

Never Make Predictions. Especially About The Future.

“Economists give their predictions to a digit after the decimal point to show that they have a sense of humour”

If anyone approaches you telling you that they are able to predict the future, quite likely your first reaction will be to cross the street and hope that they don't follow you. The main thing we know about people whose job it is to predict the future – whether economist or politician, scientist or weatherman – is that they tend not to do such a good job of it. Predicting the future in a chaotic and complex world looks and feels like an impossible task. One of the reasons that it is so difficult is that there is so much randomness around the issue of *when* things will happen. Perhaps things start to get far more certain if we are able to separate this timing question from the equally important question of *what*. Based on our previously mentioned study of over three million successful innovations, it looks like, difficult to believe as it may be, we can be extremely certain about this aspect of the future prediction story. This month we will look at how this might be true from the perspective of the evolution of technical systems. Next month we will shift our attention to business and management with the hope of demonstrating a similar level of predictability in that arena too. The month after that we will explore some of the implications for businesses around the world if it might be true that we can predict what will happen in the future.

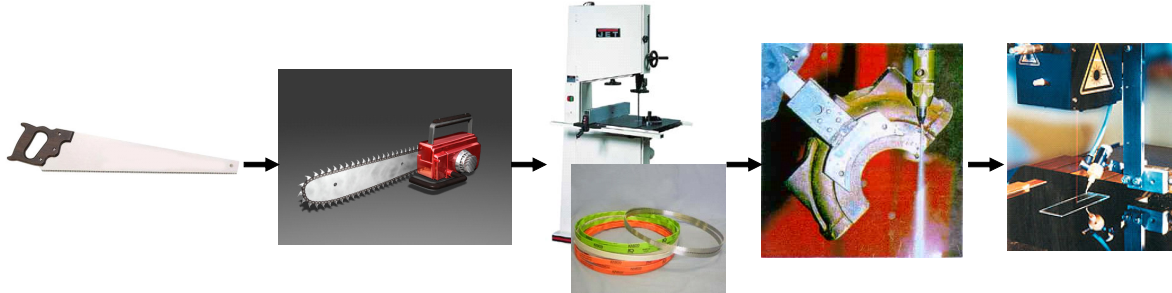
Before that though, we need to take a short trip back in time to explore how a number of different industries have evolved over time. A good way of doing this is to take all of the solutions for a given industry, place them in date order, and then see if any patterns can be traced. Let us start that journey with the evolution of body protection systems:.



Not that there was a patent database in the Middle Ages, but we can probably imagine that over time the shield was progressively enhanced and refined. There were, in other words, a series of incremental improvements in shield design. Ultimately, however, the shield suffers from some fundamental limitations. The first one is a conflict between a desire for it to cover as much of the person holding it as possible. The problem here is that the bigger it is the heavier and more unwieldy it will be. The second, probably bigger, conflict is that we require one arm to hold it, and therefore only have one free arm to do other things. As shown in the second picture in the sequence, the suit of armour solved at least the second of these problems; a person wearing the suit of armour now had two free arms with much less weight cantilevered from each arm. Alas, there were new problems that came with this new system – it was still heavy, the wearer wasn't particularly manoeuvrable, and visibility wasn't great. Again, these turned out to be fundamental limitations of the armour system. It wasn't until

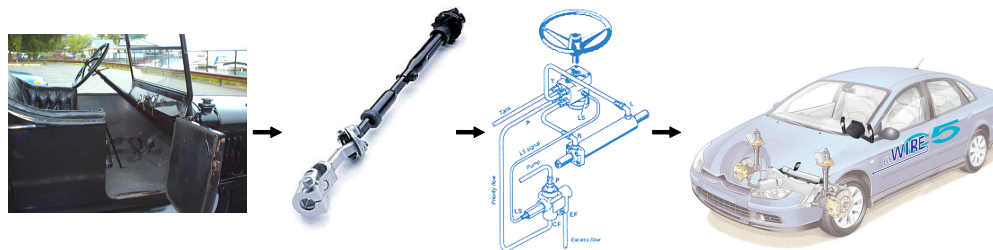
someone came along and invented chain-mail in fact that the state of the art was able to make another forwards jump. Chain-mail now gave far greater freedom of movement to the wearer, but with the best will in the world this protection system too hit a hard limit when the threat changed from swords and arrows to bullets. When the threat system changed, the protection system also needed to change. As shown in the fourth and final picture in the sequence, that change currently comprises a Kevlar-type vest.

Let's shift 'industry' now and look at how solutions for cutting things has evolved. The following sequence illustrates a similar left-to-right time progression.



The first evolution stage in this progression is a simple hand tool. The main problem with this tool is its limited productivity. A desire to increase productivity ultimately meant that the world had to add power and more cutting surfaces. The new problem now became one of accuracy. This problem was eventually solved when machine tools arrived, and the world invented systems like the band-saw. As always seems to be the case, even this system eventually hit some kind of fundamental limit. In this case, that limit relates to tool wear. In order to solve that problem, a new non-mechanical solution was required. We see such a solution arriving in the form of, first, water-jet based cutting tools, and, now more recently, laser-based systems. There is no tool-wear with a water jet. The potential for mess and difficulties of recycling and cleaning the water become the limitations of this system. The laser manages to eliminate both of these problems, as well as offering the potential for higher accuracy and an ability to form more intricate shapes.

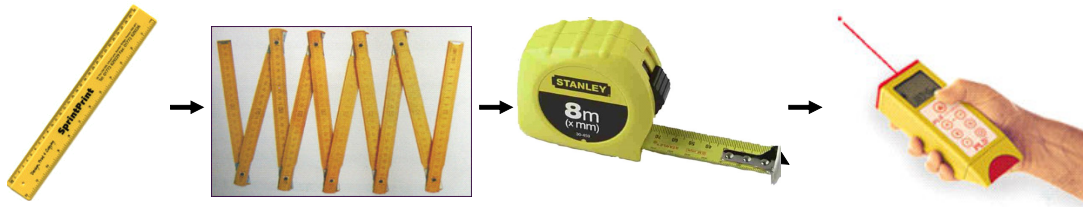
Perhaps we can begin to see connections between this second sequence and the first one. They are both completely different industries, but there does seem to be some similarity in how they have evolved. Let's try and see if a clearer pattern emerges as we shift our attention to a third industry. This time let's move to the automotive sector and the design of steering control systems. Here is another left-to-right time progression for this sector:



The reasons for the jumps between stages are different again this time. The first picture illustrates the steering column of a Model T Ford. The column is a rigid shaft. The problem with this system is that there is an engine between where we want to put the steering wheel and the front axle we want to be able to steer. We can solve this problem by introducing an articulated shaft as illustrated in the second picture. This solution solves the location problem, but is still heavy. Evolution to hydraulic steering systems (third picture) helped solve this weight problem and gave the designer almost complete flexibility as far as positioning of

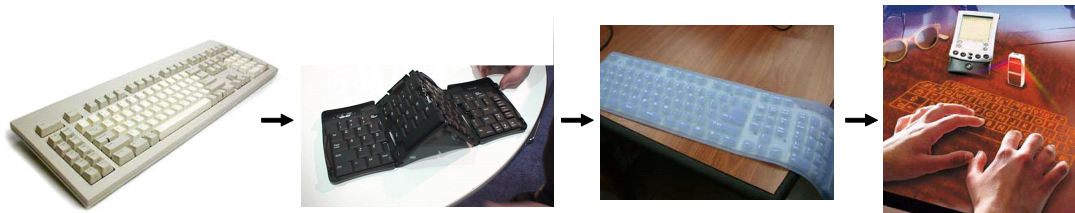
components under the hood of the car. Effective as they are, hydraulic systems also hit fundamental limitations. This time these limitations include the weight of carrying around the hydraulic fluid, the reliability and safety problems that can result from high pressurisation of the fluid, inability to recover braking energy, and certain dynamic behaviour instabilities. In the latest 'drive by wire' design solutions – a jump that the aerospace industry made several years ago – we can see yet another step-change advance, one that solves many of these problems.

Can you see a pattern yet? How about another example. This time the 'measuring distance' industry:



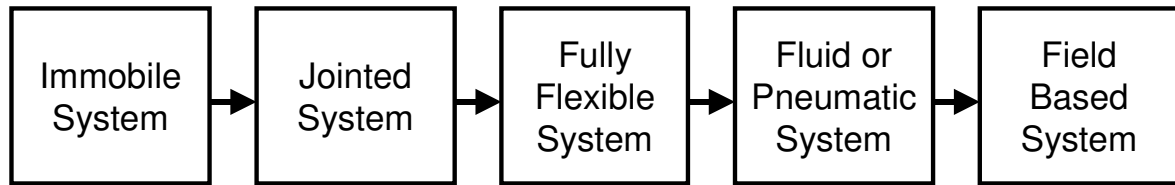
Again we can reverse engineer and see different fundamental limits at each of the stages – inconvenience, inability to measure long distances, weight, accuracy, safety, etc – but again there appears to be some kind of underlying pattern in terms of what each of the evolution stages looks like.

One final example should serve to cement the pattern. This time the focus shifts to the much more rapid evolution of the computer keyboard. The progression looks something like the pictures shown in this next sequence:



The reasons why the system has jumped from one stage to the next this time are generally speaking the same – the increasing desire to make the keyboard more compact. A folding keyboard folds up to form a smaller package than a traditional keyboard; a roll-up one is even smaller; while a projected keyboard effectively delivers the desired function of the keyboard, but now the keyboard is virtual.

What has happened in this industry is exactly what has happened in the previous four. We could find exactly the same evolution pattern if we chose to examine many thousands of other systems. From cameras to cell-phones, chairs to satellites, evolution has followed the same basic pattern. The pattern is reproduced in the next sequence. In the Systematic Innovation methodology the thing that brings this and other trends together, this pattern is called 'Dynamization'. It is all about how systems evolve in terms of how they achieve movement. The basic progression suggests that systems evolve from being static or immobile structures, to structures featuring one or more joints, to completely flexible systems to fluids or gases and then finally 'fields'.



Referring back to the earlier figures, it is possible to see that sometimes a system has leap-frogged a stage. In some cases – surgical cutting instruments for example – the system has jumped directly from scalpels to laser or ultrasound cutting devices (both of which immediately cauterise arteries and so the loss of blood following incision is close to zero). Sometimes the ‘field’ is different things – it may be a laser or ultrasound or magnetic, etc – all we can say in general is that it will be some kind of field at this final stage. Sometimes – as in the case of the Kevlar vest – the system hasn’t reached the end of the trend yet. This is where the trend becomes very interesting from the accelerated evolution perspective, since we can now examine the jumps that have occurred in other sectors that have not yet occurred with our product. Admittedly in this case, the idea of stopping a bullet using a fluid or, particularly, a field is difficult to imagine, but, if the trend is correct, then these would be good places to direct R&D efforts. More practically, we can see an evolution jump that is far more likely to occur in the near term when we look at the grass-cutting system evolution shown in yet another sequence:



Where do we think this system might evolve in the future? Based on the Dynamization trend, it seems a fairly safe bet that the system will eventually become some kind of a ‘field’ (laser?), possibly via an intermediate (water jet?) stage. Our discussion last month about systems evolving to a ‘free, perfect and yesterday’ end point will tell us that in the final situation, the need for a grass/weed-cutting device will disappear altogether. This will happen as soon as someone designs grass that stops growing when it reaches the right height. In the meantime, we have a good idea where to direct our R&D efforts if we were looking to get into this industry.

Try applying this trend to any other product you care to think of and we think you will find that it will be following this trend. Not every product will have reached the end yet – your cell-phone is probably at the first or second stage of the trend for example – in which case the trend should tell us what they will look like in the future. If your cell-phone has a flip-top, then according to the trend, in the future it will add more joints (check out the latest Samsung phones, which have already included a second joint so you can swivel the screen to different angles), and then it will become more flexible (so that perhaps we can wrap it around our

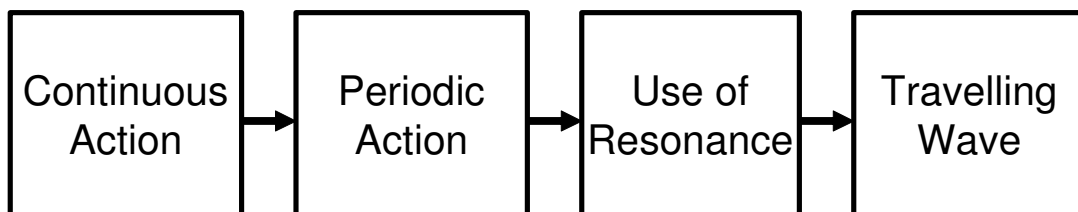
wrist, or fold it into a wallet), and then later on be transformed into some kind of fluid or field. We probably don't know how to make these last two jumps yet. Or why. At least not for the complete phone. If you can imagine a time when the voice recognition system on your phone actually works (at the moment, the state of the art is about 95% accurate, which turns out to be no use at all to impatient humans) then the keypad will disappear and we will activate the controls with our voice. Then imagine that the screen (another part of the system still at the first stage of the trend) will also disappear and become some kind of projected image. Each of these things is extremely likely to happen. The reason we can be so confident is that it is the exact same direction that three million other successful systems have evolved.

Yes, But...

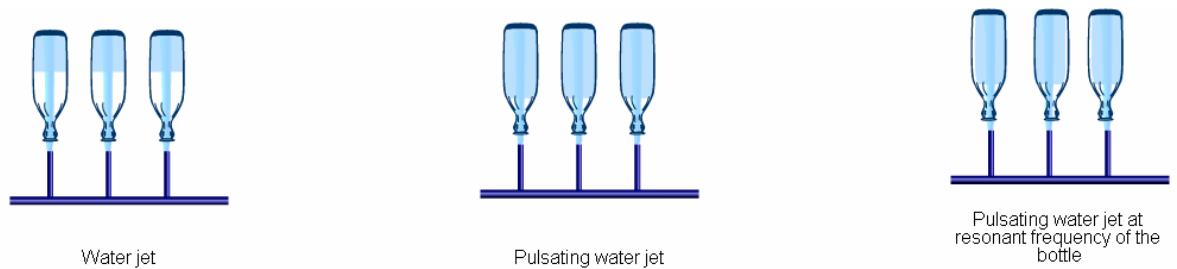
Perhaps as you read about these examples, your brain is thinking 'yes, but...'. Yes, but a laser grass-cutting system will be too expensive; Yes, but it might be unsafe; Yes, but you can't fit a projector into a tiny phone. Undoubtedly in any innovation these 'yes, but's...' will almost always be present. The big difference between Systematic Innovation and what normally happens when someone says those words, is that in Systematic Innovation 'yes, but' is a start point rather than an end. A 'yes, but..' means we have found a contradiction. Besides the future prediction part of the overall method, the next biggest part is a toolkit to assist in the process of eliminating trade-offs and contradictions. That subject takes us back to the discussion we started in the first part of the series, and forward to another part that we haven't seen yet. The main thing we need to keep in mind is that whenever a Trend direction delivers us a 'yes, but', someone somewhere has already solved that problem. In actual fact, we may be able to find the answer to our 'yes, but' problem by examining some of the other trends of evolution uncovered by the Systematic Innovation researchers. Note here that in the terms of the method, whenever we use the word 'trend' we are specifically thinking about the jumps that occur when a system overcomes a fundamental contradiction and jumps to another way of doing things and not the usual gradual directional shift we normally think of when we see the word 'trend'. Now would be a good time to examine one or two of these other discontinuous system-jump trends:

Rhythm Co-ordination

In all, depending on how the overall total is segmented, the Systematic Innovation researchers have uncovered 37 of these step-change trends. The trends seem to fit into three broad categories; trends related to the how products evolve, trends related to how processes evolve and trends relating to the way in which the interfaces between systems evolve. The Dynamization trend is primarily focused on physical system evolution. The Rhythm Co-ordination trend shown below is far more closely related to temporal evolution of systems.



Should we have the inclination, we could do for the Rhythm Co-ordination trend exactly what we have just done for the Dynamization trend. As with all of the trends, the pattern emerges from the analysis of many thousands of systems. A single example should suffice to describe how and why systems might evolve through the first three stages of this trend. The next sequence illustrates the evolution of a bottle cleaning process:



In the first stage of the trend, water is pumped continuously into the upturned bottle. Such a system makes good use of gravity to empty the bottle ('the bottle empties itself'), but uses a considerable amount of water. Process engineers later discovered that if they switched from a continuous to a pulsed water jet it was possible to get the same cleaning action with around 50% less water. Later on, the third stage of the trend – 'resonance' – gave the idea of pulsing the water jet at the resonant frequency of the bottle. Now not only did the pulsed hammer effect do a good job of cleaning the bottles, but the fact that the bottles were now also resonating meant that the cleaning effect was magnified. In fact the water consumption for the same cleaning action could now be reduced by over 75% relative to the original water-jet system.

Increasing Ideality

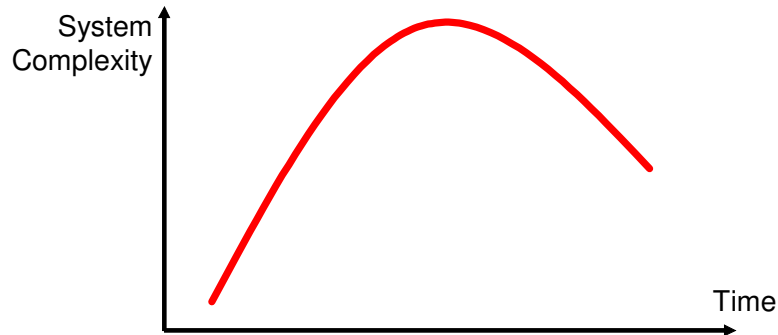
Both the trends described here, the other 35 technical trends, and the 31 thus far uncovered discontinuous business evolution trends we will look at in more detail next month are all consistent with the 'free, perfect and yesterday' direction discussed last month. This higher level trend involves the progressive evolution of systems to a state of higher ideality. Last month we defined ideality as all of the good things that a product or service delivers, divided by all of the bad stuff – the cost and anything else the customer decides is 'harmful'.

One of the gratifying aspects of this evolution direction is that over time 'harm' aspects will decrease. This is good news from an environmental and social perspective. The good news needs to be tempered slightly, however, with the knowledge that in the vast majority of systems, the customer will tend to opt for increased benefits (basically the useful functions delivered by the system that allow the customer to get done the job that they want done) or lower cost before they will go for lower harm.

The news gets slightly worse when we consider the other Systematic Innovation trends that underpin this increasing ideality trend. What many of these more detailed trends tell us – and the two selected for special consideration earlier both fall into the category – is that things often get worse before they get better:

A close examination of the Dynamization trend illustrated in Figure 6 reveals this 'systems get more complex before they get less complex' trend quite vividly. A system containing one or many joints is a system that is very definitely more complicated than a simple immobile system. It is only when we reach the 'field' stage in fact that we have the potential to create a system that uses less material resources than the earlier mechanical and fluidic systems. Likewise, in the Rhythm Co-ordination trend, creating the ability to turn a continuous action into one with pulsations almost invariably necessitates the addition of something to the system to create the desired pulsation. Once we have such a mechanism, the resonance stage comes somewhat more readily, and can often be achieved by simplifying the system (this is because 'resonant frequency' is a resource present in every system and so we don't have to

add anything new). The general characteristic that may be observed in both of these trends is reproduced in the picture below. The characteristic shows that allowing systems to evolve 'naturally' produces a period of increasing complexity – during which time, although customer benefits are increasing, costs and harms *may* be getting worse – followed by a period of decreasing complexity, when, having delivered all the possible or required benefits, the only remaining strategies for increasing net value are to reduce cost and eventually harm.



Here's another picture we've already seen in a slightly different form in the second article in the series. It is another of the really important underlying ideas behind predicting the future: Any given technical system may be at any given point in this increasing-decreasing cycle. Environmentalists may take some comfort, however, in the knowledge that as engineers make greater and greater use of 'fields' and less and less of mechanical solutions, that overall the world today appears to be in the 'complexity decreases' part of the trend. Think about the enormous increases in efficiency of jet engines or the extra-ordinary de-materialisation that has taken place in many construction materials to get a feel for why this might be so.

It is perhaps dangerous to speculate, but it would appear that increased knowledge of the Trends is creating the ability to accelerate the evolution of systems. The Trends in effect act as a signpost that says 'head in this direction in order to create a more ideal solution'. Such a signpost, allows users to potentially 'force' the evolution of a system such that systems can evolve from start to end without having to take the traditional detour via increased complexity. In some cases – using a 'field' to stop a bullet – the world isn't yet smart enough to know how to engineer such a solution. But in other sectors – and grass-cutting would appear to be one – the fruit hangs considerably lower.

The intellectual property generating possibilities once we are aware of the trends are considerable. So much so in fact that Systematic Innovation has been advertised as a 'secret weapon' in certain parts of Asia. A recently completed programme run by the Hong Kong Productivity Council, for example, has done much to make the Systematic Innovation trend tools available to companies in and around the region. By all accounts that programme has been very successful in not only facilitating the creation of considerable amounts of intellectual property, but also getting a number of new products and processes to market.

As we suggested at the beginning of this article, it seems that there are some very clear patterns underlying the way in which things evolve over time. These Trends provide clear guidance on the *what* of system evolution. Whilst it is doubtful that any of the trends can be proven to be correct 100% of the time, at the very least they offer a series of interesting guidelines for inventors, entrepreneurs and a host of other businesses that look set to have a profound impact on the innovation process. Take the investment banking sector for example. Here is a body of people who frequently work on the assumption that 19 innovation failures will occur in every 20 attempts. Imagine how this statistic might change if we could predict beforehand which attempted innovations had a chance of succeeding and which did not.

Investment banks make all of their profit from that 1-in-20 success story. Imagine the implications if we could even just double that ratio. What about if we said that in 3 million examples there was yet to be an exception. How would that change the figures? We think these trends represent the start of a sea-change in the way that business does business. The race is on to see who can make the best use of the trends. We have no doubt that the prize for those who use the trends to the best effect will be nothing short of spectacular.

Next month, we explore how the same predictable trend idea might be expected to create similar waves in the way that business and management itself may be expected to evolve in the coming years. Fasten your safety belts, it could be a bumpy ride.

Darrell Mann

Darrell.Mann@systematic-innovation.com