PETER HESSELDAHL
GROUND RULES FOR THE 21ST CENTURY
Chapter 13

# EVOLUTION DEMANDS CONSTANT ADAPTATION

It's one of the main challenges for industrial companies: Looking across the landscape of venerable and mature companies, it seems that almost all of them are struggling to move beyond what has so far been the very core of its success. The product or the business model that the company was originally built upon has begun to reach its limits. But for the organization it is exceedingly difficult to get beyond the mindset that it has cultivated over the years.

Polaroid is the archetypal example of a company that had tremendous success with one specific concept, in this case instant photos on paper. Although Polaroid expanded its business to medical applications, ID cards, design studios, etc., it never really managed to move beyond the original concept. The arrival of digital cameras that were able to play back snapshots instantly on its display meant the end of Polaroid. In 1992, Polaroid was number 27 on the Fortune 500-list of the world's most profitable companies. In 2001 the company went bankrupt, and since then the name has just barely been kept alive through a series of reorganizations and resuscitations. The organization is long gone.

## A key competence: the ability to adapt

In principle, numerous plant and animal species has gone through the same experience. Each found a niche in which they thrived for a while - until circumstances changed, and other, better-suited organisms took over.

Since time immemorial evolution has been the mechanism that has driven the blossoming of nature in all its diversity. The basic mechanism behind evolution consists of three elements: *variation, selection and reproduction*:
- New, preferably random variations and versions need to emerge
- There must be a certain scarcity, creating a competition for resources, which implies that not all variations survive.
- Finally, it should be possible to reproduce, so a successful variation can multiply, as long as there are sufficient resources to support it.

**Evolution is not just a biological mechanism. There is also cultural or technological evolution, and they work through exactly the same principles: variation, selection and reproduction. Charles Darwin described evolution in biology, but the same mechanism can also control the development of other complex systems.**

Eric Beinhocker, in his book *The Origin of Wealth,* has carefully analyzed economics and business from a complexity theory perspective. In his words "Evolution is an *algorithm*: it's an all-purpose formula for innovation (…) a program for creating novelty, knowledge and growth".
An algorithm is a program, a description of the rules, which govern a process. The evolutionary algorithm - variation, selection, reproduction - can be used to explain a wide range of development processes: How new ideas are born and developed, how

new products are designed and adapted in order to survive in the market, or why what skills you need in order to get a job changes over time.

It is not the strongest who survive

One of the objectives of this book is to highlight the increasing importance of understanding the mechanisms that control systems that are complex, dynamic and adaptive. Evolution is a central concept in this context. Evolution takes place precisely in systems where a number of players are interacting – they are *dynamic* - and the way evolution drives development is through *adaptation*.

Evolution is also closely linked with another key concept of complexity theory: emergence - the self-organization that can take place in complex systems where interaction between the components of the system lead to the emergence of qualities that are not found in the individual parts.

Evolution is a type of self-organization. It occurs from the bottom up. As the American philosopher Daniel Dennett says: "Evolution is design without a designer." A designer has a master plan and a clear goal. Evolution, in contrast, has no goals and no intention. Evolution produces solutions that work under the current circumstances, and it does so by ruthlessly weeding out the parts that are no longer fit. If you can't make it in the fight for resources, you will not be given a new round in the game. Sorry. It is not necessarily fair or sympathetic, but it keeps the system as a whole young and evolving.

Even the largest, greatest and most powerful must adapt when circumstances change. As Charles Darwin wrote in *The Origin of Species*: "It's not the strongest or the most intelligent species that survive, it is the one best able to adapt to change."

A few species have remained virtually unchanged over millions of years. Present day crocodiles are astonishingly similar to fossils of crocodiles, which are 230 million years old. The first sharks appeared over 400 million years ago, long before the dinosaurs, and the horseshoe crab, which is common in the Gulf of Mexico, is hardly distinguishable from its 440 million years old ancestors.

However, it is rare that a species can stay fit for so long. Generally evolution does not offer permanent solutions. Living conditions may change, and so may your competitors. If others are developing new tricks and fancy features then you will end up lagging behind in the struggle for resources, unless you can develop something that is even better.

It is often described as a red queen race with reference to Lewis Carroll's *Alice in Wonderland*, in which Alice and the Red Queen run a whirlwind tour through a landscape - without getting anywhere. Alice wonders, but the queen explains to her that "here you have to run as fast as you can just to stay in place."

**Adapt or die. That is the iron law of evolution and it applies to dinosaurs and dodos, as well as to companies or products. Evolution never stops. The world and the games we are playing keep changing, and what is smart today may be a handicap tomorrow. Therefore, the fundamental challenge for us all is stay adapted to the circumstances - staying *fit*.**

Small changes, big changes

Biological evolution typically stretches over thousands or millions of years. It takes a long time to build up an organism, one small mutation at a time. On the other hand, the results are then well proven and robust. For a single species, the evolution of new

features happens slowly, but the entire system and the composition of properties in it can change abruptly. Times change: One year, conditions are great for aphids, so they multiply dramatically. This provides lots of food for ladybugs, which then explode in numbers. Next season, the weather turns out different, so there are very few aphids, and the population of ladybirds crashes. These sorts of interactions in ecology are classic complex systems with feedback effects, tipping points and wild fluctuations. A species can quickly get caught out when conditions change.

In this context, the prospect of climate change is worth considering. It is likely to be a radical change of circumstances which affects virtually all elements of the ecosystem and whose secondary effects are impossible to foresee. It seems that we are facing a challenge of evolutionary dimensions. In the decades ahead, not only humanity, but countless other species of animals and plants will be confronted with the need to adapt or disappear.

The landscape of possibilities is changing continuously

Non-biological form of evolution can go through the same rapid ups and downs. Companies that have been tending steadily to their business for years can have the rug pulled out from underneath them from one day to the next - or they can experience a sudden, massive success.

Some years ago, the Atkins diet was all the rage. Suddenly, carbohydrates went out of fashion. Sales of bread, pasta and rice plummeted, and manufacturers of ready meals, cakes and even breweries scurried to develop low-carb products to compensate for falling sales.

At the other extreme, a Turkish manufacturer of shoes suddenly got extremely busy when an angry Iraqi journalist threw his shoe at U.S. President Bush during a news conference. Within a week after the episode, the shoe factory in Istanbul, which had manufactured the shoe, received orders for over 100,000 shoes of the same design, and the model was renamed, from "Ducati Model 271" to the "Bush-shoe".

Faced with large, deep change, even giants can be brought to their knees. For decades the U.S. auto industry has been extremely reluctant to change. The Big Three in Detroit - Ford, GM and Chrysler - fought tooth and nail against any additional requirements for safety, emissions and efficiency, and continued to build huge gas guzzlers in the tradition of the American dream of unbridled consumption and freedom. Meanwhile, Japanese manufacturers developed small, efficient and smart cars that are somewhat better adapted to a world with dwindling natural resources. As energy prices tripled in 2008, and the economic crisis hit at the end of the year, the car giants could no longer ignore the need to adapt or close. The industry had reached a tipping point.

Technologies die at their peak

The technical Museum of Berlin has a formidable, permanent exhibit on maritime history over 10,000 years. Through a wide range of beautiful models you can follow the development of sailing ships right up to the mid 1800's. The last sailing ship in the series is also the prettiest; a tea-clipper, slender and with a 4 mast rig, a thoroughbred sailor. Clippers could cross the Atlantic in 20 days and they brought tea, spices and silk from Asia with unprecedented speed. Yet the era of the sailing ships ended with the Clippers. The next model ship in the series at the museum in Berlin is built out of steel, a steam ship. It's heavy as a clog and almost ugly compared to the Clippers

refined and elegant lines. But the steamer was the future. Although the clippers remained significantly faster than steamships for years, they were not dependent on the winds. Motored ships were more predictable and could sail year round.
Reliability, however, was just one of a number of factors that worked for the motor vessels. They rode on the wave of new technologies of the industrial age. The invention of the Bessemer process in 1850 made steel much cheaper to produce. With the ship propeller, which was invented in 1862, motorboats became much more efficient and maneuverable than the previous paddle steamboats. Finally, the Suez Canal opened in 1869. It allowed ships travelling between Asia and Europe to skip the long trip around the south of Africa. However, the big sailing ships could not slip through the Suez. Within a decade, conditions had changed fundamentally, and after thousands of years sailing ships were no longer the most appropriate.
It is ironic that the clippers dead at their peak. They had a long evolutionary history. Every inch of them was optimized through hard-won experience. There had never been better sailing ships - and yet they were suddenly overtaken by something new and immature.
The proud sailing ships are not alone in their fate. Take a look at the technologies that have become obsolete in recent decades: tape recorders, cameras, movies, phonographs, typewriters ... each were developed to near perfection. Today they are cluttering the attics and sitting on dusty shelves, because their owners can't bear to part with what was once the pinnacle of technology.

Caught on a local maximum in the fitness landscape

What went wrong? Well, they were caught on what's called *a local maximum*.
There are usually several possible solutions to a problem, some better than others. When the first cars were developed around 1900, it was an open question, what kind of engine would be the most common. At the time, the steam engine was still a serious option, some experimented with electric motors and others again with the internal combustion engine. Each of these could probably have been further developed and would have worked well. As we know, the internal combustion engine ran away with the victory, but now, a one billion or so cars later, it seems that this technology is reaching the limit of how far it can be developed to suit future circumstances. Meanwhile, the electric motor has re-emerged because it may prove to be better fit for a time where we face a shortage of gasoline and the demand for low CO2 emissions is set to become a crucial factor.

The evolution of solutions can be illustrated by a "fitness landscape": One can depict all the possible solutions available to a problem as a landscape with mountains and valleys. The higher a point in the terrain, the better the solution at that point fits to the problem at hand. If you are standing in the middle of the landscape, you don't have an overview of where the highest point - and thus the best possible solution - is located. Instead, you have to try out the options one step at a time. With luck, you will find a mountain slope you can begin to climb towards an increasingly better solution.
If you have ever tried climbing mountains, you'll know the feeling: After a lot of effort you finally reach the top - only to discover that from there you can see many other, even higher mountains. If you want to reach those peaks, however, you first have to climb all the way down and then up again. The mountain you have climbed is a local maximum. From that point you cannot get any higher - but it is not necessarily the highest point in the whole terrain.

Let us follow the course that many successful products have followed, through the fitness landscape: A manufacturer has invented a new and superior technology, and for a long time the company develops its capabilities further, with increasingly better results. But at some point it starts to become harder continue the development, improvements are costly and come slowly and finally, there's really not much you can add to move further upwards. Meanwhile, competitors have also moved up the same hill, and now it's beginning to get crowded at the top. The only way to move forward in development implies that you must leave the mountain, which you just fought so hard to climb, and instead start over at the foot of another mountain that is higher.

Going back to the example of car engines, one could say that the industry has successfully climbed the mountain of possibilities that the internal combustion engine offers, but now it appears that the opportunities of the electric motor go higher. But if you've just spent the last hundred years developing internal combustion engines, it is very difficult to write off that investment and begin the exploration of the electric motor.
The clipper ships and the steamboat were both solutions to sailing freight around the globe, but the clipper had reached a point where it was hard to move up higher in improvements. Steamships, in contrast, were only just starting their ascent. For the proud builders of the Clippers, the problem was that almost none of their knowledge could be used to build better steam ships – the same problem that faced those who produced phonographs and film cameras.

**At the peak of a local maximum we are confronted with the evolutions inexorable demand to adapt or die.**

It's important to understand that the fitness landscape is not static. There are changes; circumstances shift and a new type of solution can suddenly shoot high into the air, while others sink. A few decades ago, CO2 emissions were not a factor that a company had to consider. But in the future it will be crucial for thriving in the market to have solutions, which affect the climate as little as possible. In the landscape of opportunities this means that companies, which rely on CO2 intensive technologies will find themselves on the wrong mountain.

Finally, the game is complicated by the fact that the participants themselves are involved in shaping the landscape through their actions. We develop new technologies, which sometimes become so widespread and so powerful that they change the world - and by extension, which solutions are most relevant in that world. Cars have made transportation easier and quicker, but the success of cars has also changed society altogether. Remote shopping centers, hour-long daily commutes, endless traffic jams and snarling city traffic – these are a secondary effect of the automobile, which in turn create new types of needs and help to define which technologies that succeed in the changed landscape.
It is *complex*, simply. There are dynamics, interactions and feedback loops. New patterns emerge and it is impossible to predict where it all leads.

The innovator's dilemma
Clayton Christensen, a professor at Harvard Business School, wrote the book *The Innovator's Dilemma* in 1997. The dilemma he described was exactly the one of approaching the top of a local maximum and discovering that the next mountain just

behind the peak is much higher. One can see that some small, shabby expeditions have started to accumulate at the foot of the new, taller mountain, but it will be some time yet before any of them reach the altitude that you have on your mountain. Should you turn back or continue a little further up the mountain where you feel at home? Clayton Christensen's point is that most companies continue to climb the familiar mountain, but suddenly it's too late to turn back. They continue until they reach the peak, and there they die.

Illustration: Innovators dilemma (product performance, hours)

Most technologies evolve as an S-curve: In the beginning, it moves upwards very slowly, but at some point the development gathers speed and the curve rises steeply. Somewhat later, the development starts to flatten out and eventually it stalls.
At the beginning of the curve, you work with a promising but still uncertain technology. A lot has to be invested in the development, before it is ready for mass market. Typically, the new technology is both expensive and poor compared to the solutions that are available already. The new special properties, which could ultimately make the fledgling technology attractive to the big market, are only appreciated in a few niche markets.
An example would be genetic testing. DNA tests were initially very expensive and time consuming and could only be used to investigate a few DNA sequences at a time. Moreover, it was still rather limited what you could use the sequences that were identified for. Science did not yet have a good understanding of how the interactions between specific gene sequences are expressed in human properties - and there is also still a long way to go. Overall, the early market for DNA tests was limited to niches, such as police investigations and paternity lawsuits.

When a technology is at the beginning of the S-curve, one of the greatest dangers is to launch it on the market too early. Enthusiastic investors and business developers are tempted to bet big on launching the latest revolutionary opportunities in order to gain a head start in the upcoming market. But often it turns out that the time is not ripe. This may be because the technology itself is not yet robust enough to function outside the laboratories, or it may be that consumers do not understand how to use it. Or the problem may be the lack of an infrastructure that can support the new technology - the surrounding system is not up to speed. At the time when users of the Internet went online with a 1200-baud modem, there was very little basis for e-commerce, since the network could hardly display photos, and money could not be transferred in a simple and safe manner.
As in nature, development begins with a lot of hopeful variations, and the vast majority of them die off before long. It's as if all new technologies must first go through a phase of false starts, initial bad investments and bankruptcies.
But after a time of adjustment, exploration and de-bugging, a new technology or new product gradually finds its form and a niche it can start to grow from. The market is ready, the price is right, the product is usable - and *then* things start moving fast forward. Typically, the technology is still so young that there is plenty of scope for further improvement and opportunities to expand the concept to ever-new markets and applications. So the new product – and the company behind it – breaks through and finally outperforms the incumbent companies whose solution now appears outdated and inadequate.

Technologies that are capable of completely changing the market are usually called *disruptive*. It is on the basis of disruptive technologies that new giant firms are established and fortunes are built. For companies that are lucky enough to possess a successful and revolutionary technology, it is important to scale quickly, by building an organization that can produce and supply goods to a rapidly growing market and by investing in further development of the technology's ability in order to maintain the lead. It's all about moving up the mountain of possibilities in a hurry.
So, returning to the terminology of evolution, what happened initially was that a number of new variations appeared. One of them proved to be fit, and now it is in the process of being reproduced.

Organizations evolve, from *disrupting* to *sustaining*
The rules change gradually in the next phase where the technology, which used to be revolutionary, eventually takes over most of the market. From being a niche product and a challenger of the existing technology, it becomes the new norm. Within a short time, consumption changes and suddenly everyone uses smart phones, iPods, email, Wi-Fi, flat panel displays and GPS - and afterwards one can hardly understand how we managed before, with the old technology.

After the initial rapid growth the market slowly starts to saturate. Virtually all those who may need the product have bought it, so an increasing proportion of sales are re-sales. The company has left what is called a *blue ocean* situation; where you are alone in the market with a solution that perfectly fits a market demand. Instead, the market has become a red ocean where competitors have smelled blood and flocked to get their share. The market is teeming with other companies who are producing their own variation of the product, often in cheaper versions. Profit margins decrease, and to compete, you need to focus, optimize, and increase sales volume. So you work on efficiency, introduce lean principles and acquire competitors.
Meanwhile, the technology has developed to a point where it starts to get harder to achieve further improvements. The technology has entered the upper part of the S-curve where the development levels off, where the market stagnates and it becomes increasingly expensive to develop ever more marginal improvements. It gets crowded, as you approach the peak of this particular mountain of possibility.

Somewhere along the way, a major shift has taken place – although the company itself may not even have noticed it: The innovation has gone from being *disruptive* to being *sustaining*. As Clayton Christensen explains, this is the point at which "excellent companies can do everything right and still lose their market position." For what does a great company do? It invests in becoming better at what it's already doing so well.

**It is completely rational strategy to focus on getting more out of the existing business rather than to embark on a costly, long term and risky bet on something entirely new. But the more you invest in the old model, the more you are stuck with a technology and a business model that is getting close to the top of a local maximum.**

If you can make it there, you can make it anywhere
Looking at the development of products and markets from an evolutionary viewpoint, the developing countries and emerging markets are particularly interesting. Compared

with the rich, industrialized countries, developing countries are much more dynamic. Currently, they are going through an upheaval of economic, technological and societal development at a pace and at a scale that comfortably exceeds the rapid development we went through during the industrialization.
Especially the cities in developing countries will be under extreme pressure. Virtually the entire planet's continued population growth will occur in developing countries, and at the same time, a very extensive migration from rural to urban areas is taking place. Billions of young people will be intensely preoccupied with finding solutions to survive under extremely challenging conditions.
A slightly cynical conclusion to draw from these trends is that one would expect such a strong evolutionary pressure to produce very hardy solutions. They are poor, it's tight, it's hot, and there are shortages of most basic resources: clean water, electricity, energy, food, transportation and sanitation. But there are mobile phones, TV and Internet access.
Someone will find new ways to survive under these circumstances, and the people who do so will have solutions on hand that are highly attractive to *many* people. It is not only the developing countries that will face the demand to manage with a minimum of resources – most of us probably will. The frugal and cheap solutions from developing countries may well be competitive in the market of the industrialized countries, too.

In the spring of 2009, the Indian industrial giant Tata launched the world's cheapest car, the Tata Nano, at a cost of approximately $ 2.500 for the standard model. And no, there is no car radio, no power windows, no power steering or air conditioning. There is only a rearview mirror in the driver's side and the engine has two cylinders and four gears. Seen from our part of the world, the most remarkable feature of the Nano are all the things that are missing: There are no airbags, no watch, and no glove compartment. There is not even a rear door for the small trunk, but the back seat folds down when you need to stove your baggage.
Tata Nano is targeted to a group of consumers for whom the alternative is to transport the whole family balancing on a motorcycle or scooter. The Nano costs around half of what the cheapest cars on the market used to cost, and this breakthrough in price means that it suddenly becomes a realistic option for millions of families who are moving up in the global middle class, to buy a car. The Nano does not compete so much with other ”proper” cars, rather it opens an entirely new market segment. Of course, it would be nice if there were carpets on the floor and if the head rests could be adjusted - but it is unimportant compared with the basics: that the Nano is a real car, with four wheels and seats, at a price you can afford.
As Clayton Christensen puts it: crummy is better than nothing.

<u>From the bottom to the top of the pyramid</u>
In his book *The Fortune at the Bottom of the Pyramid*, the late Indian-American economist C.K. Prahalad described numerous examples of how it can be good business to create solutions for the worlds poorest. The challenge is to develop products and services that are considerably cheaper than previous solutions. Prahalad gave many examples of solutions developed for the bottom of the pyramid, which have lowered the price by a factor of ten or more - for example, eye surgery, leg prostheses, AIDS and diabetes medicine, education, solar cells and mobile telephony.

As we saw with the Tata Nano, it is possible to sell a brand new car for less than $

2.500, if you cut away all unnecessary equipment and generally rethink the whole idea of what a car should be and how it must be designed and delivered.
If Tata can sell the Nano in India, there is good reason to believe that it will also be popular in many other countries where economic conditions are relatively similar. But Tata also aims to sell the car in the richer countries, albeit in a somewhat more expensive version that meets local government requirements for safety and consumer demands for comfort.
The effect is often called *trickle up*. Unlike the old paradigm, in which the technologies developed in rich countries gradually trickled down to consumers in less developed countries, now technologies developed for poor countries will begin to conquer shares in the rich markets.

There are a number of examples of products specially developed for emerging markets, which have proven to compete very well in the markets of the rich countries. The world's largest industrial company, General Electric, developed an inexpensive scanner to maternity hospitals in India, where you could not rely on a stable electricity supply. Therefore, the scanner can run on batteries and it's portable. Subsequently, the scanner has become a sales success in the U.S. market as well, partly because of price, but mainly because it can be used in ambulances.

Western companies are used to developing ever more sophisticated solutions to wealthy consumers, but it might be worth considering whether we could instead deliver the essence and utility of our products to a much larger market by rethinking the product to create price breakthroughs in the style of the Tata Nano.
This would make a company better positioned against other businesses that are simply lowering quality to compete by offering products that a just *Good enough*. Rethinking how a service or solution is delivered could open access to a huge market in the emerging economies, whose consumers are rapidly becoming more affluent and therefore gradually will demand new and more advanced solutions.

Leapfrogging
The word *leapfrogging* is used to describe how countries that have not already invested in the heavy and costly infrastructure, which the industrialized countries have installed, can leap-frog over the old generations of technology and move directly to new and better solutions. Perhaps they may even overtake us on the path to more modern technology because they do not have to take into account the depreciation and dismantling of existing infrastructure - and because, as newcomers, they are not mentally stuck in the old ways of thinking about providing a particular solution.

The obvious example is telecommunications. Many developing countries have no reason to install telephone cables for fixed telephony, because everyone is going straight to mobile phones. The spread of mobile phones has also made it possible for other industries to leapfrog. Using simple and ingenious systems based on mobile phones many banks, particularly in Africa, have begun offering their services to remote areas and people they could never have reached if they had to first build a network of brick and mortar branches. Now, the old banks in developed countries have gotten busy, trying to learn from the African banks so they can also offer their customers the advanced phone-based banking services.
One would hope that similar kinds of leapfrogging would happen in the developing countries' use of fossil fuels. Their energy consumption will probably rise sharply in

the coming years, and it would be wonderful if they could go directly to energy systems based on renewable energy, and to transportation systems that are not dominated by cars.
In principle, some developing countries in this way will have the chance to climb quickly to new heights in a future low-carbon economy - while the industrialized countries must first write off the technologies of the past.

If there is something you can learn from history, it’s that fortunes go up and down. In every country one can find ruins of what was once impressive, rich and thriving communities. Countless kings and dynasties evolved to impressive levels and then suddenly deteriorated again. Apparently invincible and superior civilizations - and yet one day, they became relics, overgrown with moss. The logic can change, circumstances change, one day it's someone else’s turn. We must live changing; otherwise we will end up in a museum.