next 20–50 years (also long term)
- Far future—50 to 200 years and beyond and for science-fiction writers can be millennia or even aeons into the future.

Other frameworks of classifying different time horizons exist of course. One example developed by a team at Imperial College London (ICL) produced a table of Disruptive Technologies (2018) broken down into four main futures categories namely:

- Horizon 1—happening now,
- Horizon 2—near future 10–20 years hence
- Horizon 3—distant future 20 years +
- Ghost Technologies—fringe science and technology, defined as improbable but not actually impossible and worth watching according to the ICL team.

Uncertainty is present to a lesser or greater extent across the whole of the time spectrum. Many people assume that there is little uncertainty relating to events which have already occurred. This may not be strictly so. The past or our knowledge of the past is no guarantor that everything is known and there are no hidden uncertainties.

By way of a summary in which to frame time periods, Table 4.1 below offers a possible schema for allocating different periods in relation to time-related terminology. Please note that such boundaries are not set in stone—which of course is part of the challenge when dealing with time in relation to uncertainty. It is then up to you, the individual reader, to define your own or your organisation's time frame boundaries.

The author would advise that the reader select their own time reference as long as you can justify your interpretation and provide a logical rationale for the time frames.

[1] In fact, medium term can be stretched to mean anything from 1 year to 5 years depending on your perspective.

Table 4.1 Time period alternatives

	Past	Future
Short term	Less than 1 year/less than 5 years	Next 12 months/next 3 years
Medium term	Last 2–10 years/last 25 years	Years 1–3/4–10 years
Long term	Last 50 years–last century	4–10 years/10–30 years
Very long term	Last millennia and beyond	10 years plus/30 years plus

4.3 Time Paths

The time frames identified in Table 4.1, however, do not give any indications as to how time "wends its way". It can follow various paths or patterns and it is these routes which we shall now explore.

In this section, I'll be summarising ways in which we look at time. The approach will be to assess a number of time concepts as they relate to planning as well as to uncertainty. I should warn readers in advance don't expect an in-depth treatise into TIME let alone into parallel universes. If that is what interests you then might I suggest you read books such as *A Brief History of Time* by Stephen Hawking or Carlo Ravelli's *The Order of Time*. And, if you are really into heavy duty physics—then take your pick from any number of learned books and papers by eminent physicists and astro-physicists of the last century. In Einstein's general theory of relativity, there's no conceptual distinction between the past and the future, let alone an objective line of "now". But we mere mortals have to deal with the everyday constraints of yesterday, today, and tomorrow—as if "uncertainty" about the future were not problematic enough!

4.3.1 Linear

This is the time path that most of us can relate to and live by—whereby we move from the past into the future in a straight line in a sequence that moves in one direction—the daily routine of life. A linear mind-set allows us to "hope" that the future, essentially the immediate or short-term future, will be a continuation of the recent past, and with a reasonable level of certainty. Unfortunately, future events can be knocked off a linear path by a host of external stimuli. With such a mind-set, taking 30 linear steps (1 m a step) one after the other (1.2.3.4, etc.) our brains have an easy time understanding that we would arrive 30 m away at the end of that sequence. Moreover, as human beings, we believe the past cannot be changed, let alone visit it, as we live according to linear future time.

4.3.2 Non-linear and Asymmetric

Non-linear is a deviation from linearity and in statistical terms is used to describe a situation where there no direct relationship between an independent variable and a dependent variable—and cannot be represented therefore as a straight line. In a non-linear relationship, changes in the output do not change in direct proportion to changes in any of the inputs. Thus, it can be argued that non-linearity can be represented by any number of lines, not just one. More importantly, these lines are interconnected with different pasts leading to alternative presents and futures. In reality non-linearity is a reflection of how most of mankind has to deal with the future, making life difficult to navigate—albeit exciting at times. Acknowledging non-linearity is an essential cognitive state that needs to be adopted if we are able to confront the future and embrace its uncertainties.

Asymmetry

Asymmetry means that something (physical objects, ideas, or concepts) is not identical and has two halves, sides, or parts that are not exactly the same. It should not be confused with non-linearity. Something which follows a non-linear path can be symmetric or asymmetric—or start in a state of symmetry and change into a state of asymmetry and even back again. An example of how the concept of asymmetry works has been in the term "asymmetric warfare".

> Asymmetric warfare can describe a conflict in which the resources of two belligerents differ in essence and, in the struggle, interact and attempt to exploit each other's characteristic weaknesses. Such struggles often involve strategies and tactics of unconventional warfare, the weaker combatants attempting to use strategy to offset deficiencies in quantity or quality of their forces and equipment. Wikipedia.

Asymmetric warfare such as guerrilla style engagement or using low-cost new technology such as drones is waged against traditionally structured and equipped opposition. Modern examples include the war fought in Vietnam by the Viet Cong against the USA in the 1960s and 1970s, by the Taliban and other guerrilla formations in Afghanistan against Soviet and then Western-based forces from the 1989s onwards and in post-Saddam Iraq. In business terms, we tend to use the more polite term "disruptive". Even more recently cyber warfare has added a new dimension as to our understanding of asymmetric warfare. Perhaps, asymmetry can be best expressed when the actions required to achieve an objective in one period of time (say a year) are out of kilter with actions developed in a different time period.

4.3.3 Exponential

In mathematical terminology "exponential" means an equation having one or more unknown variables in one or more exponents rising or expanding at a steady rate. For us more simpler souls, the term is most familiar when speaking about "Moore's law"

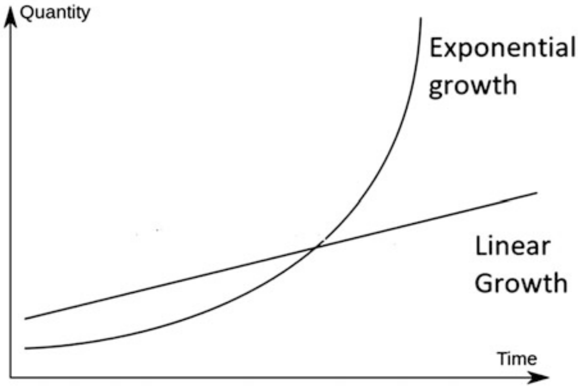

Fig. 4.1 Exponential versus linear growth

whereby the eponymous scientist in 1958 observed that the number of transistors per square inch on integrated circuits doubled every 2 years since they were invented and where he predicted that this trend would continue into the foreseeable future.

Another way of describing exponentiality is by taking our original 30 steps example referred to in the section on linearity. If we now double each of the 30 steps taken (1, 2, 4, 8, 16, and so on) in an exponential fashion, this would lengthen to 26 times around planet Earth! Another example supplied by the "Singularity University" is that *"when you fold a piece of paper roughly 0.005 cm thick (5/1000th of 1 centimetre), the paper will be just over 1 cm thick after the 8th folding. After only 42 folds, that piece of paper is thick enough to reach the moon! And after just one more fold, the 43rd doubling, it reaches all the way to the moon and back"*.

Humans are not equipped to process exponential growth, particularly as futurist Ray Kurzweil states that *exponentials* only become dramatic over long timescales, and the initial doublings can be almost imperceptible. Exponential growth is deceptive as the doubling of small numbers inevitably leads to numbers that outpace our brain's intuitive sense.

Our intuition is to use our assessment of how much change we've seen in the past to predict how much change we'll see in the future. Moreover, we tend to overestimate what can be achieved in the short term but majorly underestimate what we can do in the long term whilst assuming a constant rate of change. It is the gap between *linear* and *exponential* that is at the heart of why the future is so uncertain and the present is so unbelievably surprising—it is even more difficult to grasp when adding in non-linearity—is it random, part of a pattern or trend, or exponential (or exponentially random!)? (Fig. 4.1 above).

4.3.4 The Law of Accelerating Returns

Influenced largely by the impact of technology on mankind, Ray Kurzweil, in 1999, introduced what he called the Law of Accelerating Returns (1999) in which he addresses the accelerating rate at which technological progress occurs in the world and exponential effects of such progress. According to Kurzweil, the law states that:

- The rate of progress in any evolutionary learning environment (a system that learns via trial and error over time) increases exponentially.
- The more advanced a system that improves through iterative learning becomes, the faster it can progress.
- Advances breed faster advances and that what people anticipated to come in 50 years will be around in 5 years.

His proposition is that according to the law, machine intelligence is getting to a completely new level of advancement and that in a few decades to come artificial intelligence will overtake human intelligence. His predictions depend on existing developments, making them, in essence, reactive as opposed to exploratory scenarios (*see Chap. 7 for a detailed description of these two scenario lenses*).

4.3.5 How to Predict Exponential Growth

There are a number of examples that futurists such as Kurzweil and Diamandis at the Singularity University mention such as:

1. How in the early 1980s the consulting firm McKinsey was asked by US telecoms giant AT&T to forecast how many mobile phones would be in use by the year 2000. McKinsey forecast a global market of 900,000 units—yet by 1999 some 900 k people were signing up for mobiles every 3 days!
2. In the more up-to-date situation regarding battery technology for cars a US federal agency, the Energy Information Alliance, predicted in 2015 that the total number of electric vehicles with a range of 200 miles per charge would not exceed 1000—by the year 2040. A few months later, Tesla announced a car with a battery range of 215 miles per charge, and receiving over 300,000 pre-orders in a week!
3. Similarly, exponential growth from initial low estimates of development has been seen in relation to DNA sequencing by the Human Genome Project.

The future is notoriously difficult to predict. Failure to see, let alone extrapolate the exponential trends that will shape our world in the coming century, is likely to cause high levels of social anomie, social alienation, and "future shock"—the later concept originally coined by Alvin Toffler back in 1970.

The rate of change does appear to be increasing. Society (individuals, businesses and governments) will need to dramatically modify its predictive models to adapt to this changing reality when faced with the profound implications of disruptive technologies such as those illustrated in Imperial College's "Table of Disruptive Technologies" (2018) and in particular genetic modification, augmented and virtual reality, artificial intelligence, and other exponentially growing sectors that will manifest themselves in our lifetimes. I should also like to refer the reader to a recently published book by Azeem Azhar called *Exponential* (2021)—which addresses how accelerating technology is leaving us humans behind.

Note: The original Imperial TechForesight graphic is not suitable for transfer to either the book or e-version formats of this publication due to its original size and dense background colour. The author recommends that for those readers who wish to explore the table in greater detail that they access the Table and download the original image. This can be accessed via: https://imperialtechforesight.com/visions/table-of-disruptive-technologies-2/

An Odd Thought

So what might happen if something continues extrapolating. I looked at some elementary wave theory to introduce a "wacky" idea which you may wish to spend a few minutes to think about.

Scientists have concluded that waves break when their amplitude reaches a critical level which causes large amounts of wave energy to be transformed into turbulent kinetic energy, like a ball rolling down the hill. In other words, when waves reach shallow waters—usually near coastlines—they increase in height, and their crests meet the Law of Gravitation. The waves break.

Nevertheless, ocean floor topography will critically decide how wave energy will transform into whitewater. As waves reach the shore, the energy in front of the wave slows down due to friction with the shallow bottom.

Meanwhile, the energy behind the wave moves at full speed and is channelled upwards, climbing the back of the bulging wave. The wave breaks, and it usually does so in water depth that is 1.3 times the wave height.

Imagine that a technology life cycle accelerates exponentially so much that before it is able to transform into a typical S-curve that the rate of exponential growth is so fast that it collapses under its own weight—with dramatic effect as in a breaking wave. Or what if it turns back on itself once it reaches its peak such that it not only collapses but goes back on itself? Marczyk (2009) states that collapse is Nature's most efficient mechanism of simplification. Does this indicate that exponentiality has its limits or that if it doesn't, we cannot imagine what it is, what it might look like or be in a different dimension—or maybe a real "unknown-unknown"? *BUT* No doubt a mathematician and/or physicist has the "theoretical" answer!

We can now represent the various elements of the time path categories in the following schema (Table 4.2):

As an exercise for the reader you may wish to populate each of the cells with possible events which match each of the six cells from your or your team's perspective—quite an introductory ice-breaker thinking game.

Table 4.2 Time path alternatives

	Linear	Non-linear	Exponential
Symmetric			
Asymmetric			

At the end of this chapter, we shall merge (or integrate) this matrix with the time period matrix introduced earlier, before combining it with a further matrix illustrating the relationships between manifestations and visibility.

4.4 Time Path Overlays (Manifestations of Underlying Influences)

Hidden within the various time periods and time paths are other time-related phenomena, which I call "manifestations" and which play out across both time frames and time paths, these being:

- Cycles
- Trends
- Megatrends

4.4.1 Cycles (and Waves)

A cycle can be defined as an interval of time within which a set of actions is completed or a process that returns to its beginning and repeats itself in the same sequence. In relation to time a cycle can also be interpreted as a wave, albeit that the peaks and troughs of the wave may be asymmetric. For example, long economic cycles as hypothesised by Kondratiev (2002) have been called supercycles and such phenomena are similar to technology life cycles.

Kondratiev's long wave theory is contentious within broader economic circles, including that it may involve recognising patterns that may not exist. The Kondratiev wave—also known as supercycles, K-waves, surges, and long waves—refers to cycles, lasting about 40–60 years, experienced by capitalist economies and indicated by periods of evolution and self-correction, brought about by technological innovation that results in a long period of prosperity.

4.4.2 Trends

Trends on the other hand can be defined as an inclination in a particular direction and in analytic terms can be interpreted as a line drawn on a graph that approximates the trend of a number of disparate points.

It is more accurate to argue that a trend describes *history, or rather a* historical change over time. Changes in a trend are particularly identifiable where certain variables have been identified as being important, so that data relating to the variable having been collected are seen to alter direction of the trend—such as how households have changed their purchasing habits over the Covid pandemic lockdown: from physical purchase of goods from physical retail stores to online purchases. The trouble is that there is a tendency to imply that when talking about a trend we are imputing something about the future—this is not accurate as such an activity turns a trend into a forecast (see Chap. 6 for more discussions on forecasting). In the case of post-pandemic purchasing habits, to what extent will buyer behaviour revert to pre-pandemic patterns—or will there be a hybrid behaviour? A similar question may be asked of real and virtual office work patterns.

Nevertheless, futures studies experts do refer to trends as key precursors to exploring the future. Kuosa and Stucki (2020) state that *"A trend has a recognisable development path that is supported by multiple credible sources. It is a flow of transformations that is not redirected easily. In general, trends can be verified by collecting enough data to form statistics that prove their existence*."

Kuosa and Stucki also point out that: *"Trends usually are identified either by using time-series analyses or by experts who are well aware of the latest changes within their fields .... Trends and their behaviour become more challenging to predict over a more extended period."*

A large number of trends are "in process" at any one time—easily identifiable examples include the Internet of Things, and rising populism in Europe and other formerly politically democratic countries.

The Future Today Institute (2020) goes on to state that strategic trends share a set of four laws called the Four Laws of Tech Trends (2020).

1. *Trends are driven by basic human needs*
2. *Trends are timely, but they persist*
3. *Trends are the convergence of weak signals over time*
4. *Trends evolve as they emerge*

One method cited by Kuosa and Stucki to explore trends is Trend Impact Analysis (TIA), first introduced by Theodore Gordon in the early 1970s, when forecasting used mainly quantitative methods based on historical data and via trend extrapolation but tended to ignore the impacts of future unexpected events. The focus is on identifying the sub-trends of a larger trend and analyses the impact of each of these separately or combined with the primary trend. The TIA method, although using quantitative methods, tries to improve the basic forecast by using expert opinion approaches such as the Delphi method about probable events in the future—an early-stage hybrid approach. TIA has been used not just for forecasting but contingency planning and strategic planning. It has also been used for scenario writing but as identified in Chap. 8, due to its inflections off past trends, is largely deployed in *reactive* scenario mode.

Kuosa and Stucki point out that trend extrapolation, at its heart, is pure forecasting—directly extrapolating the development shown in a past or present time series into the future answering the question of "What if this development continues to the future without any changes?" Yet this approach assumes that whilst a trend can be extrapolated all other things are to be treated equal *"meaning that only one trend and its impacts are at the focus, and all other impacting factors and trends are left out of* *the calculation"*. In essence TIA ignores "future noises" and relies more on probabilities rather than the in-depth exploration of, yes, "uncertainty".

Yet trend analysis does have its uses, as long as the analyst is aware of its limitations, so it can help the analyst understand what other interactions (or collisions) the trend may have with other trends.

The Future Today Institute (FTI) in its 2020 Tech Trends Report states that a trend should not be confused with trendy. *"Trends driven by demographics, the economy, technology, politics and social movements and are formed over a number of years and are not necessarily linear. Trendy on the other hand are much more transient or ephemeral (fads), briefly capturing out attention before burning out"*.

Trends are constantly changing and mutating—some increase in prominence—others decline—somewhat similar to a football league table. With reference to the Future Today Institute, cited above, its 2020 Tech Trends Report was published in January 2020—and contained no reference to the impact of a pandemic—as it was in the future and not visible as a trend (or was hidden or disguised enough to be not identified as being a trend). Yes, trends have their uses but other uncertainties need to be assessed when looking to even the near future.

For those readers wanting to review what other experts in the domain of trend identification have come up with, there are numerous professional sources—however at a personal level may I point out those trends dynamically represented by organisations[2] such as:

- The Futures Platform: https://www.futuresplatform.com/ (Finland)
- Shaping Tomorrow: https://www.shapingtomorrow.com (UK)
- The Future Institute: https://thefuturesinstitute.org (USA)
- The Future Today Institute: https://futuretodayinstitute.com/foresight-tools-2/ (USA)
- SITRA: https://www.sitra.fi/en/ (Finland)

Many countries carry out foresight activities. A report published by the European Union Institute for Strategic Studies (2014) called "Foresight in Government—Practices and trends around the world" carries a review of countries which carry out foresight activities including Australia, Brazil, Canada, China, Finland, France, Germany, India, Indonesia, Italy, Japan, Mexico, the Netherlands, Norway, Russia, Singapore, South Africa, South Korea, Sweden, Switzerland, the UK (UK), and the USA. https://espas.secure.europarl.europa.eu/orbis/document/foresight-government-practices-and-trends-around-world

[2]There are numerous other sites where the reader can access trend data including:

- The Future Today Institute: https://futuretodayinstitute.com/foresight-tools-2/
- European Data Protection Agency: https://edps.europa.eu/press-publications/press-news/blog/foresight-essential-element-analyse-tech-trends_en
- European Commission Knowledge for Policy.: https://knowledge4policy.ec.europa.eu/foresight/megatrends-implications-assessment-tool_en

There are of course many other organisations providing trend evaluations from *The Economist* to the *Financial Times* as well as all the main global consulting companies such as McKinsey, PwC, Kearney, Gartner, etc. along with a plethora of output from national and international NGOs.

4.4.3 Megatrends

Now then, what is the difference between a trend and a megatrend? Megatrends are seen as major, global, long-term change developments that impact the broader environment in which we live—economic, social, cultural, etc. Often, they are combinations of multiple trends and issues with heightened levels of interconnectivity and can help shape, once identified, strategic directions for organisations of all types as well as social movements.

Megatrends can be the foundation for foresight analysis. They contain opportunities and risks—invariably both—and when the latter happens the analyst and decision-maker has to be aware of unintended consequences—as such megatrends may be precursors of, or have hidden in their complexity—"wicked problem" outcomes.

Megatrends usually reflect observable phenomena over longer periods of time than just simple trends (years and decades). This allows the analyst greater confidence when projecting or extrapolating the path of the trend. The danger, however, is that the stronger the duration of a trend the greater the temptation to ignore signals which may alter the trend line—and therefore the analyst must be aware of weak signals that could bring about unexpected and dramatic change to the trend (see the next section).

Reader Aware Notice *Trends and Megatrends. Many organisations profess to be the experts at identifying trends and megatrends. One has to challenge them as whilst they may be good at identifying current trends, how good are they at identifying how that trend might pan out or mutate and at what rate? How many of the trend specialists identified the Covid-19 pandemic—or Putin's invasion of Ukraine?—very few!*

4.5 Visibility (and Its Relationship with Time)

One of the main issues with data, whether in quantitative or qualitative form, is how visible such data are—even if some data are visible, have they been properly interpreted and/or do they hide information which can have an impact on the future? Let's look at some aspects of data in both their visible and less visible manifestations. Visibility as discussed in Chap. 2 is a key component of the uncertainty profile matrix (Fig. 2.2).

4.5.1 Current

Current—it's what data we have today—that is, we have access to some data that does exist and from which we can assign degrees of confidence as to the veracity and/or accuracy (see next chapter on the Evidence base), and from which the analyst can develop rationales and assumptions—subject to . . . . The fact that current data is visible does not guarantee such data is accurate or true—but does provide some form of (if only a temporary) anchor to develop further hypotheses until more data can be obtained. Propaganda sourced information is eminently visible but rarely true.

4.5.2 Emerging Issues

Emerging Issues—Although regularly used by analysts and decision-makers when attempting to address the future, a "*trend is just one of the key "building blocks" that analysts use when forecasting alternative futures"* (Lum, 2016). Lum qualifies this statement by saying the phrase, "trends and emerging issues" are often used as meaning the same thing albeit they are distinct components in the foresight process. He points out that the analyst needs to be aware of emerging issues as a trend-based forecast:

- May not have all the relevant variables.
- May not reflect correctly all the relationships between the variables used in the forecast.
- The historical relationships of the selected variables may have changed without the analyst being aware of it—hidden or lost in the noise.
- The subject of the forecast may inherently produce unpredictable outcomes with low visibility due to the early stage of emergence.

With a trend, it is presumed that various data points related to key previously defined variables can be tracked and used for extrapolation purposes. With emerging issues a different mind-set has to be deployed as the analyst is looking at *new* things that *may* become important in the future. In essence a more exploratory viewpoint is required as opposed to a more a reactive, backward looking one (see Chap. 9). Emerging issues reflect technology, concepts, and policy which are not yet mature or properly formulated but could emerge into the mainstream under certain conditions, whether they be known today or unknown.

Some emerging issues may be considered so weak that they are overlooked, ignored, or discarded. This leads us into a discussion about "weak signals" themselves.

4.5.3 Weak Signals

What are weak signals, and when and where do they exist? Again, it is important not to confuse them with a trend (as per emerging issues above). It is argued that with weak signals being seen as phenomena which may play out in the future, it is important to distinguish between prediction methods relating to forecasting and foresight—the former relying on historical and current data which can be predicted with high degrees of confidence or probability, the latter much less so—this will be discussed further in Chap. 7.

If not strictly by definition, one can say that "weak signals" reside within the domain of the uncertain. Decision- and policy-makers are continually seeking alternative, if not new, approaches to make better, more informed decisions and to mitigate risks of making bad decisions under various states of uncertainty (and complexity) (Camillus, 2008; PWC, 2012).

One of the earliest references to weak signals was by Igor Ansoff (1975) (of *Corporate Strategy* fame) in 1975. He used the term within the context of a *Strategic Early Warning System (SEWS)*, developed to help organisations deal with discontinuities and strategic surprises. A SEWS assumes that discontinuities do not emerge without warning. As an early warning system, it identifies behavioural factors such as "blind spots" which in turn hinder identification of weak signals.

Yritys (2014) states that *"Weak signals are first symptoms or early signals of a change telling about a strengthening trend and bringing information that is not yet seen …and can reveal threats and opportunities for an organisation. They could also be defined wild cards that change the development and are unpredictable when turning up. Weak signals are events below the surface, overlooked, but that may be signs of big evolution."*

Looking for weak signals can be seen as one of the foundations for strategic foresight; however, be aware that non-rationality of humans make accurate prediction difficult if not impossible. The challenge of course is how can such signals be identified amid all the noise generated by high levels of interconnectivity and complexity in a rapidly changing environment.

The *uncertainty profile matrix*, introduced in Chap. 2, can be used as a guide in positioning where weak signals are most likely to occur within the risk spectrum and why the barriers to detection are as much behavioural as methodological.

Digging Deeper to Find Weak Signals

Maybe the best place to start is to ask what they are not. Pedbury (2019) claims that weak signals have to be isolated from the notion of "trends" (discussed in the previous section) since:

> **Trends** describe the expected future, the high probability, high impact developments we need to address. Focusing exclusively on the trends risks being blindsided by surprises. Trends are based on data. All data is in the past. It may be unreliable if the underlying system is changing in fundamental ways.

Pedbury re-enforces his position by stating that surprises come from places people are not looking and that *"Scanning identifies* ***weak signals*** *with unknown probability but potentially significant impact that are often ignored.*" His argument is that many organisations are focused too much on predicting the expected future, those high probability, high impact developments that could disrupt their operations. Conversely those issues seen to have low or unknown probability and potentially high impact are often discounted or ignored with weak signals being lost in the general noise of issues to be addressed (Harrysson et al., 2014). Voigt et al. (2011) highlight the dilemma of analysts when challenged to identify where and how to weak signals reside:

> Generally speaking, incorporating weak signals in strategic discussions is a known dilemma because on one side the vast variety of potential signals requires us to select which signals to process and which to ignore and on the other side the very concept of 'weak signals' disqualifies the selection rules we would usually apply, such as selecting signals that stand out or signals that have been helpful in the past.

In addition, cultures exist within organisations that militate against addressing new challenges to current policy, acting as barriers to foresight. In effect analysts lack (or have not identified) those tools and methods which might allow them to narrow down weak signals in terms of not just inevitable surprises, but the differing shades of uncertainty and in particular genuine uncertainty (confirming the standpoint of Camillus and PwC noted earlier).

Although weak signals often have no history, and thus no basis on which to build a pattern, one has to consider that there may be "Sleepers"—overlooked, forgotten, dormant potential indicators waiting for some "techno-analyst prince charming" to awaken it. Such signals will tend to be qualitative in nature as there is little hard data to enable signal strengthening. This problem is compounded by the non-linearity of issues development, with some changing slowly, much like the "slowly boiling frog" analogy, whilst others change fast and very radically.

In addition, whilst information exists in the environment, individually of little consequence or impact, but when clustered together with other weak phenomena can reveal interesting information or signal strengthening options—what can be termed "symbiotic clustering". Both symbiosis and serendipity have useful roles in resurrecting and transforming "interesting" but neglected signals and new clusters, e.g. biomimicry.

Note Not every point in the cluster has to be weak but a combination of the unknown, semi-known, and even known. And, as Yritys rightly points out, weak signals are a continuous or non-stop process and that consequently weak signal search should not be seen as a discrete activity.

Sources of Weak Signals and Where Do They Abide?

Current methods and tools used to identify weak signals include think-tank groups, brainstorming, Delphi method, or a pattern management framework, which means collecting signs of weak signals from published documents including magazines, academic papers—and of course social media along with data analytic "trawlers". Note that the danger exists of spurious correlation!

Hiltunen (2008) differentiated between texts, online resources, and human sources. However, much of the former are static in that they cannot elaborate on the signals they contain, whereas human sources engaged in face-to-face debates, virtual chats, or email exchanges can provide further contextual information if needed (e.g. reasons, assumptions, examples). Hiltunen's study did reveal that the most frequently used sources of weak signals are researchers, future studies experts, and colleagues. For a more expansive view of methods in the broader futures domain, Poli (2018) discusses how future-related methods should be classified. Perhaps, more important is how much influence such practitioners have over policy- and final decision-makers?

There has been a recent tendency to think of weak signals as mainly manifesting themselves in the new technology/product area—partly due to the seemingly exponential rate of technological change and the urgency attached to identifying future development opportunities. However, weak signals should not be seen as just "eureka" moments which can only be identified by the analyst or indeed brainstorming-sourced inspiration processes—and mistakenly being classified as "unknown/unknowns" (aka black swan events). Weak signals are also present within the domain of socio-economic and political—identification of which is key to developing ongoing strategic awareness via scenarios so that policy (commercial and political) can be continually challenged and re-assessed.

There is one final category of phenomena which can influence the future and is often overlooked—outliers and wild cards and which we shall briefly introduce.

4.5.4 Outliers/Wilds Cards

If you thought weak signals were difficult to spot, how about these two little fellas?

An outlier is basically data which does not "fit in" with the other data being analysed. It doesn't really matter if it is part of a group as long as it is a valid data point, i.e. possible. The conundrum for analysts is that it may be just a discrete random piece of noise. One shouldn't become obsessive about looking for outliers, which may or may not be real, but recognition that they may exist should be enough to put into place processes which allow "fringe" ideas to be considered—the "unthinkables" of this world. It is also possible that outliers may morph into weak signals or into emerging issues. Just be aware that there is some "weird stuff" out there—so do not develop a mind-set which is antipathetic to considering such eventualities.

Both the "manifestation" and "visibility" criteria can be combined into a matrix framework (Table 4.3), populated with examples of each paired cell. Readers can populate the empty cells according to their specific problem issue.

Table 4.3 Time frames manifested and visibility

Visibility	Manifestation		
	Cycles	Trends	Megatrends
Current			
Emerging issue			
Weak signal			
Outlier/wild card			

4.6 Integrating Time-Based Criteria (MTTs)

In this chapter, we have introduced four basic criteria for classifying time and discussed how they play a role across the uncertainty/risk spectrum, being: times frames, time paths, manifestation, and visibility. From these four criteria three frameworks were developed: times frames, time path, and combined manifestation/visibility matrices. These three frameworks were individually presented in matrix format. At the conclusion of this chapter the task is to integrate, or merge, the three matrices into a combined framework which analysts can use as a template when looking at time-based variables for individual futures projects.

These frameworks when combined into an integrated table yields some 960[3] different configurations for time-related criteria as shown in Table 4.4. What this section has identified is that when time-based criteria are included as part of the exercise to better understand uncertainty, the analyst has to consider a large number of different parameters. The tables presented in this chapter will help the analyst to:

(a) Comprehend better the importance and characteristics of time-based criteria when addressing uncertainty
(b) Isolate particular relationships within each of the three time-based matrices presented
(c) Understand the combinatory influence of these time-based criteria
(d) Prevent oversimplification of time-based influences when dealing with uncertainty; this helps improve the quality of the analytical process.

User Exercise

It is now time, for you the reader, to populate these templates according to those boundaries of the problem that is facing you or your organisation. In Table 4.5, please feel free to amend any of the time period in each of the cells—such that your interpretation of "short term" could be the previous 3 months or "long term" defined as being up to 10 years.

[3] The reader may wish to carry out a pair-wise analysis exercise, identifying inconsistence pairs thus reducing the total number of viable configurations to be evaluated. For example, it can be argued that a short-term time period within the last 5 years is likely to be inconsistent with a long-term future time frame over, say, the next 25 years—the gap between something that happened 3 years ago is unlikely (but not impossible) to be linked to something which will manifest itself in 25 years' time.

Table 4.4 Integrated time criteria

Time frame past	Time frame future	Time paths	Manifestation/ visibility
S-T < 1 year/5 years	S-T next 12 months/ next 3 years	Linear symmetric	Cycle—current
M-T 2–10 years/last 25 years	M-T years 1–3/4–10 years	Linear asymmetric	Cycle—emerging issue
L-T last 50 years/last century	L-T 4–10 years/10–30 years	Non-linear symmetric	Cycle—weak signal
Very L-T—last millenium & beyond	Very L-T up to next 500 years	Non-linear asymmetric	Cycle—outlier/wild card
		Exponential symmetric	Trend—current
			Trend—emerging issue
			Trend—weak signal
			Trend—outlier/wild card
			Megatrend—current
			Megatrend—emerging issue
			Megatrend—weak signal
			Megatrend—outlier/ wild card

Table 4.5 Time frame alternatives

	Past	Future
Short term	Less than 1 year/less than 5 years	Next 12 months/next 3 years
Medium term	Last 2–10 years/last 25 years	Years 1–3/4–10 years
Long term	Last 50 years–last century	4–10 years/10–30 years
Very long term	Last millennium and beyond	Up to +250 years

Top-Down/Bottom-Up Approaches

Another level of analysis can be achieved by changing the order within which each of the matrices is introduced. Thus, for example you may deem that a more exploratory approach needs to be carried out by allocating different scenario options to the "time frame" table as a first phase followed by refining the possible event (s) the manifestation/visibility. Alternatively one could begin with the manifestation/ visibility criteria and then work backwards to allocating the event to a particular time frame. I would recommend that both routes are explored as such an exercise can identify gaps within the analysis—the examination of which can yield interesting sets of differing rationales (Tables 4.6 and 4.7).

Table 4.6 Time paths

	Linear	Non-linear	Exponential
Symmetric			
Asymmetric			

Table 4.7 Manifestation and visibility

	Manifestation		
Visibility	Cycles	Trends	Megatrends
Current			
Emerging issue			
Weak signal			
Outlier/wild Card			

When you have populated each of the three matrices you can then combine them into the "integrated time criteria" template (Table 4.4)—you may be surprised at some of the outcomes of such an exercise.

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