Knut Samset

Beforehand and Long Thereafter

A look-back on the concepts of some historical projects

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Cover illustration: Channel tunnel. Historical picture of Napoleon's troops invading through a tunnel beneath the English Channel. From La Telegraphie Historique by Alexis Belloc (1888)

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1 Introduction

What is meant by a concept? It is a mental construction of a solution to a problem. A concept is fundamental in the sense that there conceivably may be several different concepts that provide alternative solutions to the same problem. Consider the example below:

Proposals have long been made to build a tunnel for ships through a mountain between two fjords on the west coast of Norway. Ships then need not sail at a stretch of the coast where the sea is particularly rough when waves are large. The idea made sense in the old days when ships were small and stayed close to the coast where the sea was at its worst. The ships of today are larger and safer and can sail farther out. Shipwrecks are happenings of the past.

Nonetheless, proposals have been made again and again by local authorities to build the tunnel with government funding. But repeatedly, they have been turned down on the grounds that the concept of a tunnel was not feasible, the net benefit would be negative. Instead, two other projects were conducted to improve safety at sea: (1) A shipping lane further out from the problematical areas near land, (2) continuous monitoring and reporting of wind and wave conditions, directly accessible via the Internet.

Now the project originators proposed a larger tunnel that could accommodate even larger ships. However, this concept is even less suitable, because its logic remains unchanged. A larger tunnel will be even less relevant (because larger ships are less affected by the problem) and less profitable (sincebecause construction costs would be far greater). Moreover, safety already is greatly improved, with modern and safer vessels, new shipping lanes and wave warnings.

In this case, there is one problem (safety at sea) and five different concepts to solve it (safer ships, safer shipping lanes, wave warnings, small tunnel, large tunnel). The first three concepts have already been implemented. The last two are irrelevant and expensive. The conclusion is self-evident: building a tunnel will be costly but will not lead to a similarly positive net benefit. The proposal should be rejected.

This book is concerned with the choice of concept and with how the concept with the greatest benefit may be chosen. It looks at ten projects in different countries, sectors and historical periods. The projects were chosen to illustrate essential criteria in the overall assessment of large projects according to the so called OECD model. The model requires that a project (1) exploit resources efficiently, (2) attain agreed goals, (3) have no appreciable negative effects, (4) be relevant with respect to societal, market and user needs, and (5) be sustainable in the sense that its benefit is realized over time.

What analyses of historical projects can reveal is what happened in a long time frame. They allow us to study consequences in the broadest sense. In turn, we then can verify if a project fulfils the success criteria above, and particularly the last two of being *relevant* and *sustainable*. The result often is startling.

This book is the result of a project in the Concept Research Programme at the Norwegian University of Science and Technology. The aim of the Programme is to help improve resource utilisation and impact of major public investment projects in Norway. Public projects with budgets in the billions are large and important, and some may be said to be spectacular. But history can reveal projects that are even more spectacular and groundbreaking - and in some cases even disastrous. . Much can be learned from these projects. They are worth examining in terms of today’s knowledge. And they can also be used as background to reflect on the usefulness of today's major public investment and the value of today’s governmental system for assuring the quality of these.

The resources available in this project have not made it possible to identify and verify of all aspects of the complex cases described. But that was not the intention. In a way, the project is an experiment that illustrates the diversity of information readily accessible via the electronic media of today. Internet sources have been used extensively, not least Wikipedia, with its extensive references and links. So some aspects of these tales written by a non-historian might be questioned, perhaps with justification. I hope then that the reader will excuse any inadvertent factual or historical errors and still benefit from this book. Many thanks to colleagues for inspiring comments and ideas, and special thanks go to Peder Berg in the Ministry of Finance, who has followed the project and shared from his great knowledge of history.

Trondheim, Norway, May 2012

Knut Samset

2 The judgment of history - traces in time

The Canadian professor of management, Henry Mintzberg[1], relates the following story to illustrate how history leaves traces in the evolution of technologies through the centuries.

The American Space Shuttle's booster rockets were built in Utah and transported to the launch site in Florida by train. The designers might have preferred to make them a bit fatter, but had to restrict the size because of the narrow size of train tunnel.

U.S. standard railroad gauge is only 4 feet 8.5 inches (about 1.4 meters).Why was that gauge used? Because that's the way they built them in England, and the U.S. railroads were built by English expatriates. Why did the English build them so narrow? Because the first rail lines were built by the same people who built the pre-railroad tramways, and that's the gauge they used. Why did "they" use that gauge? Because the people who built the tramways used the same jigs and tools that they used for building wagons, which used that wheel spacing. These were designed to match the spacing of the wheel ruts on the old, long-distance roads in England.

These roads were originally built by Imperial Rome for their legions after England was conquered, and have been used ever since. The ruts in the roads were all alike in the matter of wheel spacing so as to avoid wheel wreckage. The wagons were designed to be drawn by two or more horses in tandem.

What all this means is that a major design feature of what is arguably the world's most advanced transportation system, the Space Shuttle, was determined over two thousand years ago by the width of a Roman horse's ass.

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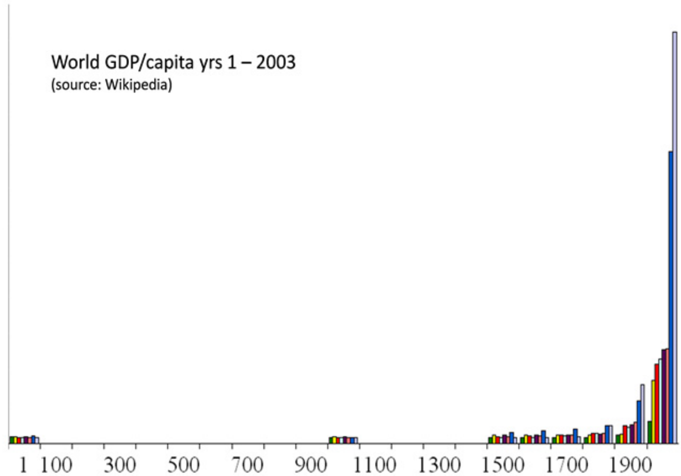
[1] For a more detailed version, see Henry Mintzberg et.al., "Strategy Bites Back", Prentice Hall/Financial Times, 2005, pp. 226-227

The history of technology is a story of evolution through gradual change and of simultaneous developments in different sectors. It also involves trends that with time are broken or strengthened. Moreover, breakthroughs that in practice may be small or major revolutions bring about new trends.



Economic growth, an indicator of technological development in the 20th century.

Throughout the 20th century, the number of scientific breakthroughs and technical innovations has grown exponentially. In turn, this has accelerated economic growth, as shown in the chronological bar chart below. The result has been profound changes in human civilization and in its impact on nature. Most of the examples in this book are from this dramatic exponential period, with its technical and economic breakthroughs, world wars, development optimism, and, finally the abilities and threat of the two superpowers to annihilate life on the planet.

Retrospective analyses may uncover numerous traces that go far back in time, as in the above example. At the same time, with hindsight, we see that some of these traces were useful, some were dead ends - and some even fatal. To a great degree, the history of civilization may be regarded as an undertaking involving the access to and use of resources on one hand to gain power and wealth on the other hand. Such an undertaking inevitably involves choices that favour the few. Many of these choices have far-reaching consequences, way

Ancestral cult Moai statues on Easter Island

into the future. For example, the ancestral cult of Easter Island led to deforestation. In turn, that led to conflicts, famine, and finally, helped by seafarers from abroad, extinction of the entire population. The Russian Revolution had fatal consequences for millions and through its authoritarian regime led to an arms race that could have wiped out a large part of the world's population.

But also, history will tell that the consequences of choices seldom are exclusively negative. For example, the invention and use of the internal-combustion engine probably is the technological development that had the greatest impact on economic growth of the 20th century. At the same time, it brought about exploitation of non-renewable energy resources and the emission of greenhouse gasses that many believe may lead to dramatic ecological changes on Earth.

3 The choice of concept – looking ahead and reflecting backwards

Among the numerous trends and technological and economic breakthroughs there are individual initiatives or undertakings worth closer examination. Today we call them “projects”. In Mexico there are urbanizations built thousands of years ago with such precision that it’s difficult to believe that they were built by engineers from Planet Earth. When Britain retained colonial control of British East Africa, the British Empire built a railway popularly called "The Lunatic Express". The line started on the coast of the Indian Ocean and went inland in what now is Uganda. The project led to thousands of workers dying of disease in squalor and to extensive battles with the natives. Labourers were brought in from India to build the line. They contributed to economic development but also to ethnic conflicts in the following century. In 1972 they were collectively expelled by the country’s dictator, Idi Amin. More than 100

The Great Wall of Chia

years ago, an extremely high tower was built in Paris. It had no purpose other than being an attraction at an exhibition. At the time, it must have seemed to be a meaningless waste of resources. But afterwards, the project proved to be a gigantic success in economic terms.

History is full of spectacular, epoch-making, irrational, successful or unsuccessful, well known or unknown projects. But first and foremost, there are many interesting projects from which we might learn something about the choice of concepts, how decisions are made, and what the long-term consequences of decisions may be. At the same time, history provides a backdrop for communicating the potentials and limitations inherent in essential decisions of our day. So the lessons of history may be useful in today's discussions of the choices of concepts. They also can trigger interest as well as be entertaining reading.

Aurland hydro power station turbine

As its name implies, the Concept Research Programme focuses on choices of concepts. Its purpose is to equip planners and decision-makers with know-how and tools to help identify and select more and better concepts relevant to a specific problem. The goal is to increase the economic net benefit of public investments.

This book is the result of a promotional project that intends to bring forth historical events as worthy examples to illustrate relevant problems in the field of project governance. The material is presented in ways that bring out the principal courses of events and not the many details. Experience suggests that most people are not much interested in how projects are conducted, but many may take interest in why project concepts are chosen. So spin-off effects may enter the picture, as the project concept is what the project manager is presented with, and is assigned to make come true in terms of a project.

The material that follows is arranged for ease of reading. Ten projects are described and analysed in Chapters 4-13. An overview analysis and conclusions are presented in Chapter 14. The questions to be addressed: What happened, why were things done the way they were, and what were the long-term results?

4 King Sverre the Frigate - “The Scare of Europe”

The Napoleonic Wars from 1800 to 1815 were conflicts between France on one side and Great Britain, Austria, Prussia and Russia on the other side. In 1807 Denmark was unexpectedly drawn into the conflict. Great Britain sought to keep the Danish-Norwegian fleet out of enemy hands. So Great Britain dispatched a large fleet that arrived at Copenhagen on 22 December. For four days, it bombarded the city with cannons and rockets.

Denmark capitulated and the entire fleet that was in port fell under British command. The loss for Denmark and Norway was enormous and consisted of 16 ships of the line, 10 frigates, eight brigs, several smaller ships and 92 transport ships. So then Denmark/Norway was at war with England. The British blockaded the coast of Norway, which was outgunned by the warships maintaining the blockade. Without warships, the Norwegians focused on defending their coast and coastal waters to keep English ships out of Norwegian harbours. In 1814, Norway had a fleet of just seven brigs, eight gunboats and about 100 lesser vessels.

Copenhagen in flames after the English bombardement. Ppainting by C.W. Eckersberg

There were several initiatives to rebuild the Norwegian fleet after the Norwegian Constitutional Convention May 1814, which ended the union with Demark and marked the beginning of the United Kingdoms of Sweden and Norway, effective of 4 November 1814. But the level of ambition surpassed the financial resources of a poor country. Little happened.

But the Norwegian merchant fleet grew rapidly after the peace accords of 1815 in Vienna. So there was a need for a Navy. Even so, years passed before the first Norwegian frigate was launched in 1828. It was built by the Naval Shipyard in Horten and named *Freia*, the goddess of fertility and war of Nordic mythology.

Battle between the Frigate HMS Tartar and Norwegian gunboats near Bergen in 1808 (Wikipedia)

The Naval Commission of 1818 had recommended rearming to 20 ships of the line, 32 brigs and 46 gun sloops. But the only ship built was the Freia. In 1833, a new Naval Commission downscaled the plan to four frigates, four corvettes, two brigs and 20 gunboats. Moreover, the main part of naval defence was to be the existing coastal squadron of 120 gun boats, 50 gun yawls and eight small steamships.

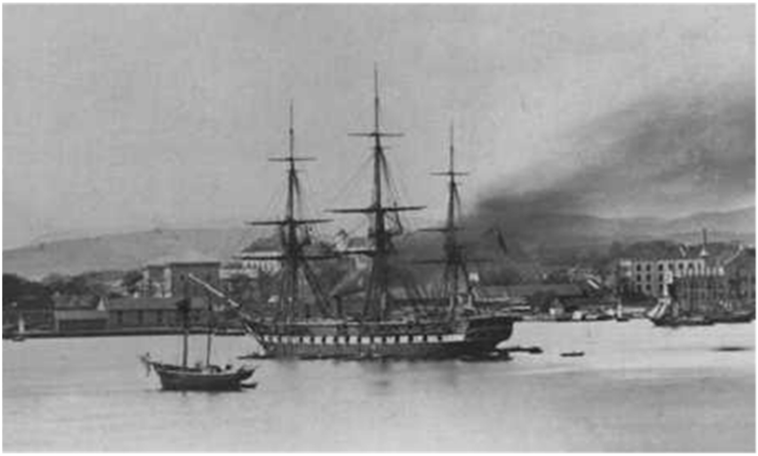
At the same time, significant technological breakthroughs were changing the planning of naval defence. Previously, spreads of sail and numbers of guns had been decisive in outfitting a warship. Steam power and explosive shell guns changed that. Steam power threatened sail power, and explosive shell guns enabled smaller boats to set wooden ships on fire. The Naval Commission's plan was to have been realized by 1851. But the fleet turned out to be smaller than planned. Only two frigates were built. In step with technological developments, the emphasis had shifted to smaller ships. Shells that exploded upon impact could cripple a superior fleet and made wooden ships particularly vulnerable. Moreover, smaller ships could be manned by smaller crews. So more could be spent on materiel.

The city of Tønsberg in 1868. The King Sverre frigate is in port.

By the mid-19th century, it as clear that the age of sail was over. Armoured ships had proven superior to wooden ships in the American Civil War. Steam-powered ships could outmanoeuvre far larger ships. Explosive shells could easily set a wooden ship afire.

Nonetheless, Norwegian Defence continued to build wooden sailing ships. A plausible explanation of this paradox might have been that naval administration had not kept up with developments. It was more concerned with the problems of the new technologies and less aware of their advantages. One argument was that coal was expensive whilst wind was free. Besides, a steamship was helpless if its motor failed, which of course could happen.

Driven perhaps by a wish to overcome a feeling of inferiority and be noticed, little Norway decided to build the world's largest frigate, The King Sverre, nicknamed in advance "the fright of Europe".



The King Sverre at anchor. It had a 1800 HP steam motor that alone enabled it to sail at 11.5 knots. (Oslo Municipal Museum)

Navy ship building inspector Håkon Adelsten Sommerfeldt designed The King Sverre. It had a displacement of 3500 tons and a length of 110 metres. That made it three times as large as the largest merchant vessel ever built in Norway. In 1858, building of the ship started at Slagentangen, led by Hans

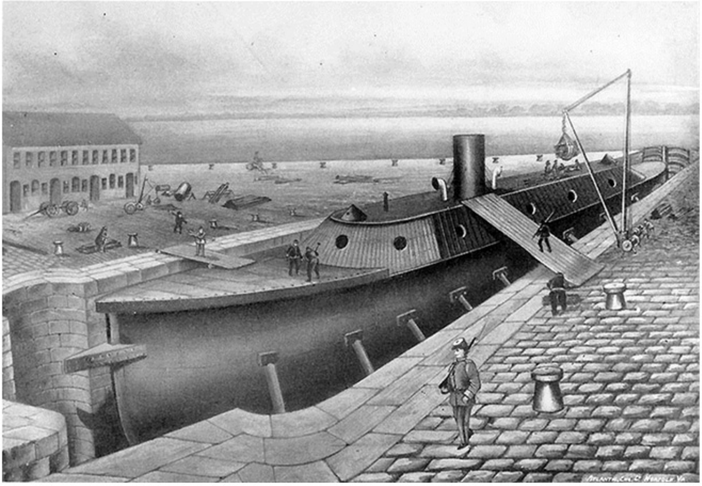
Bakkeskau. The hull of the ship was made of Italian oak, up to 50 cm thick. Building and commissioning took time. The ship was finished three years after launch.

It was a frigate with modern, powerful guns and a crew of 600. On each side of the ship there were 44 cannons in two rows. The anchor hawser had a diameter of 18 cm and was 200 m long. After it arrived by rail from the rope-walk, 120 sailors carried it from the railway station, accompanied by a Naval band, moving through the streets like a giant sea serpent to the shipyard. The masts of The King Sverre were 66 m tall, taller than the Oslo City Hall of today. In addition to its sails, it had steam power and could attain a speed of 12 knots. Its building cost was 570,000 rixdollars, equivalent to about NOK 2 million (0,4 million USD). Compared to the financial capability of the country, that was much more than the cost of a modern Norwegian frigate.

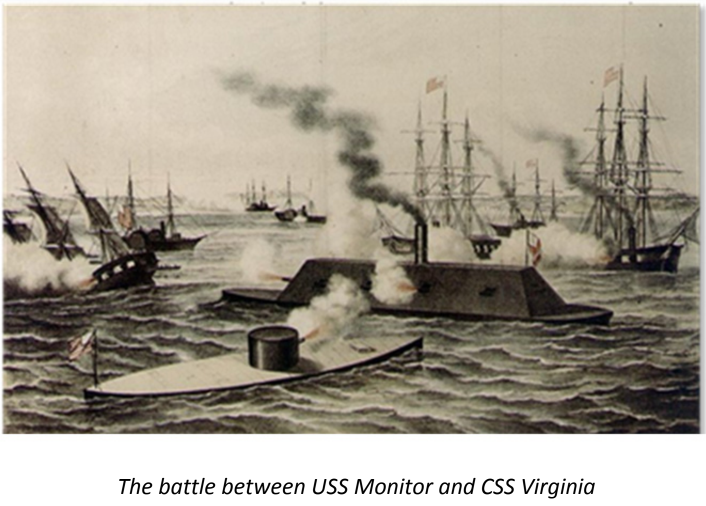
On 11 April 1864 it ceremoniously started operations, under the command of commodore C.H. Valeur. But four months later, after its first cruise, it was taken out of service. The inevitable had become obvious. The frigate was too expensive to operate. And it was insignificant as a warship.

For 30 years, The King Sverre was laid up in the inner harbour at Horten. In 1894, its machinery and armaments were removed and it was unrigged. A roof was built over the top deck and the ship was decommissioned and used for training and lodging. For 20 years it lay empty and abandoned in the harbour. There was an effort to collect funds to preserve the ship for posterity. It was unsuccessful. The once proud ship was towed from Horten to Stavanger to be broken up. Only a few parts of the ship remain. Some of its decking has been used for flooring in The Shipowners' Association in Oslo and the Naval Museum in Horton. The "Sverre Hall" of the Sola Strand Hotel is built of the frigate's woodwork.

In retrospect, it's easy to see that the project was obsolete from its planning stage on. But was that so obvious then? We know that before The King Sverre was launched, the major powers had begun building propeller-driven steam warships of iron. And at the time it had become obvious that fixed broadside cannons were effective only in close quarters, so they were being replaced by gun turrets and longer-range guns. Iron cannonballs were replaced by cylindrical projectiles that exploded upon impact and caused far greater damage. It also was obvious that large ships were clumsy and difficult to manoeuvre as well as themselves being large targets.



The captured frigate USS Merrimack being rebuilt as the ironclad CSS Virginia



The battle between USS Monitor and CSS Virginia

Armouring of warships had become commonplace, from the Crimean War of 1853-56 on. In 1862, during the American Civil War, the USS Monitor and the CSS Virginia had famously met in the Battle of Hampton Roads. The Battle ended indecisively, as both ships were iron clad. It was the breakthrough battle that proved the worth of ironclad ships. That certainly must have been known in naval circles, at least before the building of The King Sverre began. So Norway's showpiece was doomed to be one of the country's biggest white elephants, even before it was built.

There's an obvious parallel to today's Nansen-class frigates that were built in 2003-2010. They were built to replace the five Oslo-class frigates built in 1964-66. At the end of the concept phase in 1997, the goal was to procure six frigates of which two were to be training ships in port, two were to be reserve ships and only two were to be operational in the North Atlantic fleet. The ships were delivered at an average cost of NOK 4 billion each (0,8 billion USD).

At the christening of the first frigate, The Fridtjof Nansen, Minister of Defence Kristin Krohn Devold implied that the frigates were a poor investment. In an interview, she said that she was pleased that the decision to procure the frigates hadn't been made during her tenure as minister. Her assessment was probably based on two conditions. First, the race in weapons technologies had obsoleted frigates. Second, the political landscape had changed and reduced the military threat significantly.

Again, the question arises as to whether defence planners and decision-makers were aware of these aspects when the plans were made.

In weapon technologies, the new frigates suffer from the same mindset that troubled The King Sverre 150 years earlier. Their technologies were relevant during the Second World War, in service as escorts for large ship convoys. The present frigates are too slow to hunt submarines or to serve as weapon platforms for attacking other targets. At the same time, they are vulnerable to attack by smaller vessels, submarines, aircraft and missiles. Nor are they suited for their current task of pursuing Somalian pirates in tropical waters.

Obviously these conditions were well known in defence circles when the project was planned.

The political landscape had changed considerably since the days of the Cold War, when Norwegian politicians mostly agreed on the threats in the Nordic region. The small NATO country of Norway feared its giant neighbour, the Soviet Union. In 1985, Mikhail Gorbatchev became the General Secretary of the Communist Party and initiated a chain reaction of political changes. In October 1986 there was a summit meeting between Gorbatchev and Ronald Reagan on Iceland. The disarmament agreement of December 1987 ended the arms race. In 1989, the Soviet Union withdrew from Afghanistan and the Berlin Wall fell. The Warsaw Pact was disbanded on 1 July 1991, and the Soviet Union ceased to exist on 26 December that year. So the Cold War had been called off long before the frigate project was approved.

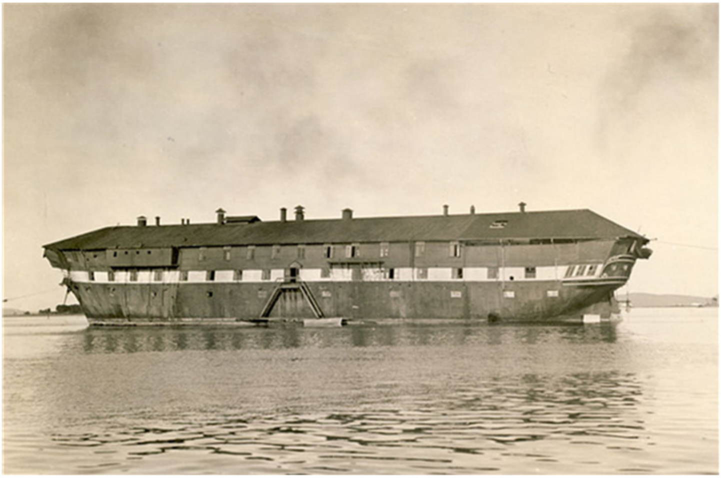
The first frigate of the Nansen class, the KNM Fridtjof Nansen (F 310), at the quay in Oslo

Assessment

Today's situation is that Norwegian Defence has five frigates, of which two are operative and three are training or reserve ships. The Navy has no tasks for the ships. One of them patrols for pirates in the Gulf of Aden. The operational costs are so high that the ships most likely will stay in port for years to come. The technical complexity is very high and it probably will be difficult to maintain sufficiently large, adequately skilled crews.

The King Sverre stayed in harbour for 50 years before it was broken up, because in 1932 the tiny amount of NOK 32.000 (about USD 5,000) had not been collected to preserve it. It then was sold to the Stavanger Skibs-

Ophugnings Co. AS ("Stavanger Ship and Shipbreaking Company") for NOK 20.000. If today's frigates are to avoid a similar fate, it's believably best that a buyer for them be found, if possible. How much of the initial investment of about USD 4 billion that could be recovered is unknown, though probably very small.



The King Sverre was taken out of service, stripped of its rigging and used as a training and lodging ship

History suggests that despite the 150 years between them, both cases suffered from path dependence. That is, one does what one did last or what one always has done. Decisions are made without sufficient reflection on the choice, or orientation on changes in the past and the future that may point to other more relevant solutions. If that is to be done, what might be the problem must be thoroughly analysed before solutions to it are sought. However, the most common error is that the problem is formulated as the absence of a particular solution. Consequently, the action space is constrained to that one solution.

In 1850, the problem was not that Norway had no large frigate. That wasn't the case in 2000 either. The problem in both cases was that defence was weakened, in 1850 because England had captured Norway's warships and in

2000 because Norway's frigates were too old and were scheduled for decommissioning. However, in both cases the military technology of the day suggested that other weapons systems would be more relevant. The consequences of such misjudgements are small in peacetime and can be expressed in monetary amounts. But in wartime, the consequences of the wrong choices are far greater and may affect the political landscape and cost human lives.

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5 The Eiffel Tower - national pride and vanity on display

Monuments always have been built to honour famous people, commemorate significant events or pacify superior beings. Looking back, we're easily overwhelmed by the scope and resource consumption of such projects. The building of the pyramids is a good example. The stone statues on Easter Island is another. The Eiffel Tower is a structure that falls into this category, but not quite.

The World's Fair in Paris was held in 1889 to commemorate the 100th anniversary of the beginning of the French Revolution. That's also said to be the reason for building the Eiffel Tower. Another equally plausible reason may be that the Fair just before the turn of the century provided an opportunity to show French technology and engineering feats to the world. Despite its colossal dimensions, the Tower was intended to be temporary and stand for just 20 years. At the time that must have been astounding. The immense size of the construction is equally impressive today, more than hundred years later.

Maurice Kochelin

The tower was an expensive exhibition object intended to show off France as a leader in science and technology in a dazzling, barrier-breaking way. In that it succeeded, first and foremost apparently because of its enormous size.

But at the same time, there were many who felt that it was a meaningless enterprise. Even today, its size and the initial intent that it should be temporary remain a mystery. At the same time, with hindsight the Eiffel Tower may be said to be among the most successful and profitable projects that ever have been built.

Maurice Koechlin's original design

Tall towers of iron were first proposed in the mid-19th Century. Engineers in several countries had suggested that with iron, taller monuments could be built, instead of building obelisks and monoliths in stone. At the time, the French entrepreneur Gustave Eiffel was a well established and well known engineer. At the age of 33, he had started his own engineering firm and had designed railway bridges, aqueducts and railway stations in many countries. Not least, he had produced the supporting interior framework for the Statue of Liberty in New York. It was made in 1885 in France in parts that were shipped across the Atlantic, assembled, and covered with a copper skin before the unveiling in 1886. Eiffel was an ambitious man capable of succeeding.

In 1884 he assigned two of his engineers to design a high tower for the International Exposition in Barcelona in 1888. They were Maurice Koechlin, who had been responsible for the Statue of Liberty, and Emil Nouguier. They proposed an extremely tall, spectacular tower. However, neither the Exposition organizers nor the citizens of the city liked the proposal. The conclusion was that the tower was an unsuitable, expensive structure unacceptable to the cityscape. After that rejection, Eiffel decided to submit the tower proposal to the arrangers of the World's Fair to be held the next year in Paris. He patented the design of the structure that permitted building to heights of over 1000 feet, or about 300 metres. In other words, the proposal relied heavily on the magic of numbers.

Stephen Sauvestre

Architect Stephen Sauvestre then was engaged to give the tower a design that would appeal to the French organizers. Eiffel's plans were accepted. The tower was to be located so it would form the entrance to the Fair grounds. But there was considerable opposition to that decision. The Tower was said to insult French tastes and aesthetics. Famous writers, such as Guy de Maupassant and Alexandre Dumas dismissed the Tower as a product of the "*baroque mercantile fantasies of a mechanical builder*". Eiffel's retort was that the Tower was beautiful. He claimed that engineers are as capable as artists in creating aesthetic objects, because "*harmony is a basic precondition for building something sufficiently strong*". Moreover, he pointed out that as engineers could build colossal structures, they also could go beyond the barriers of what artists could accomplish. The Eiffel Tower was to be twice as high as the towers of Notre Dame and the largest pyramids in Egypt. For its time, that was remarkable.

Eiffel's permit for the Tower was valid for 20 years. According to plan, it was to be dismantled in 1909. Retrospectively, there's cause to doubt that the original design by Eiffel's engineers would have stood so long had it been built. It was no doubt the architect's far better design that ensured Eiffel's success. In other words, it was architect Stephen Sauvestre and the engineers that were responsible for his good luck.

Eiffel himself was a building contractor and businessman who realized an idea. But he wasn't directly involved in the design, as often believed. His genius was in the technology of building. He was a leader in the use of wrought iron in large structures. But he also knew how to carry through so large a project.

The secret of its success lay in meticulous preparations that not only shortened construction periods but also made projects far less expensive than those of competitors.

Fifty engineers worked with design and produced more than 5000 constructional drawings. All structural parts were accurately calculated and produced with great precision. A hundred men worked to produce the iron components. The thousands of parts were delivered to the site in the sequence that they were to be fitted. They were numbered and fitting was accurately planned and described. Some 132 workers fitted the parts on the site. The wrought iron parts were riveted together with 2.5 million steel rivets. The total weight of the structure is more than 7000 tons. The Tower was built in less than two years. And there was only one fatality, a sensationally low number at that time. The total cost was 7.8 million French Gold Francs, equivalent to about 125 million Euros at today's gold prices.

The Tower was finished by the time the Fair opened. Upon closure six months later, the Fair had drawn two million visitors and had earned enough to cover an appreciable part of the construction costs. Soon thereafter the Tower proved profitable.

Gustave Eiffel

Its design ensured its success and made it a historical monument. It became an icon and an unrivalled tourist attraction. Arch-critic Guy de Maupassant stood firm in his view that the Tower was an eyesore, but later had lunch in the Tower restaurant every day. Upon being asked why he ate there, he replied that it was the only place in Paris from which he could not see the gigantic structure.

In addition to being a tourist attraction, the Tower has been used for research in meteorology, astronomy and physics. In 1898 an antenna was mounted on the Tower to initiate the first wireless telegraph in France. Eiffel worked to promote socially useful functions of the Tower. After the turn of the century, it was used for radio broadcasting and military communications. Together with its popularity, these utilitarian functions led to it not being dismantled in 1909 but kept as a national monument.

During the German occupation of Paris in 1940, the French cut the Tower lift cables, so Hitler could not take the lift but would have to climb stairs when he visited the city. The Germans could not get parts for the lift, so soldiers climbed the stairs to the top to fly the Nazi flag. Hitler chose to stay on the ground. That pleased the citizenry. It was said that Hitler had conquered France but was defeated by the Eiffel Tower. In August 1944, as Allied forces neared Paris, Hitler ordered the German governor of the city, General Dietrich von Choltitz, to destroy the hated tower. But the governor disobeyed the order. A few hours after Paris was liberated in 1945, the French had repaired the lift, which then functioned normally.

These events underscore how symbolic the Tower had become for the people of France. Looking back, the Eiffel Tower has been a unique tourist attraction and has contributed to strengthening the image of Paris and France in the world. In 2002, the total number of visitors to the Tower passed 200 million. The socioeconomic benefit of the structure has been considerable due to its spin-off effects, particularly tourism. Moreover, the Tower has been extremely profitable for the city that acquired it in 1909 at no cost, as contracted with Eiffel, and has benefitted from the proceeds for more than 100 years. It has remained profitable, despite considerable operation and maintenance costs. Every seven years it must be painted. The work takes 15 to 18 months, and uses 60 tons of paint.

Assessment

As a project, the Eiffel Tower is interesting because it breaks with deeply ingrained perceptions of the prerequisites of success. It came about by chance as a temporary measure with no clear goal and no rooting in existing problems. It was completely oversized physically and financially relative to its initial task. It was an obvious candidate to be the greatest financial fiasco of its time. At the same time, it's obvious that its combination of size and design made the structure a national and then international monument that innumerable people have come and paid to visit for more than 120 years. That's unique. The Eiffel Tower was the world's tallest building until 1930, when it was surpassed by the Chrysler Building in New York. But it is so tall that 100 years later, the world's tallest building (Petronas Twin Towers in Malaysia) are only 50% taller.

In other words, the structure was a breakthrough in what was believed possible, so much so that it impressed the world. It is still the world's best known and most visited tourist attraction. There's also good reason to be impressed by the planning and conduct of the project. It took less than three years with the construction machinery of its time. It was completed on schedule and within budget, almost without accidents.

But ultimately, its success in this case may be ascribed to the timing and to the state of technology at the end of the 19th century. Iron and steel as building materials permitted large latticework constructions. Railways and the telegraph had made transportation and communication more efficient. And electric lights had prolonged the working day. These factors as well as low labour costs provided the basis for industrialization and for technological breakthroughs. The events took place in a period of optimism and vitality, a golden age of admiring beauty, new inventions, Art Nouveau, luxuries for the new rich, and peace between France and its neighbours in Europe. In retrospect, the period is known as *La Belle Époque* ("The Beautiful Era") that was brutally terminated when the First World War broke out.

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6. Laugstol Works - the spark of a country's electrification

Mountainous Norway seems naturally made for hydropower production, in both its topography and its geology. About 40% of the land area is at an elevation higher than 600 m above sea level. Glaciers gouged and formed the land so much of it consists of large plateaus at elevations of 600 m to 1200 m, and valleys are U-shaped. Such a landscape is better suited to energy storage of quantities of water than areas with pointed peaks and V-shaped valleys made by river erosion. The climate also is favourable. Norway has high precipitation levels, averaging 1.5 metres a year, with some areas up to six metres a year. Evaporation is moderate due to relative low air temperatures. So water power is one of the country's prime natural resources.

Water power was used as early as the Viking Age, when a water wheel (now called a Norse Wheel) was used to grind corn in a tub mill. In the 16th century, water wheels were used in mining to drive lifts and crushing mills, pump water and power bellows. With time, water power was used in pulp mills, in cellulose and paper mills and in other industries. Not least, water powered sawmills were vital. They were built on rivers, and towns and cities grew up around them.

In the mid-19th century, Norway was a backward country dependent on other countries for knowledge, materials, services and most industrial goods. The population was 1.4 million, and Kristiania (now Oslo) was a small, sleepy city with 30,000 inhabitants. The crafts and commerce dominated business. The craft guilds were abolished in 1839. Industrialization started gradually, principally in Kristiania. Many industries were set up along the Aker River (see map).

Water power provided the energy for Norwegian companies. By 1870, some 1644 industrial companies were registered in Norway. Of them, 1174 used water power, 277 were powered by humans or horses, 177 by stationary steam engines and 96 by a combination of steam and water power. Industrialization was rapid.

In the last half of the 19th century, technological breakthroughs came one after the other round the world. In 1820, the first turbine probably was developed in France by Benoît Fourneyron, who called it a hydraulic motor. In 1866, the first dynamo was made in Germany. In 1876, Henry Woodward patented the first electric light bulb. He sold the patent to Thomas Alva Edison, who conducted the first successful test of an incandescent lamp in 1879.

1835 Nitedal Krudtverk
1836 Foss Bryggeri
1842 Aker Mek Verksted
1845 Nydalens Compani
1845 Graahs Spinderi
1845 Ellindalen Spinderi
1847 Foss Spinderi
1848 J.&A. Jensen & Dahl
1849 Brødrene Hals Pianofabrikk
1849 Langaards Tobaksfabirik
1849 Hjula Veveri
1850 Lilleborg og Kildals Fabriker
1951 Myrens verksted
1853 Kværner Brug
1854 Christiania Spigerverk
1854 Nylands Verksted
1854 Frydenlunds Bryggeri
1855 Christiania Bryggeri
1856 Eger & Co.s Bryggeri
1856 Christiania Seildugsfabrik
1856 Christiania Mek. Veveri
1859 Holms Hattefabrik
1860 Nitedals Tændstikfabrik

25 years of industry start-ups in Kristiania, most along the Aker river

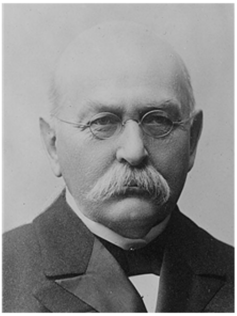
In Norway, the knowledge and experience of centuries led to using water power to produce electricity. At first, several small plants were built to provide companies with lighting. In 1876, the first was built for Lisleby Works in the town Fredrikstad. It was installed by the owner's nephew, who had acquired the agency for selling Grammes dynamos in Norway. It was powered by a stationary steam engine and consisted of a dynamo and two arc lamps for lighting. That was a year before streets were lighted by arc lamps in Paris.

Electric arc lamp bought by Lisleby Works in 1876 and used in the first electric lighting system in Norway. Height 69 cm. (Norwegian Museum of Science, Technology and Medicine)

In 1882, water power was first used to produce electricity for Senjen's Nickel Works in Troms County, which was owned by Sir Henry Hussey Vivian of Cornwall in England. It probably was the world's first facility of its sort. It consisted of a large Grammes dynamo that supplied electricity to eight arc lamps with carbon electrodes. The electrodes burned up slowly and had to be changed every third hour.

At the time there were two visionary men in the Skien area that were to initiate a technologically revolutionary project. One was Hans Abraham Hansen Bakken, who was a forest owner, miller and Haugianer (Norwegian puritan movement of the time). In 1860 he had seen a note in a German newspaper on an invention pulverizing wood so it could be used in papermaking. After reading the note, he remarked that "*the price of wood pulp is higher than that of rye flour, and* *the price of wood is less than that of rye. So there's money to be made in pulverizing wood."*

Fired by his protestant belief, he felt called to using his resources and abilities to serve God. In 1869, together with his son H.C. Hansen and his son-in-law Nils Kittelsen, he began experiments in grinding wood to pulp. They were among the country's pioneers in wood pulp production. The first had been engineer Christian August Anker, who in 1867 built a pulp mill in Fredrikshald (later Halden) and exported pulp to Great Britain.



Gunnar Knudsen

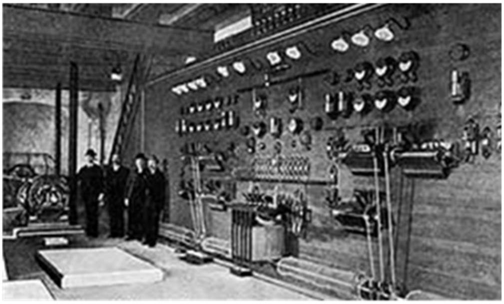
H.C.Hansen

N. Kittilsen

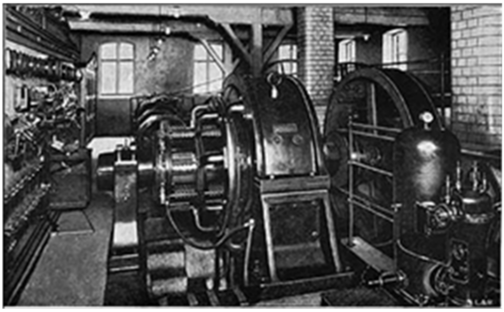
The other founder was Aanon Gunerius Knudsen. Later he chose to be called Gunnar Knudsen. He was the son of a shipbuilder and shipowner in Porsgrunn town. As his father wished, he started law studies in Kristiania. But he dropped out in favour of engineering studies at Chalmers technical college in Gothenburg, Sweden. Thereafter, he worked as a naval engineer at the Akers Shipyards In 1869-70 and then Sunderland in Scotland in 1870-71. A year later, when he was 24 years old, he and his brother took over their father's shipyard and most of his ships. So he then was both a shipowner and an engineer.

Gunnar Knudsen was preoccupied with the new inventions of the era and the uses to which they could be put. The next year, when he was 25, he formed a partnership with plant owners H.C. Hansen and N. Kittelsen, as well as others. They started the Laugstol Works pulp mill. The company had a solid foundation. Through its owners it had access to large forests and the rights to use the four metre fall of water between Hjelle Lake and Brygge Lake in the middle of what now is the city of Skien. The company then delivered spruce wood pulp to Manchester and ash wood pulp to France, Spain and Italy.

In the beginning, the large grinding stones were driven directly by water power transferred to line shafting and flat belts in the factory. Knudsen believed that water power could be used to produce electricity for production. Rebuilding was planned and the machines bought. On 1 October 1885, electricity production started at Laugstol Works. It used a Francis Turbine made by Myrens Works in Kristiania and supplied enough electric power for 120 arc lamps. That met not just the company needs. Some of the power was sold to subscribers in the city of Skien. So Laugstol Works became the first electric power plant in Scandinavia to sell power to customers. That was the historical event that triggered the electrification of Norway.



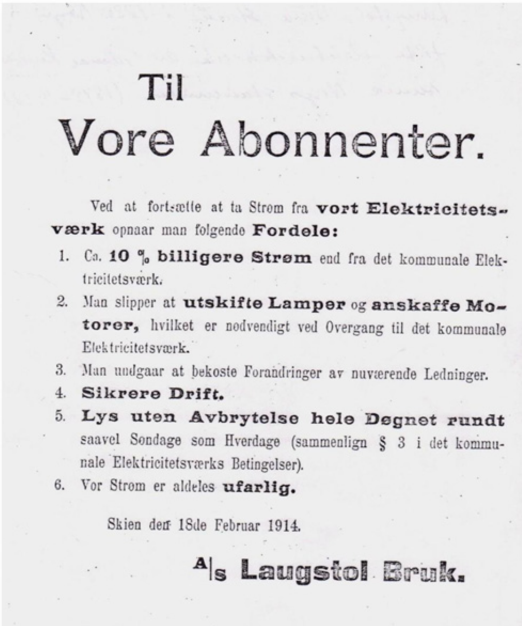
Control room of Laugstol Works, 1885



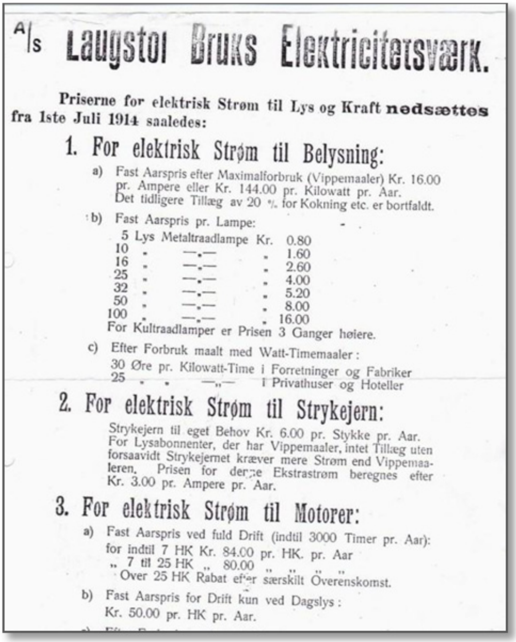
***Generator.** The 1908 machine was connected to a wood grinder at one end and a dynamo at the other end.*

In 1886, the first dynamo was destroyed in a fire. Three years later, a new facility was operational. Its generators supplied power to 1100 arc lamps and made the plant a financial success. Within a year, in addition to meeting needs at the Works, the plant supplied electric power for lighting to the city hall, church, public baths, some streets, harbour authority and some private manufacturers. The facility had a capacity of 1100-1200 horsepower.

At the time, electricity was expensive. Converted to the price levels of today, electric energy delivered by the Laugstol Works cost NOK 30 per kWh (about 5 USD). Today's spot market price is less than NOK 1 per kWh. In 1885, the first arc lamps cost NOK 12, equal to NOK 700 today (120 USD). But prices fell, and 30 years later, an electric lamp cost NOK 0.40, equivalent to NOK 20 today. The Laugstol Works expanded to meet the demands of an increasing market for electric light. The first underground electric cable was laid in 1891. In 1908, the Works installed a turbine that powered a shaft with a dynamo on one end and a pulp grinder on the other end. So power for lights could be generated at the same time wood was ground to pulp. In 1913, the electricity supply network covered the whole city. In that year J. Borchsenius wrote that: *"It's interesting to ponder what it was like for a spectator outside Laugstol that evening in 1885, when the first arc lamp was lit and filled everyone with wonder, compared to today's situation in which there is electric light in every corner of the city".*



In 1901, Gunnar Knudsen became chairman of the board of the Works. Mr. Knudsen also was a Liberal Party politician and in 1886 the mayor of Gjerpen municipality. He subsequently became a prominent figure in Norwegian politics and society, held several Ministerial posts and was involved in the start of several industries, among them Porsgrunn Porcelain Works. In 1891, he was elected to the Storting (Parliament). In 1908 he was appointed Liberal Party Parliamentary Leader, and he was the Party leader from 1909 to 1927. He was Minister of Finance briefly in 1905 and Prime Minister in 1908-1910 and 1913-1920. During his tenure in the Government, he favoured State purchase of waterfalls, and was prominent in the debates on concession acts, industrial exploitation of hydropower and establishment of The Norwegian Water Resources and Energy Administration.



A/s Laugstol Bruks Elektricitetsværk.

Priserne for elektrisk Strøm til Lys og Kraft nedsættes fra 1ste Juli 1914 saaledes:

1. For elektrisk Strøm til Belysning:

a) Fast Aarspris efter Maximalforbruk (Vippemaaler) Kr. 16.00 pr. Ampere eller Kr. 144.00 pr. Kilowatt pr. Aar. Det tidligere Tillæg av 20 % for Kokning etc. er bortfaldt.

b) Fast Aarspris pr. Lampe:

5 Lys Metaltraadlampe Kr. 0.80
10 " —.— " 1.60
16 " —.— " 2.60
25 " —.— " 4.00
32 " —.— " 5.20
50 " —.— " 8.00
100 " —.— " 16.00
For Kultraadlamper er Prisen 3 Ganger høiere.

c) Efter Forbruk maalt med Watt-Timemaaler:

30 Øre pr. Kilowatt-Time i Forretninger og Fabriker
25 " " —"— i Privathuser og Hoteller

2. For elektrisk Strøm til Strykejern:

Strykejern til eget Behov Kr. 6.00 pr. Stykke pr. Aar. For Lysabonnenter, der har Vippemaaler, intet Tillæg uten forsaavidt Strykejernet kræver mere Strøm end Vippemaaleren. Prisen for denne Ekstrastrøm beregnes efter Kr. 3.00 pr. Ampere pr. Aar.

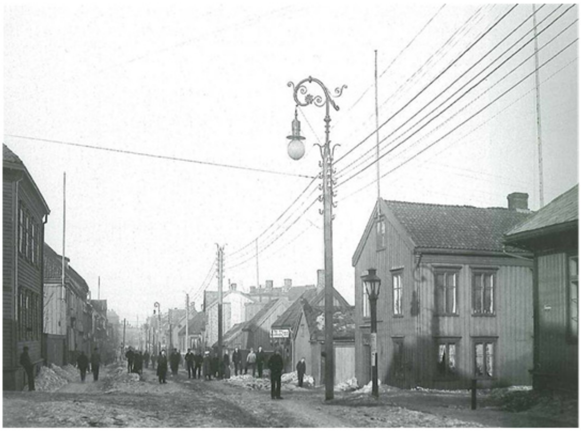
3. For elektrisk Strøm til Motorer:

a) Fast Aarspris ved fuld Drift (indtil 3000 Timer pr. Aar):
for indtil 7 HK Kr. 84.00 pr. HK. pr. Aar
" 7 til 25 HK " 80.00 " " " "
Over 25 HK Rabat efter særskilt Overenskomst.

b) Fast Aarspris for Drift kun ved Dagslys:
Kr. 50.00 pr. HK pr. Aar.

The electrification of the country initially had aimed to illuminate cities. In 1891 the remote city of Hammerfest in northern Norway became the first town in Northern Europe to have electric street lights. The lighting network was a public venture powered by a hydroelectric plant built in 1889. In that period, electric motors were gradually introduced to provide mechanical power. In 1894, Kristiania became Scandinavia’s first city with an electric tram line. Many cities and companies followed in building hydroelectric plants.

Around the turn of the century, private and commercial actors began developing large industries based on electrochemical and electrometallurgical processes. Two large companies, Hydro and Elkem led the development and industrial expansion of hydropower up to 1920. The factories were located close to large waterfalls and drew industries to them, as in Rjukan, Odda, Høyanger and Sauda. The local and municipal power plants developed lesser watercourses and with time mountain reservoirs to public power supply. In 1945, there were more than 2000 power plants in Norway. Their total production was about 11 TWh. After the Second World War, hydroelectric power development accelerated. Today's production is more than ten times as much as in 1945. There are fewer, larger power plants. The 12 largest deliver 1 – 5 TWh per year. Electricity for the country is produced in about 600 power plants, 200 of them underground.



The main street in Tromsø city 1898. The electric street lights have been fixed in place. The old kerosine lamp in the foreground has not yet been taken down. Source: Troms Kraft

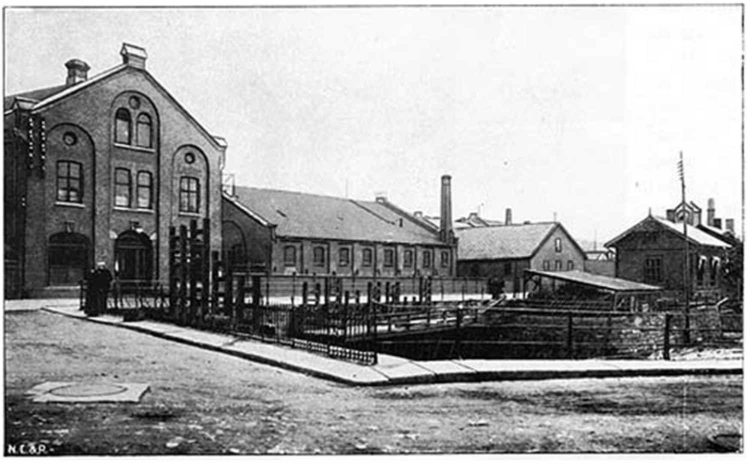
Since 1972, Norway has led the world in per-capita electric power consumption. Hydroelectric power accounts for 99% of the electric power produced in Norway. Internationally, that's unique. In 1920, 64% of the population of the country lived in houses having electricity. In Sweden the corresponding figure then was 17%. In 1965, the per-capita figure was nearly 100%. In 1989, only 260 people in the permanent population had no electricity at home.

Hydropower is clean, renewable energy that saves the environment for what otherwise would be an enormous CO_2 load. The companies involved in the development and utilisation of hydro power, such as Kværner, Myren, Thune, Elektrisk Bureau, NEBB, etc., developed world leading competence in the sector and ensured that Norwegian hydropower plants were built within budget, to schedule and of projected quality, which in itself was a considerable accomplishment.

The hydroelectric developments have had tremendous spin-off effects and have been the prime trigger to the country's economic development. The electrification of the country based on hydropower that started at Laugstol Works therefore, because of its wider impacts, might be considered the most successful project ever in Norway.

Assessment

Many historical projects involve incidents that coincide in time or place, unintended events, persons, political decisions or technological breakthroughs. People on the whole think ahead and plan both individually and collectively. But many significant events nonetheless are strongly influenced by chance, for better or worse



Laugstol Works was the country's first power plant to sell electric power to consumers. The plant was located close to Skien city centre.

In retrospect, the coincidences of the Laugstol Works project seem obvious, as if they were predetermined. Abundant water power was there to be exploited more efficiently, the relevant technological breakthroughs had been made and were ready for use, and the people involved were well qualified to act as they did. One had the technical expertise and understood what was possible. The other had access to property, water and forest resources. All were entrepreneurs, wealthy and privileged citizens. All that was needed to realize their combined potential was for them to meet. There's no historical record of how that happened.

At the time, the uncertainty of the project most likely was how risky it was. With hindsight, it seems to have been a project that could not fail. The partners had ready access to capital. They had markets for both wood pulp and electric power.

But small Norway at the time was a poor country, far away from the leading technological and financial actors, such as the USA, England, Germany and France. So probably it was a remarkable coincidence of fortunate circumstances that made the project a breakthrough. Electricity production at Laugstol started at about the time of Edison's development of the incandescent lamp, just a decade after dynamos and arc lamps had become commercially available. It was just three years after the world's first hydroelectric plant started operation at Senja. The history on the electrification of Norway can therefore be described in two periods, before and after Laugstol.

The personality of the key actor, Gunnar Knudsen, contributed to the significance of the project. He was a successful entrepreneur and must have been extremely dynamic. That led to him having a key place in the financial and political history of the management and development of the country's water power resources. Gunnar Knudsen was known as a devotee and a social policy pioneer. It was said that he saw his political activities in light of his conviction of the Christian call and therefore didn't want honorary orders. So he held only the 7th of July medal commemorating the dissolution of the Union of 1905 that then was bestowed upon the members of the Government and the Parliament of the time. Since then, higher classes of the Royal Norwegian Order of St. Olav have been bestowed upon persons who served the country less than the statesman and power pioneer Gunnar Knudsen.

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7. Summerland - the cradle of off-shore oil exploration

Modern oil industry is popularly believed to have begun in 1859 when Edwin Drake drilled for oil in Pennsylvania and subsequently founded the Seneca Oil Company. But as often is the case, Drake's drilling wasn't the true first. Twelve years earlier, in 1848, Russian engineer F.N. Semyenov drilled for oil in Baku. His well was 21 metres deep and yielded as much as 90% of the world's oil production up to 1861. But of course this happened long after the Chinese drilled for oil and built oil wells in 300 B.C.

Until the end of the 19th century, the oil industry operated only on land. But in 1894, it ventured offshore, off the coast of California at Santa Barbara.

The Chumash Indians were among the first tribes to settle in North America several thousand years ago.

For some 13,000 years, indigenous peoples had used the tarry stuff that they found in some places along the coast. The Chumash Indians used it to chalk their boats. The Chumash culture was matriarchal, and its people were known to be friendly. It was advanced in construction, technology and art. But like many other indigenous peoples on the North American continent, it succumbed to colonization from the East.

Spanish settlers arrived in numbers in the 18th century. The natives had no immunity to diseases that the Spanish brought, such as influenza and smallpox. They also were extensively exploited by their conquerors. Within two hundred years, they were devastated. Only 200 individuals remained from a population of thousands.

The Spanish colonies in North America, called “New Spain” (*Nueva España*), consisted of a greater part of what now is the southern USA and Central America. After 300 years under the Spanish Viceroy, the people rebelled in what is called the Mexican War of Independence. It ended in 1821 with the creation of Mexico as a country. In 1846, territorial dispute led to the U.S.-Mexican War. That war was ended by the signing of the Treaty of Guadlalupe

Hildago on 2 February 1848, in which Mexico ceded the area that now is the U.S. southwest. The Mexican Cession included California.

The very same day, on 2 February, gold was found at Sutter's Mill in northern California. It was announced to Congress by President Polk on 5 December the same year, and triggered a gold rush. Prospectors flocked to California from the rest of the USA and abroad. The Gold Rush lasted seven years and led to the population of California increasing from 14,000 to more than 200,000.

But few prospectors made a fortune. Many who had come seeking gold in California now sought land to settle. Years of lawlessness followed. Then came the American Civil War of 1861-1865.

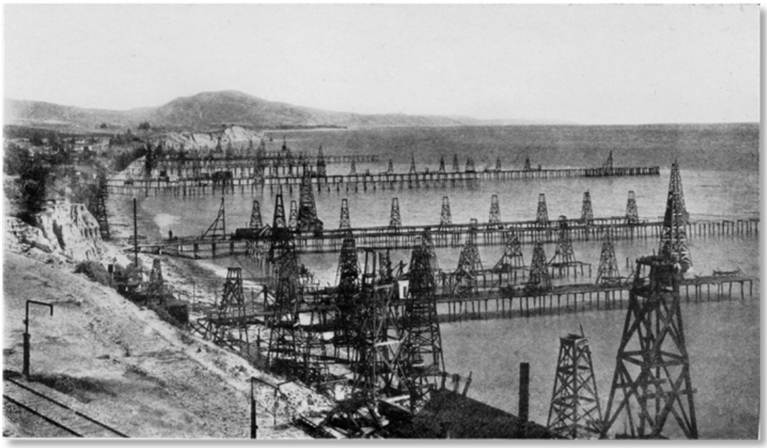
In 1885, twenty years after the end of the Civil War, a man named Henry LaFayette Williams arrived in Santa Barbara, California. He had been a Major in the Civil War and later was a Treasury Agent. He sought land. He found the Ortega Ranch that lay east of Santa Barbara and bordered on the ocean. Williams bought an 1100 acre parcel of it, ostensibly to raise pigs. But he soon found other uses for the land. A rail line being built between San Francisco and Los Angeles was to cross the property. He envisioned building a town between the Ocean and the inland hills. He hoped that would get him out of his financial difficulties.

Williams was a devoted follower of spiritualism, a religious movement that had spread in the USA. The movement is said to have begun after sisters Margaret and Kate Fox in the State of New York had gone on tour, claiming that they could communicate with the dead. Up to the 1920s spiritualism was a popular religion in the USA and in Europe, with up to nine million followers. Williams sought to create a society for spiritualists. He called the project Summerland, after the Spiritualist name of the place where souls reside and can be contacted after death. Summerland was the heaven of Spiritualism.

Williams divided the area in small lots of 20 x 8 meters that were sold for $25. A lot was large enough for a tent. Those who wished to build houses could buy several lots. The project drew spiritualists from across the USA. Many of them settled and built houses. An area was set aside to build a temple for séances and social gatherings. In it mediums were to help citizens contact friends and relatives "on the other side". Rumours of strange activities in Summerland circulated in the surroundings. People called the town "Spookville".

By 1890 it became apparent that there was a great amount of natural gas in the area. Children were said to have tapped pipes into the ground to light the gas that came up from them. In the light of the flames they could play after sundown. Four years later, in 1894, a man named Smith Cole dug for natural gas and found oil in the ground. That triggered a new gold rush in California.

This gave Williams the chance of his life. He quickly changed his view of spiritualism and wrote his creditors in San Francisco to promise that he would soon forsake these "twisted people" and make way for oil extraction. Things happened fast. The coastal zone soon was full of oil rigs. It didn't take long to find that there was more oil offshore. Wooden piers were built to support drilling rigs up to 300 metres off the shore.



Piers with drilling rigs in Summerland

The population grew. Ten years later, in 1900, the town didn't have just a few families with half-finished houses and a few tents, but a population of 700 in houses heated and lighted by natural gas. There was a water works, a community centre, a school and a railway station. The town had its own newspaper, the Summerland Advance Courier, which claimed to be the voice of the southern Santa Barbara area. Within a few years, the price of a lot had gone up from $25 to $7,500.

Summerland had up to several hundred drilling rigs. The largest facility belonged to the Southampton Pacific Railroad. The company built a pier that jutted 370 m offshore and had 19 drilling rigs. The railway gradually switched from coal to oil fuels, and Summerland became a tank depot on the stretch between Los Angeles and San Francisco.

Summerland had earned its place in world history as the base of the first offshore oil field. The population continued to grow. Hotels and bars were opened, much to the dismay of the spiritualists. The town looked like a battlefield, and people in the surroundings complained about the smoke from and stench of the facilities. There were several acts of sabotage. Among those affected was J. Paul Getty's father George Franklin Getty, one of the actors in Summerland. The town had become a hornet’s nest of contractors, and most spirtualists had left.

H.L. Williams built a house for his family on the west side of Ortega Hill. But his enjoyment of it was brief. In 1899 he was killed in a fall from one of his own rig installations.

His wife remarried. She was a devoted spiritualist and continued to hold séances for others. However, her second husband, George Becker, was a keen businessman. He bought his stepchildren’s interests in William’s oil companies and took over control of them. By 1924, his ownership had grown to about 75%, and he owned about a third of the town.

After chaotic growth, the oil-driven prosperity came to a dramatic end. In 1903, a winter storm destroyed many of the wooden structures on the beach and in the piers jutting offshore. By 1906, production had come almost to a standstill, but many of the oil rigs remained, some for decades.

The first oil boom had lasted about ten years. But drilling continued until 1920, when a storm again destroyed many rigs. After the depression, Summerland was a mere shadow of its former self. In 1939, production stopped completely, and the remaining piers and rigs were removed. In all, 412 oil wells had been drilled.

In the years that followed, oil prospecting and drilling technologies developed rapidly, not least in the use of seismological prospecting methods. After the Second World War, oil prospecting in the area resumed, in response to escalating needs for oil.

With modern technologies and centralized production, the new facilities weren't so prominent in the landscape. Annual production was about 100,000 barrels. But in 1957 a new field was discovered two kilometres offshore. Two production platforms were built, in 1958 and 1960, for wells at a water depth of 30 metres. They produced nearly 30 million barrels of oil before they were shut down in 1996.

Today, all the oil facilities have been removed from Summerland. But a hundred years ago, there were no rules on the termination of oil production. Old wells were filled with whatever was available, such as earth, stone, sand, timbers, old mattresses and other waste. Oil is lighter than water. So through the years, small amounts of oil and gas have leaked out and risen to the surface. So recently there have been extensive efforts to locate and plug the old wells with cement to stop the leaks.

Today's undisturbed beaches where the oil rigs once dominated the scene

In the 1960s and 1970s, Summerland was rediscovered by hippies, artists and surfers. The houses were cheap and most had good views of the ocean. In the 1980s, a new waterworks triggered a building boom. House prices rose rapidly, and today Summerland is a sleepy small town for vacationers and well-off people. Folks and their pets throng to the beaches, and all the scars of the past are gone. The New Age movement, lifestyle philosophy and dreams of the good life have replaced Spiritualism. As long as it lasts.

Assessment

In this case, the project started with the founding of a town for spiritualists motivated by a wish to earn money. Pure chance was decisive. The crucial factor was that a railway line was to be built across the area. Oil and gas were discovered later. Fortune hunters came in and crowded out the spiritualists.

The oil drilling project wasn't planned. It was a real-life Wild West story. A situation suddenly occurs, and developments are rapid. There are struggles for big earnings, and the principle that might makes right applies.

Ironically, the greedy originator was the big looser. He died in an accident, and his family thereafter duped by their sly stepfather into loss of what had been rightfully theirs. The circumstances suggest that there might have been a plan. Did the man die in a true accident or was he murdered?

When there's no more oil, the project breaks up. The fortune hunters leave, and only a collection of abandoned houses and oil rigs remain. This project is a goldmine story in which the gold is black. Some win, and the most lose. Life goes on. In the same era, there were many such projects. Summerland was one of the smaller projects and consequently of lesser interest. Its story is included here because it provides a bit of background for Norwegian offshore oil exploration, which is a far larger and more successful project. Summerland illustrates how small the beginning was a hundred years ago. So the Summerland project may be said to have had colossal spin-off effects. The world most likely would have been a bit different had not people realized that it was possible to exploit oil and gas resources under the seabed. This is particularly so for Norway.

In many ways, the history of offshore oil development in Norway resembles that of Summerland, but in more modern times and far greater scale. The riches were there for the taking. The project has made the country affluent and caused a complete makeover of society, but many fear that the decline may be great when the oil runs out. Only time will tell how dramatic this will be and what implications it will have for the society. Ending up with a dormant and peaceful haven for newly rich people as in Summerland is probably the least likely scenario.

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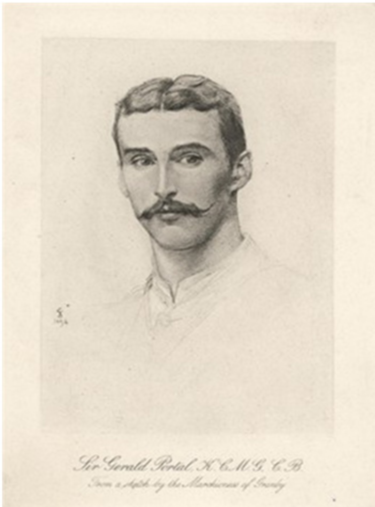
8. Lunatic Express - the British Empire's iron snake in Africa

The first Europeans arrived in East Africa in the 1840s. Most were missionaries who settled in the area between the Indian Ocean and Kilimanjaro under the protection of the Sultan of Zanzibar. A Scottish shipowner, William MacKinnon, traded with India and East Africa and also had an agreement with the Sultan. His company had extensive activities on land around the Indian Ocean. In 1885 at the Berlin Conference, the African continent was divided between the European countries into spheres of influence which lay the foundations for colonization of the continent. In 1888, the British government allowed MacKinnon to establish the Imperial British East Africa Company (IBEAC), a commercial association that was to develop trade in the part of East Africa defined as being in the British sphere of influence. It consisted of lands that today are Kenya and Uganda and extend from the east coast of Africa to north of Lake Victoria. The company set up a transport route into the fertile highland areas of Uganda that were viewed suitable for European settlement. But the company had assumed a difficult task. The British government finally faced an ultimatum.

Barghash bin Said Sultan of Zanzibar (wikipedia)

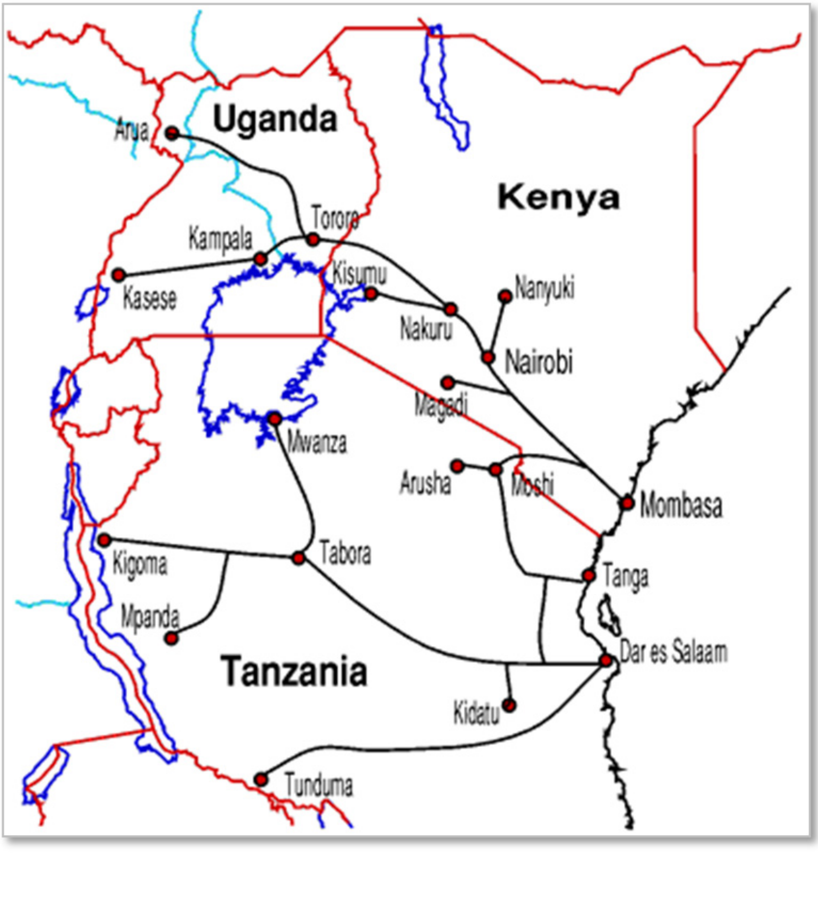
William MacKinnon worked to convince the British Crown to build a railway from the coast inland to Lake Victoria. He felt that was the only way to develop the area under British hegemony. But the government had its hands full with the first Anglo-Boer war in South Africa and also doubted the usefulness of such a project. It was in general reluctant to declare a protectorate under the Crown, yet preferred to let private actors develop the area.

From the start, the East Africa Company had set up outposts from the coast through Kenya to open up a route to Uganda. However, the route could not be held open due to lack of people and money. By 1891, the situation was precarious and the company went bankrupt. The Company threatened to abandon the area unless London provided support and promised to build the railway. The government was under pressure from the Church and the Army. In 1892 it decided to send two commissioners to Uganda to assess the desirability of assuming hegemony over the area. The two were Gerald Herbert Portal, the young Consulate General for British East Africa stationed in Zanzibar, and his brother Raymond. Back in London the following year, their recommendation was positive, both for the protectorate and the railway. Both died in 1894 of typhus contracted on their travels. In June 1894 the British Crown declared Uganda to be a British protectorate. The transport route in to the new protectorate was difficult and risky. It crossed deserts and savannahs with predators and hostile tribes. The East Africa Company had tried to hold the route open by setting up a series of well protected forts. That entailed an annual changes of corps at all forts, in all 2000 men. With the Protectorate established and the IBEAC bankrupt, it became urgent to



Gerald Portal

establish British presence in Uganda and therefore build the railway. The territory from the highlands to the coast was considered worthless. Yet the area, present-day Kenya, also became a British Protectorate, to control the area that the railway was to go through and to have access to the sea. In 1894, the British government assumed administration of the area and what was left of IBEAC was disbanded.



The goal of the railway was to take raw materials out of the Protectorate and bring in finished products from Great Britain. The proposed project was controversial and met considerable opposition. British newspapers called it “The Lunatic Line”. Its prime support had been Gerald Portal, who believed that the time was ripe to build it. The reasoning was (1) the source of the Nile must be protected from the enemies of Great Britain, (2) the railway would open up a large market for British products, and (3) it would be decisive in the economic development of the area. Liberals were of the opinion that (1) the government had no right to build a railway through an area owned by the native Maasai people, (2) construction would exploit African workers, and (3) it would be a waste of the taxpayers’ money. The conservatives refuted that reasoning by saying that if the British didn’t build the line, other countries would.

In 1896 London Magazine Truth published a poem with the title "Aboard the Lunatic Express" that summarized the opponents’ view of the project:

What it will cost no words can express;
What is its object no brain can suppose;
Where it will start from no one can guess;
Where it is going nobody knows;
What is the use of it none can conjecture;
What it will carry there's none can define;
And in spite of George Curzon's superior lecture,
It clearly is naught but a lunatic line.

But the process had started. On 11 December 1895, the SS Ethiopia arrived at the port of Mombasa. George Whitehouse, who had been hired as chief engineer for the project, was on board. He had experience in building railways in South America, Mexico, India and South Africa, and was well qualified for the task ahead. With an enormous budget of 3.25 million Pounds, work on the railway began in 1896. It entailed laying about 1000 km of rails through inhospitable terrain at the equator, with a total elevation gain of 1150 metres. The line had to go 600 m down into and then as much up from the Rift Valley, cross a desert and a 160 km stretch of marshes. The sleepers were made of iron, as wood sleepers would have been destroyed by termites. The line was single-track with a gauge of 100 centimetres.

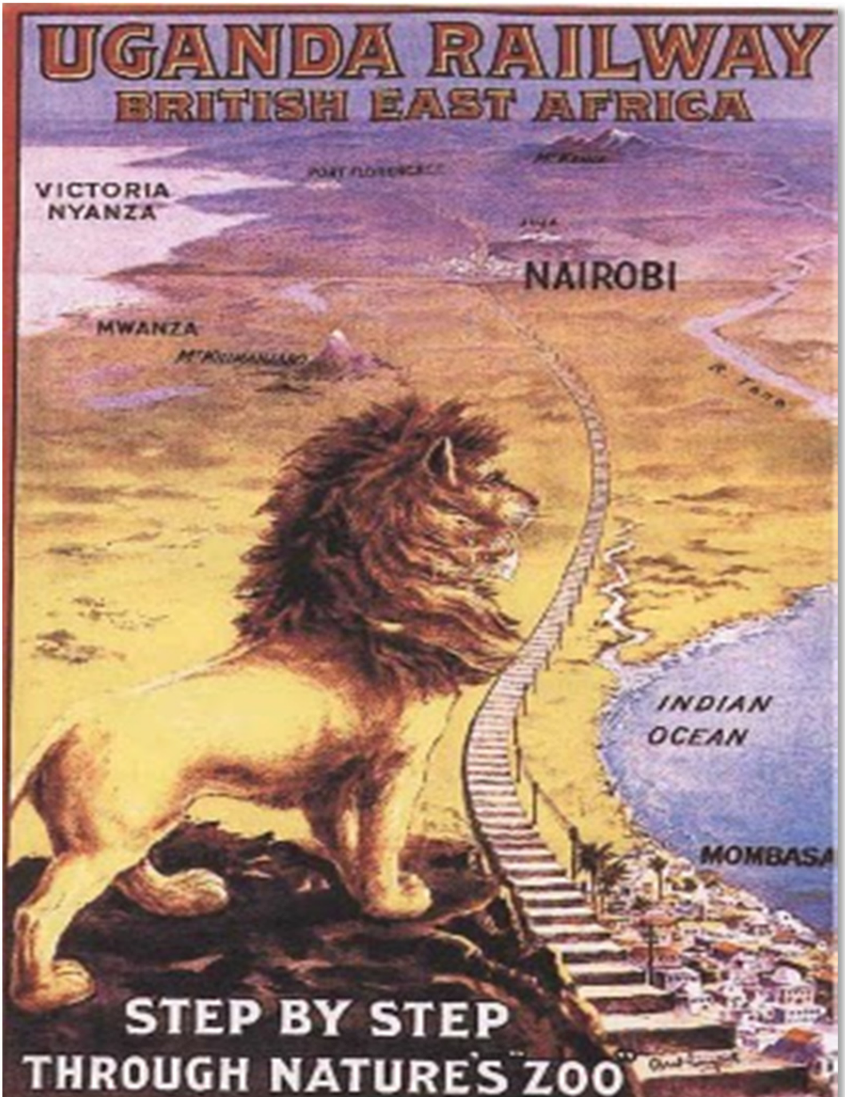
The English authorities brought in large numbers of workers from India to build the line. They were lower caste coolies who would construct the line, while the rough work and transport was done by African labourers. It became a mad race against time and the forces of nature. Diseases such as malaria, dysentery, cholera and typhus, as well as sleeping sickness transmitted by tsetse flies were rife and attacks by hostile tribes bothersome.

Whitehouse was well informed. Four years earlier the government had sent out an expedition of surveyors to map the route and estimate costs. It consisted of seven Europeans, 41 Indians, seven local foremen, 40 guards, 270 porters and 60 donkeys. The expedition coped with the ultimate of natural difficulties. Thirst was a major problem. It returned after a year and submitted its report in 1893.

Near Mombasa 1899 (wikipedia)

Clearly, the project had to be self-supporting in that everything had to be transported by train as the work progressed forward into the unknown. There were no roads, and transport by pack animals was difficult due to tsetse flies and lack of water. There were two supply trains a day, in the morning with materials and equipment and in the evening with food and water.

People, animals and locomotives need great quantities of water, which was temporarily stored in large tanks along the line. Water in the tanks often was polluted and caused diarrhoea, dysentery and liver conditions. Outbreaks of malaria was a constant problem. The logistics were so critical that the train derailments that sometimes occurred could be a matter of life or death for those out in the field.

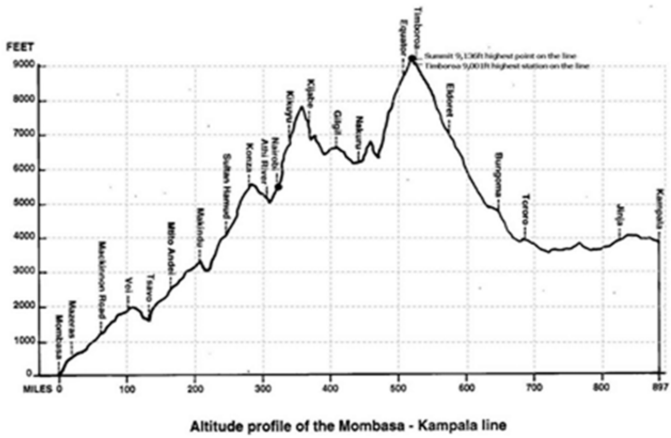

UGANDA RAILWAY
BRITISH EAST AFRICA
VICTORIA NYANZA
NAIROBI
MWANZA
INDIAN OCEAN
MOMBASA
STEP BY STEP
THROUGH NATURE'S "ZOO"

No target date was set for project completion, but it was assumed to require five to six years. It soon became obvious that more workers were needed to keep to that schedule. In the first year, 4,000 Indians were brought in. The agreement with the government in India was that when their work finished, these workers could settle in Africa if they wished. But the next year, plague broke out in India, and the supply of labour stopped until the end of 1897. Two years thereafter, the workforce numbered 18,000 men. It grew further, and toward the end of the project, 32,000 Indians were at work. Fewer than 2,000 Africans worked on the project as porters and assistants to the Indians. In the Railway Committee's report they were described as of little use, unreliable people for whom "*not even hunger would cause them to seek work*". It is reasonable to assume that low wages and maltreatment were the underlying cause.

Engineer Ronald O. Preston led construction work in the field. He had ten years of experience in building railways in India. But he didn't know Africa. Africans called the project that continuously ate its way into the terrain "the iron snake". An old prophecy of the local Maasai and Kikuyu peoples holds that a black snake will slither in over the land and cause all cattle to disappear. The railway project was seen by the natives as a materialization of the prophecy. So they quite naturally opposed the iron snake's intrusion into their areas.

Ronald Preston was in his 30s. He was muscular, fit, and had a black moustache. In photographs he appears in working clothes, with a rifle in hand. He was a man of action and foremost a capable engineer who always found suitable solutions to technical and practical problems. He also was very impatient and restless. He was extremely dissatisfied whenever many of the Indian workers stayed away from the job when they so wished. Work progress was slow. Preston wrote in his diary that *"people spend six days a week in relaxation while the seventh is a holiday"*. He found that the reason was that their working contract with the British authorities was based on a day rate, with no productivity requirement. He called the workers together and offered them wages based on kilometres of line built, which would allow them to earn more in less time. His offer was accepted. The situation changed completely.

Preston had struggles aplenty. In periods, as many as 500 workers were hospitalized with serious tropical diseases. At the most, more than half of the workers were reported sick. In the rainy season, soil and sand became clay, and large areas under the permanent way were washed away. Small and large bridges collapsed. In the dry season, the temperature in the desert could be more than 50°C. There were shortages of drinking water. The transport problems were considerable. According to plan, at least 30 locomotives should be available. But seldom were more than 15 in service. Ten of them were old, worn-out locomotives no longer used in India. Some 225 goods wagons were available, but the amount of goods to be transported was enormous. There were 1.2 million sleepers and 200,000 lengths of rail, each weighing 250 kg. It was necessary to use draft animals to overcome the lack of rolling stock. At one time, there was as many as 800 donkeys, 600 oxen, 350 mules and 63 camels, in all 1800 animals. Of them, 1500 died in working in one of the areas of Africa most infested with tsetse flies. Most of the rest died of exhaustion and dehydration in the desert.



Altitude profile of the Mombasa – Kampala line

The project occasionally was delayed because herds of rhinoceroses attacked the trains. At one time the animals almost derailed a locomotive. In one area there were so many mosquitoes that after 72 hours, the entire workforce lay in tents, ill with malaria, and had to be replaced by new workers from the coast. Only Preston stayed in the field, even though he also was knocked out by fever.

After a year of building through the desert and dry savannah, the line extended 200 km inland to the Tsavo River. It was an ideal place to camp, so a new main camp was set up there. Compared to what the project workers had been through, this place was an oasis. Few knew that in the Bantu language, Tsavo means “slaughter place”. It was where caravans usually camped. But it had an ominous reputation. It was a favoured place for attacks by the Maasai, known for never taking slaves or prisoners. They killed all men with spears, while the women were killed with clubs in the course of the night. Nobody was left alive when the Maasai withdrew. Predators and scavengers devoured the remains and multiplied.

During the months that the camp was kept up, many workers disappeared mysteriously. Some five to six thousand men lived in tents spread around the area. Rumours spread that there were man-eaters around. The Europeans didn’t believe the rumours. But one night an Indian foreman disappeared. His orderly said that a lion had stuck his head through a tent opening and had bitten the foreman's throat. There was just a short scream before he was dragged away. Traces on the ground showed where the lion had tugged him.

In the following 15 months, there were sporadic attacks. Finally, bridge engineer J.H. Patterson, who was a skilled hunter, killed the two man-eating lions who had attacked the camp. In all, 135 people had been killed, 28 of them Indians. Alone, these happenings delayed the project several months. The lions have become part of the historical record, as the man-eaters of Tsavo.

During the construction period, there were several bloody conflicts between the construction workers and the natives who detested the intrusion into their areas. These led to retaliatory actions. The biggest encounter was the Kedong massacre, when a group of Maasais attacked a supply caravan with 1,100 workers. The attack had been triggered by the rape of two Maasai women. The Maasais killed almost half of the workers. Thereafter a revenge expedition led by Englishman Andrew Dick was sent out. It killed 50 Maasais. In the heat of battle, Dick ran out of ammunition. He was the only white man killed, impaled by Maasai spears.

Despite the problems with weather, topography, diseases and attacks by animals and the natives, Preston managed to get through the tropical belt to the highlands. He wrote in his diary that the highlands seemed to be "*an absolute picnic*". Here there was ample water and wood, a pleasant temperate climate, no malaria mosquitoes, and a satisfied, hard-working workforce. But the problems were far from over. A three-month period of continuous rain halted work and destroyed almost 100 km of the permanent way just finished.

In 1899 the workers came to a highland place named Ewaso Nai'beri, where they camped. The climate was pleasant and there was plenty of water. Moreover, it was a swampy area that kept lions away. In the local language, the name meant "*a place of cool waters*". The British could not pronounce the complex name. So they called it Nairobi. Due to its favourable climate and connections to Uganda and the sea, in 1919 the place became the capital of British East Africa.

The project worked further inland, where several problems awaited. It left a tropical climate and came to chilling cold at an elevation of 3000 metres. Thereafter, an enormous amount of work was involved in building the downhill and uphill stretches to cross the Rift Valley. Cableways were built to carry supplies and machines. Thereafter, the project had to press through a new hostile area and suffer frequent attacks by Nandi warriors. Preston wrote in his diary that "*Hostility toward the white was first and foremost directed toward the brown workers who not only laid rails on the ground but also laid every Nandi girl or boy that they could lure into their tents".* On their side, the natives stole all they could find, not least iron that could be used to make weapons.

On 19 December 1901, five years after its start, the railway project reached the shore of Lake Victoria, 930 km from Mombasa. The place was named Port Florence in honour of engineer Ronald Preston's wife, who had accompanied her husband for five years, throughout the expedition from Mombasa. She had the honour of driving the last spike, on the shore of Lake Victoria. The line was opened two years later, in 1903. Subsequently, Port Florence was renamed Kisumu.

After the last sleeper was laid, the overall project accounts were compiled. Some 2500 Indians were dead and 6000 were disabled. An unknown number of African workers also were dead. Moreover, a considerable number of natives had been killed in conflicts. The financial cost was enormous. The original budget of 1894 was three million pounds. When the books were closed in 1902, the total cost was almost six million pounds, or about twice the original budget.

The Lunatic Express has for years been a favoured means of travel for big game hunters. One of the earliest travellers was Winston Churchill, who said of the railway: "*The British art of muddling through, here seen in one of its finest expositions. Through everything – through the forests, through the ravines, through troops of marauding lions, through famine, through war, through five years of excoriating Parliamentary debate, muddled and marched the railway"*.

The most famous hunter to travel on the railway was Theodore Roosevelt. In 1909, after his term as President, he left from Mombasa on a two-year safari. He was accompanied by 240 porters, several Smithsonian Institute scientists, and his son. He shot several hundred animals on the safari, which ended in Cairo. Thereafter, he travelled to Oslo where he held his speech for the Nobel

Peace Prize that he had been awarded in 1906 for his contribution to ending the war between Russia and Japan.

The new railway enabled the transport of raw materials to the coast and laid the foundation for the colonization of that part of Africa. That had been its intent, so in that sense the project was very successful. Hordes of white settlers came in to take over the most fertile land areas and exploit African workers. A great part of the original 32,000 Indians settled in East Africa. In the early 20th century, others followed them from India. With time, they became important in commerce. The black iron snake had permanently changed the cultural and economic landscape.

The financial importance of the railway gradually declined. In the 1970s, trains stopped running on the Ugandan side, and on the Kenyan side unrest and sabotage degraded operation. Since the 1980s, the market share of goods carried by train declined from 70% to 20%. At worst, less than a third of the railway was operational. Today, the railway is a marginal carrier of goods compared to road and air transport. For passengers, it’s a curiosity more than a practical conveyance, primarily for people with some money and plenty of time.

Assessment

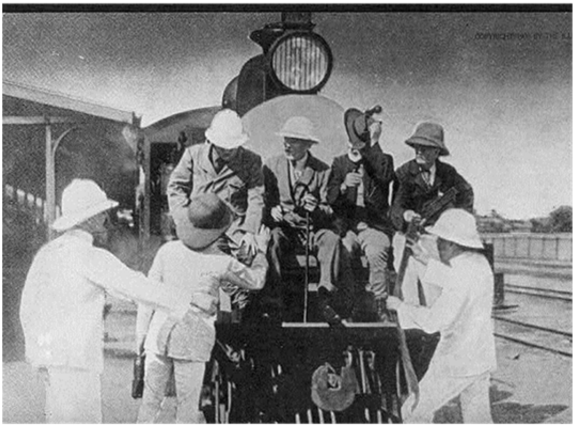
From its start, the project was a stepchild. The government in London was pulled reluctantly into it. All that was known about East Africa was that it was arid and unproductive and little hospitable. The British Empire had its hands full with colonies in other places.

Historically, infrastructures are built to establish connections to places with considerable resources, such as mining or farming. Roads or railways are built when there's reasonable assurance of benefits that will justify investments in them. In this case, the opposite was done. The railway was built in an unexplored region. In newspaper debates it was said that the politicians in London invested in railway tracks so they could travel comfortably to the unknown and thereafter find that there was nothing there. So the opposition might have good reason to protest.

At the same time, little was known about all the cost escalating uncertainties that might be encountered. For example, in the 28 September 1891 edition of The Times, the project was described favourably, because “*It is not, after all, a very serious matter to build four or five hundred miles of railway over land that* *costs nothing".* The problem in this case was that so many other aspects incurred expenses. At the time nobody could have known that the project would finally incur a cost overrun of 100 per cent. In hindsight that is hardly surprising.

This indicates that the preliminary survey that took half a year in the field must have been inadequate. With a realistic budget twice as large, the project might have been abandoned in London. Or maybe not, since the approval of the project most likely can be ascribed to it being part of political manoeuvring on territories and on controlling the source of the Nile.

What's remarkable is that the project managed to stay on schedule, despite unforeseen difficulties. Equally remarkable, instead of being stopped, the project received a doubling of funds as compared with the initial budget. This illustrates the reluctance to abandon an investment already made but commit further, even though there's greater risk of larger losses.



Theodore Roosevelt and his party on the observation platform of the locomotive, 1909. (Wikipedia)

When the project was over and the politicians had swallowed the bitter pill of its cost, the railway was seen to have had some positive effects. For the colonial power, there were new settlements and economic development of the colony. Administration moved from tropical Mombasa to the more comfortable highland Nairobi. For the African people, it ended slave transport from the interior to the coast, in accordance with the proclamation of the Berlin Conference. But the Africans lost their independence, and the nomads saw their traditional lands taken over by European settlers.

The extent to which the investment in the railway was profitable in the socioeconomic sense has probably not been assessed. With the railway came a population of 100,000 white people and a considerable minority of Indians in the 60 years until the countries gained independence. That gave rise to ethnic conflicts, not least between Africans and Indians. In turn, the conflicts led to some 80,000 Asians being expelled in 1972 by Uganda's dictator Idi Amin.

After independence, the railway was a deteriorating but vital part of the infrastructure for years. Most of its traffic was transferred to roads. In 1995, the Uganda Railway Corporation collapsed. In the following years, there were several more or less successful efforts to privatize operation of the line. Today, the trains that take 15 hours to travel the 500 km from Mombasa to Nairobi are a popular tourist attraction. The average train speed is less than 40 km/h. So tourist passengers have plenty of time to admire the scenery and the animals in the nature preserves that the train goes through. But the railway no longer is a competitive means of transport.

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9. Larderello - geothermal power from the Devil's Valley

Geothermal energy is the designation for the enormous amounts of thermal energy generated and stored within the Earth. A very small quantity of that energy can be used to meet human energy needs. People have long known that there's heat under the surface of Earth, as evidenced by volcanoes and hot springs. But it was not before the 16th and 17th centuries, when mine shafts went sufficiently deep underground, that it became clear that temperature increased with depth. Yet, the first temperature measurements of that phenomenon were made in France, as late as 1740.

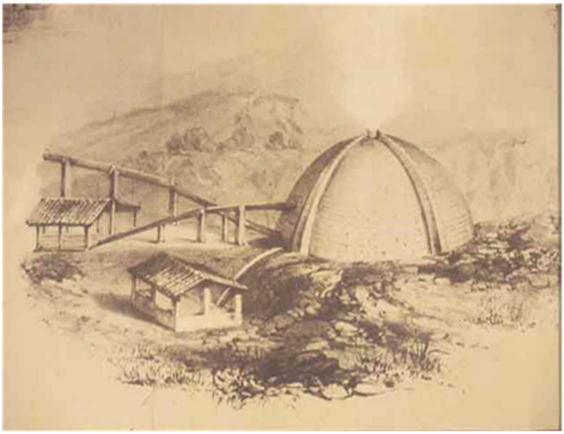
People have used hot springs warmed by heat from within the Earth for thousands of years for baths. Not least the Romans were known for their public baths and the Japanese for their Onsen. One of the first applications of geothermal energy for industrial purposes took place in Toscana in Italy, where borated water was taken from hot springs to produce boric acid. The water was boiled in iron vats over open fires.

The Pisa Province in Italy

The story of the world's first geothermal power station goes back to the 12th century. At that time, people collected a white powder that fell on the ground in the Montecerboli valley near Pisa.

Monte Cerberis means "Devil's Mountain" and refers to the steam that emerges from underground hot springs in the area. The steam condensed to deposits including the white powder, which was boric acid. At the time, the powder was put to many uses, including ceramic glazing, detergents and food preservatives.

In 1789, the year the Bastille was stormed in Paris, a boy was born in an aristocratic family in Dauphine, France. He was named François de Larderel. In 1814, at age 25 and educated as a chemist, he immigrated to Toscana in Italy. At the time, Italy was part of the Napoleonic Empire. He came to the Montecerboli Valley and found that the steam from the ground must be rich in boric acid. At that time, boric acid was an essential antiseptic. It was expensive, and the prime sources were as far away as Tibet. François invented an elegant method of extracting the boric acid using "covered lagoons". It was successful. For a while he had a monopoly on the production of boric acid in Europe, which made him wealthy. A town grew up around the boric acid factory. Grand Duke Leopold II of Tuscany was enthused by de Larderel's scheme and awarded him the title of Count of Montecerboli. The town was



A covered "lagoone" in Larderello that in the early 19th century used geothermal energy to boil borated water.

named Larderello and today is an administrative part of Pomerance Province in Tuscany.

The production of boric acid required enormous amounts of energy. The borated water was boiled over open flames. That harmed the forests around Larderello. In 1827, de Larderel thought of directly using the heat from the ground. It was a great improvement that considerably increased production profits. De Larderel built a palace at Livorno for himself and his family. Today it is a public building.

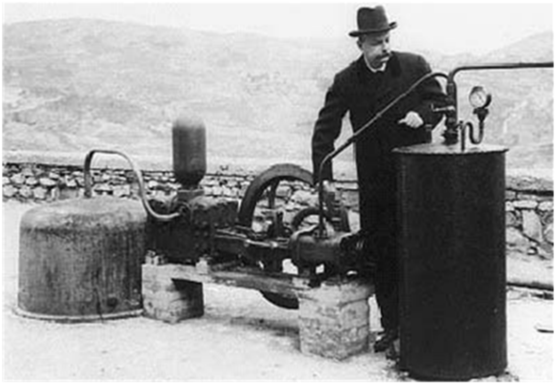
Francesco de Larderel (1789-1858)

This period in history was characterized by progress and intellectual and technical development, also in remote Tuscany. The factory in Larderello is an example. Another came in 1854, when engineer Eugenio Barsanti invented and patented the internal-combustion engine, 23 years before Nikolaus Otto, who is credited in history with having been first. At that time, Barsanti's engine had already been in production for several years in Belgium.

The chemical factory in Larderello was family owned for three generations. In 1894, de Larderel's great-granddaughter Adrina married Prince Piero Ginori Conti of Florence. He was young, dynamic and visionary and took over the directorship of "f. De Larderel, & C.".
Conti was fascinated by electricity and its uses, not least in the dynamo invented in 1865 by Antonio Pacinotti, professor of physics at the University of Pisa, seven years before the Siemens and Wheatstone dynamo.

Electricity as an energy carrier was the miracle of the time. In 1877, the first arc lamps illuminated boulevards in Paris. In 1879, Edison had developed an incandescent lamp that lasted more than a thousand hours. Electricity was the magic word that promised much for the future. The telegraph had been in operation for many years. In 1855, the Italian physicist Giovanni Caselli had invented an electric telegraph that could transmit pictures, the predecessor of facsimile. Electricity was used in chemical industries to make calcium carbide, calcium cyanide, sodium hydroxide and chlorine.

But electricity was expensive, because it was produced by dynamos driven by thermodynamic engines fired by wood or coal. Piero Ginori Conti realized that he could gain great advantage by using the steam in the Devil's Valley as a free resource.



Larderello in 1904. Inventor Prince Piero Ginori Conti and the machinery first used to produce electricity using geothermal energy.

He had a reciprocating steam engine built and on 15 July 1904 used it to drive a 10 kW dynamo that lit up five light bulbs. This way of using heat from the ground was a much noticed technological breakthrough. It was decisive for continued borax production in Larderello. At the end of the century, large deposits of borax had been found in Death Valley, California. That changed the competitive climate, ending Larderello's monopoly.

The pilot project of 1904 was the result of several years of trial-and-error. The solution finally chosen was a binary system in which steam emerging from the ground went through a heat exchanger that produced steam from pure water to drive a reciprocating steam engine. That design avoided destructive chemical contamination of the system.

The following year, the first prototype facility was in operation and generated 20 kW of power. In 1908, production was doubled with another facility. In 1911 Piero Conti built the world's first power station based on geothermal energy. Water was pumped down to hot rocks and taken up as steam at 220°C. In 1813, the first commercial power station, Larderello 1, was operational. It used a turbine instead of a reciprocating engine and produced 250 kW. The turbine operated at a pressure of up to three atmospheres. Again, the system was binary, with heat exchange from steam at 200° to 250°C. It was extremely successful, and in 1916 produced up to 2.7 MW. The plant supplied electricity to factories in Larderello and its surroundings. During the First World War, Marie Curie visited the plant, which helped publicize it.

The world's first geothermal power station was built in 1911 in Larderello,in Valle del Diavolo, ("Devil's Valley").The plant was the world's only geothermal electricy power station up to 1958,when a similar plant started operation in Wairakei, New Zealand.

Energy from the plant was used in all parts of the chemical production in Larderello and in surrounding towns. However, during the First World War, the activities suffered from strikes and social unrest. At the time, Conti and the Larderel family supported Mussolini and fascism. The workers suffered considerably from the political situation. Several hundred workers were dismissed. They lost their rights to sick leave, free medical care and homes, and had to join the fascist party. Production stopped until 1922 when Mussolini had started to revive the country's economy.[2]

In 1923, two 3.5 MW generators were installed, which made Larderello by far the world's largest commercial geothermal electricity producer. In the 1920s, developments continued by installing turbines that used the underground steam directly. In 1930, the total installed capacity was over 12 MW. In the 1930s, the hot springs in Val de Diablo were nationalized, and in 1939, plant ownership was transferred from the Larderel family to Ferrovie dello Statia, the Italian railways.

Benito Mussolini

Electricity production then was more profitable than making chemicals. In 1943, the capacity was 132 MW. In 1944, disaster struck. The power plant was strategically important as a supplier to the railway network in central Italy. The Allies bombed the plant. Afterwards, only a 23 kW training facility remained in operation.

After the Second World War, the plant was rebuilt. In 1950, its capacity was 300 MW, and today it produces 800 MW, or 5.3 TWh a year (2003). At the same time, the temperature of the steam from the ground has gone down about 30 degrees. So deeper access wells are being drilled, down to 3000 to

[2] At the time, Mussolini was admired and respected by other western politicians, such as Einar Gerhardsen and Winston Churchill.

4000 metres, where the temperature is about 400°C. This has triggered considerable interest in several countries where geothermal energy can be used for producing electricity.

Assessment

Larderello was the first visionary attempt to use geothermal energy in a big way. It triggered corresponding developments in New Zealand, the USA and Iceland. Today, the largest geothermal energy producing countries are the USA, the Philippines, Mexico and Indonesia, followed by Italy in fifth place. Today Larderello generates about 10% of the world's geothermal electricity, though up to 1958, it was the world's leading producer.

Cooling towers looming in the landscape trigger debate among today's environmental activists

Today the plant is a controversial issue in the local community. Its large cooling towers make it look like a nuclear power station. They loom in the landscape and emit sulphur odours in a broad area. High land prices hamper expansion by the present owner, Enel. Some of these problems probably can be solved by building a more integrated facility and by scrubbing the steam.

After 100 years of operation, however, experience indicates that exploitation of geothermal energy can be profitable, can operate for many decades, can produce electricity at prices competitive with those of other energy sources, and can have declining production costs – in opposition to energy based on renewal sources, for which prices are increasing. More important, the energy is clean and in practice renewable from unlimited sources. The use of geothermal energy eases the demand for non-renewable, limited resources such as oil and gas.

Currently, the total potential of geothermal energy round the world that can be exploited with today's technology, is about ten times the industrial electricity production from renewable resources (water, wind, solar and biomass). If the heat from bedrock further down is exploited, the resources may be sufficient to radically change the energy market and therefore society as we know it today. If that happens it would be a good reason to rank Piero Conti's project in Tuscany as a historical milestone.

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10. The nuclear power plant in Mount Moon

Nuclear power long was a phenomenon completely unknown to the general public. In 1896, Henri Bequerel discovered radioactivity, but it was not until the fateful events of 6 and 9 August 1945, when atomic bombs were dropped on two Japanese cities, that the energy unleashed in splitting the atom became commonplace knowledge. Bequerel's doctoral student Marie Curie had been a pioneer in research on radioactive elements. That earned her two Nobel Prizes, in 1903 and 1911. But she might have been the first victim of massive exposure to radioactivity in history. It caused her death in 1934. A little more than a decade later, the atomic bombs dropped on Hiroshima and Nagasaki together killed up to 250,000 people.

From the military viewpoint, a single bomb that could destroy an entire city was a shocking breakthrough. The destruction of the two cities ended the Second World War. It also triggered a frantic arms race between the superpowers to build arsenals of atomic weapons. In turn, peaceful uses of atomic power came on the agenda. That led to lasting controversy.

The atomic arms race started earlier, in 1939 in Nazi Germany, with the *Arbeitsgemeinschaft für Kernphysik* ("Working group for Nuclear Physics") project. In the USA, the Military Application of Uranium Detonation (MAUD) committee submitted its report in 1941. The Soviet Union initiated nuclear weapons research in 1942. In the USA the Manhattan Project was launched the same year, aimed to develop the first atom bomb, which was tested in New Mexico, July 1945

Early on, Norway became involved in the nuclear arms race. In 1934, Norsk Hydro had built the world's first commercial facility for producing heavy water at Vemork near Rjukan. During the German occupation, capacity was strongly increased and already in 1941 it reached 12 tons of heavy water a year. That was taken by the Allies as an indication that Germany intended to develop an atom bomb. It therefore became urgent that heavy water production in

Norway must be stopped. So in 1942-44, there were three sabotage missions that successfully terminated the production of heavy water at Vemork.

In these early years of the Second World War, Norwegian astrophysicist Gunnar Randers worked at institutions in Los Angeles and Chicago. He had come to the USA in 1939 as a 25 year-old research fellow. For a while, he worked in the same building where physicist Enrico Fermi and colleagues were preparing the first test of a chain reaction in uranium. News had leaked out that Fermi believed it was possible.

The Allies demounting the German test reactor at Haigerloch near Stuttgart in April 1945. (source: Wikipedia)

On 2 December 1942, Fermi's team initiated the first self-sustaining nuclear chain reaction in a nuclear reactor built in a rackets court under the stands of a stadium at the University of Chicago. It was named Chicago Pile-1 and consisted of 300 tons of graphite blocks, 35 tons of uranium oxide and five tons of uranium metal. Initially it produced no more than half a watt of energy, but demonstrated that the enormous amount of energy that is liberated in splitting a nucleus can be brought under human control.

In autumn that year, Randers travelled to England to join a Norwegian meteorology group assigned to scheduling military actions in Norway. In London, he came to know Jomar Brun, the chief of production at the Vemork plant, who had been brought to England to plan the sabotage of the heavy water plant. There he became familiar with the idea of building a nuclear reactor moderated with heavy water instead of graphite as used by the Americans.

After the Normandy invasion in 1944, Randers was transferred to Operation Alsos, a branch of the Manhattan project that aimed to find how far Germany had come in its development of nuclear weapons. In that task, he came in contact with key scientists and gained first-hand knowledge of developments in nuclear energy.

In 1945, Randers was back in Oslo as an interim leader of the Astrophysics Institute. But he remained fascinated by the potential of nuclear energy. Not least, he had been inspired by the Smyth Report, "Atomic Energy for Military Purposes", published 12 August 1945, the week after atomic bombs had been dropped on Japan. The report explained the Manhattan project and provided an introduction to the scientific principles of the exploitation of fission energy. It also had a relatively detailed description of the methods the USA had used to produce the plutonium and uranium bombs.

In 1946, Randers was appointed director of the department of physics of the newly-established Norwegian Defence Research Establishment (NDRE). He was convinced that a research reactor should be built using natural uranium and Norwegian heavy water. Together with Odd Dahl, a self-taught design genius from Christian Mikkelsen Institute, in 1946 he went to the USA to collect information. There the two also visited Fermi's modified reactor, Chicago Pile-2.

The reality of the atom bomb revolutionized military thinking, in Norway as elsewhere. The Government and the Ministry of Defence were interested in atomic energy primarily for its military purposes. Randers enthusiastically argued that in view of Hiroshima and Nagasaki, one had no choice: *"either one gives up hope of effective defence, or without effective countermeasures, one must also aim in the future to have the capability of using atomic weapons".* In his opinion, the only effective protection against atomic weapons was *"to have an atomic bomb ourselves and be able to deliver it to a target".*

Minister of Defence Jens Christian Hauge, who had been the chief of the Milorg armed resistance during the War, sought to realize Randers' vision of making Norway a nuclear power. On 12 November 1946 at a meeting attended by the Prime Minister, the Minister of Finance and the High Command, he put forth recommendations to the Defence Council including "*The possibilities for industrial production of an atom bomb"*.

Jens Christian Hauge Gunnar Randers Odd Dahl

At the time, the goal of nuclear research at NDRE and the scope of research were not fully clarified. In 1946, in a study report to the Defence Commission, the research directors at NDRE and the Defence Technical Committee put forth the opinion that it was better for Norway to be allied with atomic powers than to attempt to produce its own atomic weapons. The special committee of which Randers was chairman maintained that an atomic bomb was the least expensive weapon one could have, even though the cost of its production was high.

The nuclear committee of the Norwegian Council for Scientific and Industrial Research (NTNF) considered civilian uses of nuclear power and concluded that nuclear power could not compete pricewise with hydroelectric power. Production of radioactive isotopes was then the only remaining promising civilian application. Opinion varied widely on military uses.

In 1948, nuclear research at the military research institution NDRE was reorganized as a separate institute under the Research Council NTNF. Named the Atomic Energy Institute (IFA), it was to work with the civilian applications of nuclear energy. Gunnar Randers was appointed its director. One key task was to finish the construction of the research reactor begun by NDRE, based on what could be accomplished with national resources. The goal was to conduct research on the industrial uses of nuclear energy. The civilian utility of the reactor had not yet been clarified.

A process then started and rapidly became extensive. Randers put forth a budget of NOK 5 million (about 1 million USD) to build an experimental reactor. Jens Christian Hauge arranged for appropriations within the budget for Defence materiel procurement. In all, four experimental reactors were built. The first, Jeep I, a research reactor, was finished just three years after IFA was founded. Then came a power plant/research reactor in the city of Halden in 1959, the Nora zero-power reactor in 1961 and the Jeep II research reactor in 1967, both at IFA's premises near Oslo.

The prestige of IFA activities was formidable. In 1947-51, governmental appropriations for the nuclear program were more than the total appropriations for all other research in the natural sciences. IFA expanded steadily. In 1951 it had a staff of 43. By 1960, it had a staff of 500 plus foreign scientists. It then had become the country's largest research institute.

The research triggered extensive international cooperation, but IFA remained an institute in search of a goal. In 1964, IFA released a report, *Guidelines for atomic energy work in Norway,* in which the principal aim was said to be "*ensuring the possibilities for Norwegian industry to design and build ship reactors, atomic power plants and components for them, preferably based on Norwegian R&D".* The Research Council supported that goal but indirectly inquired as to its basis in reality by requesting a survey of industrial interest in building ship reactors and atomic power plants.

Halden reactor

After the Atomic Energy Institute was established, Randers favoured construction of a power-producing heavy-water reactor to build expertise in the large-scale exploitation of atomic power. The institute had meticulously searched Eastern Norway in vain for a site to build the reactor. There were problems, not least getting rid of waste heat from the rector. However, chance came to his assistance. The Sawmill Association needed to increase the capacity of steam production for the paper mill in the city of Halden south of Oslo, and was considering building an additional boiler house. The boilers were to be coal-fired. Erik Erichsen, the chief engineer at the mill, had read about research at IFA and asked if nuclear power could be used for the purpose. Sawmill Association director O.P. Jarlsby wrote to the Atomic Energy Institute a letter of inquiry. He had hit the nail on its head. The scientists wanted a 25 megawatt reactor. The sawmill could not finance such a reactor, but was willing to provide a place to build it and to pay for power produced.

Development optimism prevailed in Norway, and there were few objections to the idea. However, several scientists worried that nuclear research would take funding away from other research. In a newspaper interview, Professor Harald Wergeland, who then was rector of the Norwegian Institute of Technology (NTH), said that it was too early to plan facilities for industrial uses of nuclear power. He felt that it would be a case of "*putting the cart ahead of the horse*". He pointed out that General Director Vogt in the Norwegian Hydroelectric Authority had concluded that within the foreseeable future, nuclear power could not be competitive with hydroelectric. He also was of the opinion that the harmful effects and health hazards of nuclear power were not sufficiently understood. He also was concerned about the handling of waste from a nuclear reactor. On 10 February 1956, at a meeting of the Norwegian Engineering Association (NIF) he described the Halden project as a "*very tall skyscraper on a frail foundation".*

But that viewpoint was ignored in the higher echelons of government and the country at large. The project had started. There was general agreement that medical and biological research wasn't sufficiently advanced to assess the effects of radioactivity on people. But the Atomic Energy Institute claimed that there would be no problems with the waste products of the planned facility. It was said that the only problem was with the fuel rods when they were taken out of the reactor when expended. However, the problem was to be solved by sending the expended fuel rods to England for processing. Building the reactor 100 metres into Mount Moon ("Månefjellet") was regarded optimal. The chief engineer Odd Dahl told newspapers that the reactor would be built safely on solid bedrock and be efficiently rid of steam. Therefore, the reactor itself would never explode. But if it did, which "*always is a possibility, the damages will be limited to the reactor". "Nothing will come out of the reactor, not even wastes. The radioactive products will be buried close to the reactor and sealed* *in concrete. We will let the future find what's in that grave.* (VG newspaper, 26.10.1955)

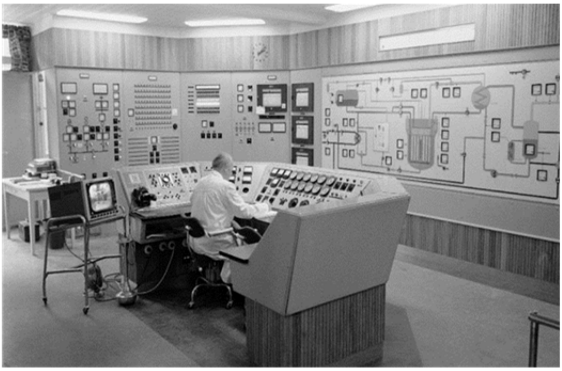
In March 1956, the Industrial Committee of the Parliament decreed that the reactor should be built. Its justifications were that the reactor would be important in the development of atomic power in Norway and that Norwegian scientists already were internationally known for their work in the field. Professor Njål Hole of the Norwegian Institute of Technology claimed that discussion of the case had been biased and incomplete. The committee gave no further details of its discussion but justified its finding by saying that "*the experiment can produce results invaluable in the use of atomic power for peaceful purposes".* (VG newspaper, 14.03.1956)

On 10 October 1959, the Halden reactor was opened by King Olav V (the middle civilian, with hat in hand) flanked by Gunnar Randers (left) and Odd Dahl (right). Photo by IFA.

The events that followed reflect the mood of the times and the prevailing political situation. On 18 May 1955, just four weeks after the proposal was made, the Government recommended that an atomic reactor be built in Mount Moon at Halden. One month later, the Parliament unanimously voted to appropriate NOK 13.9 million to the task. There was a Labour Government and Labour had a majority in the Parliament. Jens Christian Hauge was now Minister of Justice and was, as earlier an enthusiastic and loyal supporter, the underwriter for the results. The Atomic Energy Institute was so certain that the proposal would be accepted that it started blasting before the Parliament had approved the project.

The wholly Norwegian reactor was to usher in a new era in the country in which atomic power was to supply energy along with hydroelectric plants. At the same time, the ambition was to develop national expertise that would be internationally recognized. The country already had the advantage of having built one of the world’s first reactors for power production in 1951.

The planning and construction of the reactor in Mount Moon proceeded apace and took just four years. It was a cooperative effort involving the Atomic Energy Institute, the Sawmill Association, and the main mechanical industries in the country, which built the greater part of the components. On 10 October 1959, the reactor was officially started up by King Olav V.



Halden reactor control room.

The Atomic Energy Institute was obliged to enter alliances with other countries, principally the USA, to finance operations and procure fuel and heavy water. The Organization for European Economic Cooperation (OEEC, now the OECD) wished to make the Halden reactor an international project. In 1958 an agreement was entered under which Norway and Euratom covered half of the operating expenses, and Great Britain, Sweden, Switzerland, Denmark and Austria covered the other half. In the years that followed, many countries sent personnel to Halden for training and research.

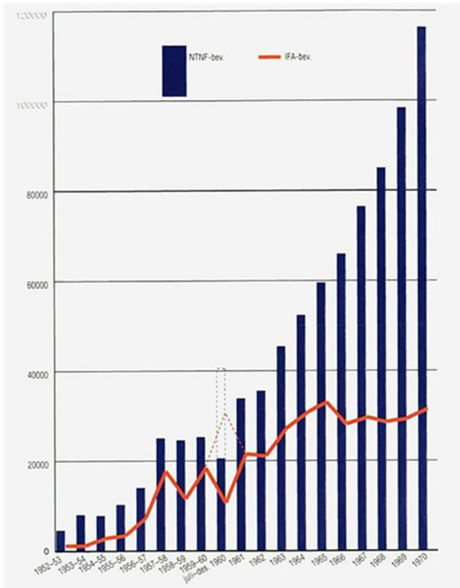
The ambition of building commercial nuclear power plants was never realized in Norway. General Director Vogt in the Norwegian Hydroelectric Authority had won that debate. In the 1970s, there was vigorous public opposition to nuclear power. Several studies showed that the profitability of nuclear power plants was uncertain, not least in light of the prognoses for future reactor fuel costs, safety measures, decommissioning, etc. In addition, there was the disaster at Three Mile Island nuclear power plant in the USA, with a partial melt-down of a reactor core. More that 70 contracted plants were cancelled round the world. After holding referendums, Sweden and Austria decided to close down existing nuclear power plants.

JEEP II research reactor at Kjeller, inaugurated in 1967. Thermal power MW.

In 1978, a governmental study of the future of nuclear power in Norway (The Granli Committee) was made public. The Committee majority of 18 to 3 went in for the building of two nuclear power plants. However, it became apparent that the conclusion was based on questionable risk analyses already disallowed by the Nuclear Regulatory Commission of the USA.

It's unclear what influenced the decision, but immediately after the Commission's report was made public, Minister of Energy Bjartmar Gjerde announced to the press that nuclear power would not be built in Norway. In 1979, the Parliament finally banned nuclear power. Already weakened, the Atomic Energy Institute faced a serious identity crisis. It was subsequently renamed the Institute for Energy Technology (IFE).

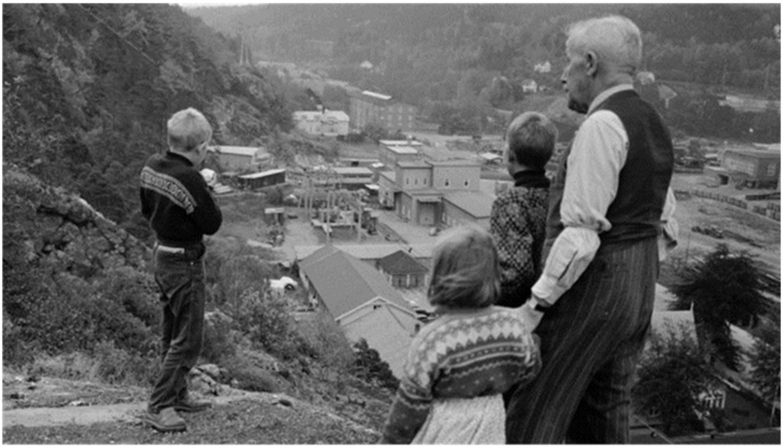
Now, 50 years later, the reactor in Mount Moon is still in operation. It's primarily a test reactor. The initial production of steam heat for the Sawmill Association met only about a tenth of its needs. Technically, the facility may be regarded to be a historical object rather than a research reactor. Operation remains mostly financed by OECD, and the facility still produces relevant research results. Today it operates only about half the year. The other half is spent in maintenance and in loading and removing experimental gear and fuel. Testing fuel rods for the international nuclear power industry is one of its principal tasks.



Public funding of the Research Council, and IFA's share (red line). Current prices. There was a drop around 1960 and a major decline relative to the institute sector from the mid 1960s on. Source: NTNF

Nonetheless, the reactor produces 60% of Norway's radioactive waste. In 2001, there was a serious leakage when a fuel rod ruptured and the primary circuit of the reactor released a considerable amount of radioactivity. Two years later, cracks were discovered in the reactor cooling system, so many parts of it were replaced before the reactor could be started again. In 2004, IFE, which is responsible for the reactor, found that in normal operation, it leaked about two litres of radioactive heavy water a day through gaskets and seals. Nonetheless, it was granted a concession for further operation until 2008.

The environmental organisation Bellona Foundation reckons that the reactor activities in Halden have produced ten tons of nuclear waste, to which 80 kg are added every year. Today the waste is stored in Halden. The government is reluctant to build an intermediate depot for storing nuclear waste, as it would cost about a billion NOK (about 0.2 billion USD). The critics probably are right about the problem. Waste handling (and decommissioning) most likely would be the decisive expenses in the assessment of the long-term profitability of nuclear power.



A resident at Mount Moon who has a view of the reactor facility, here with his grandchildren (Norwegian Broadcasting Corporation)

In the 50 years it's been in operation, the Norwegian nuclear project has been much criticized. In the beginning, it was obvious that nuclear power most likely would be far more expensive than hydroelectric power in Norway, as was the contention of politicians and technical communities from the start. Moreover, there was substantial resistance from universities and the Research Council, because nuclear research would take a greater part of the overall research budget. The same is true for industry in general, which has lamented the lack of funding of research in other sectors more vital to business. The Institute's incentives to market its expertise internationally, not least to Israel, have triggered political debate in the opposition parties. Environmentalists have recently claimed that the materials research conducted at Halden to improve the safety of nuclear power plants in other countries actually have the opposite result, as they prolong the lifetime of old reactors that should otherwise have been decommissioned. Moreover, there's been furore in the past few years after it became known that the Halden reactor was used for research on Mixed Oxide Fuel (MOX) that environmental organizations claim is a means of getting rid of stores of weapon-grade plutonium, as held in Russian and the USA. The troubling aspect is that it's relatively easy to separate plutonium from this material, which might substantially lower the threshold for making atomic weapons for countries not having them.

Finally, from the standpoint of energy technology, in principle, a nuclear reactor is the same as an old-fashioned steam engine. True, it powers a turbine and not a reciprocating mechanism, which makes it somewhat more efficient. But the principle is the same. Nuclear power is converted to electricity by boiling water to steam. Thermodynamically, this is the Carnot Cycle. So most of the energy is wasted as heat. Viewed in that way, a nuclear power plant is a museum piece.

Assessment

Retrospectively, after the disasters at Three Mile Island, Chernobyl and Fukushima, there's cause to be pleased that the visions of nuclear power production in Norway never were realized. So General Director Vogt was proved right. More than others, he knew that Norway had an overabundance of hydroelectric power.

In this project, as in so many others, what triggered it was the daring initiative of one person. But the decisive element in his success was the timing of it. He returned home with ideas and knowledge from abroad. It was peacetime. Development optimism prevailed. Internationally there was a nagging fear of the consequences of Stalin's next move. At home, the Government had a comfortable majority and the politics were extremely stabile. Randers had the full support of the most powerful people in the Government. The project proposal sailed through the political system almost without opposition or further study. Major resources were devoted to realizing the initiative, which incomparably was the country's most advanced military and industrial project. Doubtlessly, the era was decisive for the success of the project.

But there were and still are problems. The reactor was built, and then came the question of its purpose. Money no longer flowed freely, and neither industry nor the military could use the research conducted at the reactor. The saving grace was to have been that Norway would develop internationally leading expertise in Nuclear power. But the chances of that happening were insignificant. In the first place, the superpowers devoted massive international research efforts to developing nuclear weapons. Little Norway wasn't a part of that game. Second, the world's needs for energy are insatiable. Countries with less power potential than Norway would make major commitments to nuclear power and thereby gain expertise in it.

So the research reactor at Halden became less of a research institution and more of a materials testing site for the international nuclear industry. Its income comes from the OECD, from clients using it to test materials and from sale of steam power to the Sawmill Association. Governmental funding levelled off in the 1960s and thereafter declined in real purchasing power. In that manner, the project has survived for 50 years. Gunnar Randers resigned in 1978, just before the Parliament nailed the nuclear power coffin shut.

The story of nuclear power in Norway may be viewed as a variation of Ibsen's Peer Gynt. It's a mix of nationalism, megalomania and naïveté. It's materialized in a project that at best can be characterized as predominantly unsuccessful relative to its original intent. But the building of one of the world's first nuclear reactors, in a short time period with limited resources, remains impressive. Nonetheless, there's reason to believe that in its 50 years, the project has had spin-off effects on many disciplines and has been useful in many ways. But opinion remains divided as to whether the result is commensurate with the effort.

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11. DDR: Internment of a Nation - from Nazi to STASI

Major fortification and barrier building projects have been conducted throughout history. The Great Wall of China is the biggest and probably best known of them. But extensive barriers have been built in all parts of the world, not least Europe. Barrier building continues today, such as in Israel, on the border between the USA and Mexico, in Saudi Arabia and Yemen and many other places. Barriers have always been built to bar enemies or undesirables.

The inner German border between East Germany (DDR) and West Germany (BRD) was a fortification with the opposite purpose of keeping citizens inside the DDR. It stood for exactly 45 years to the day. Escape from a totalitarian regime and a misguided social system had undermined the DDR. Efforts to prevent people leaving the country became so extensive that they finally led to economic collapse and government downfall.

The inner German border was 1381 km long and stretched from the Baltic to what then was Czechoslovakia. It was formally established on 1 July 1945 as a boundary between the zones of Germany occupied by western forces and the zone occupied by the Soviet Union. It became a barrier, guarded on both sides, by western soldiers and by Soviet solders. Behind them were military forces that together numbered about a million men. In addition there was the Berlin wall, a barrier around West Berlin that was built 16 years later.

In 1949, the zones controlled by the western Allies were amalgamated and the Federal Republic of Germany was established. As a reaction, the Soviet Union declared parts of the Soviet zone as an independent state, the German Democratic Republic (DDR). Twenty years passed before western countries recognized the DDR as a legitimate country. Escalation of the Cold War and the establishment of the DDR led to the border gradually becoming a barrier, both physically and in its strength of guards. Nonetheless, there was relatively free flow of people between east and west. Until the Berlin Wall was built, the easiest route to the west was to the west zone of Berlin.


Road / Straße
(all travellers / alle Reisende
Road / Straße
(Germans only / nur Deutsch
Rail / Bahn
River, canal / Fluße, kanal
Danmark
Bundesrepublik
Deutschland
Polska
Československo
Rostock
Schwerin
Neubrandenburg
East Berlin
West
Berlin
Frankfurt
(Oder)
Potsdam
Magdeburg
Cottbus
Halle
Leipzig
Dresden
Erfurt
Gera
Karl-Marx-Stadt
Suhl
Schlutup / Selmsdorf
Lübeck / Herrnburg
Gudow / Zarrentin
Schwanheide / Büchen
Lauenburg / Horst
Schnackenburg / Cumlosen
Bergen / Salzwedel
Buchhorst / Rühen
Wolfsburg / Oebisfelde
Helmstedt / Marienborn
Helmstedt / Marienborn
Walkenried / Ellrich
Duderstadt / Worbis
Bebra /
Gerstungen
Herleshausen
/ Wartha
Ludwigsstadt
/ Probstzella
Eußenhausen
/ Meiningen
Rottenbach
/ Eisfeld
Hof /
Gutenfürst
Rudolphstein
/ Hirschberg

People from the DDR were automatically granted citizenship if they settled in West Germany. Up to 1961, some 2.5 million people emigrated. Many of them were young and well educated. So their emigration constituted an economic loss for DDR. In the same period, only 200,000 emigrated from the Federal Republic to the DDR.

In 1952, Josef Stalin ordered the leaders of East Germany to strengthen the border between east and west. Barbed wire was stretched along the entire border, from the Baltic to Czechoslovakia and onward along the Czechoslovakian border to Bavaria in Germany.

There were three zones along the border. The first was a ten-metre broad belt up to the fence. The border guards had standing orders to shoot anyone who tried to cross the boarder through this zone. Then there was a 500 metre wide security zone that only authorized personnel could enter in daytime. Beyond it lay the restricted zone, 5 km wide. People living in the zone had to show identification if they travelled into our out of the zone and were not allowed to visit other areas in it.

Erich Honecker and Leonid Breschnew

Border to other countries in the east, that is Poland and Czechoslovakia, were mostly open, though in practice difficult to cross. A passport was required. For most people, only temporary passports were available by application with justification. The people of the DDR were in principle interned in their own country.

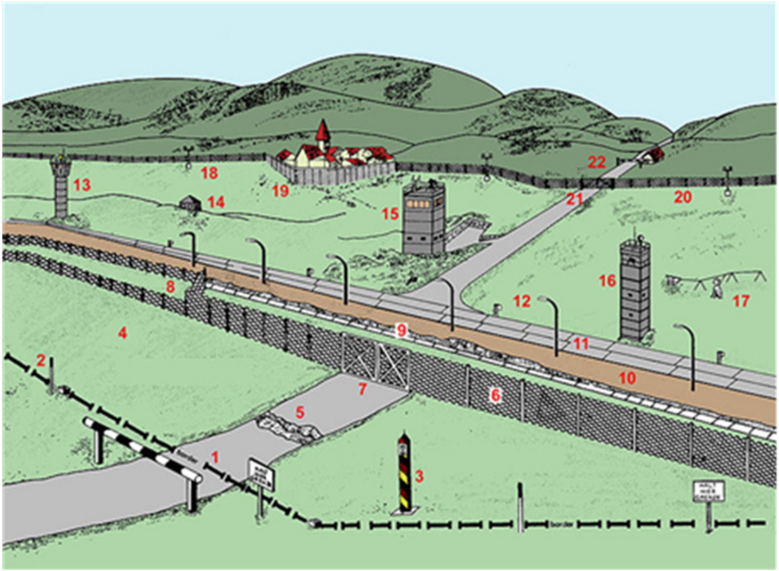
Nonetheless, the measures were ineffective. As late as 1957, more than 260,000 people illegally crossed the border into West Germany, many via Berlin. The Berlin Wall was built in 1961 to plug the last hole in the border system against the west. In the 1960s and 1970s, the border zone was substantially upgraded. The barbed wire was higher and anti-personnel land mines were laid. An army detachment took over the task of the police. In 1966 the barbed wire was replaced by a metal mesh barrier that was 2.4 m high. Plastic land mines that could not be detected by metal detectors were laid.

Tripwire-activated anti-personnel mine, of which 60,000 were mounted along the fence.

Four years later, the fence was built higher, up to three to four metres. In all, 1.3 million mines had been laid. In addition, 60,000 anti-personnel mines were laid. When triggered, they detonated to spray shrapnel that was potentially lethal within a range of 120 metres. In 1984, a three-metre high electric fence was built 450 from the border. At that time, the border was patrolled by a military force of about 48,000 men.

On the western side, there were no fortifications, save from the presence of border police and customs officers. To prevent conflicts, foreign military personnel were not allowed to approach the border.

The border on the coast of the Baltic Sea in the north was closed in several ways. The coastal strip in the west was closed to the public. There was extensive military presence, watchtowers and restricted access to boats. High-speed patrol boats were used to intercept escapees to the sea. This made escape via the sea particularly dangerous. Of the 1100 people who attempted to flee to the west, 189 people died attempting to flee via the Baltic. But that was only the tip of the iceberg. Many citizens were imprisoned for attempted escape. Even more were under surveillance to prevent escape attempts. After the *Republikflucht* ("flight from the Republic") law prohibiting escape was enacted in 1957, more than 75,000 people, an average of seven a day, were imprisoned for attempted escape. *Republikflucht* was considered a criminal act punished on the average by one to two years imprisonment. Border guards who attempted escape were more severely punished, with an average of five years imprisonment.



The three border zones within a stretch of five km from the border.

The economic impact of the gigantic imprisonment project was enormous. Building and maintaining the colossal physical facilities drained resources from the relatively poor country. The permanent military posting of 50,000 men for decades was even more expensive. Moreover, a security and political police service, known as Stasi, an abbreviation of its name, was a suppression and surveillance instrument for the communist party that comprised the state.

At its height, Stasi had 91,000 employees and a large number of informers. That’s equivalent to one monitor for every 180 citizens, about the same as was the case for the Gestapo of Nazi times.

Stasi had key tasks in identifying possible escapees and preventing escape. That led to a surveillance of individuals of unparalleled extent. It was non-productive work that incurred even greater cost. In addition, some 6900 square kilometres of land were laid waste in the border zone toward the west. That was more than 6% of the area of the country. Sine 11,000 people were forced to move. Transport routes were blocked and rerouted. Transport and communications were impeded.

Caricature of the Honecker-Breschnev embrace painted on the Berlin Wall.

The situation had serious economic consequences for all living in the zone. From being active producers, large parts of the population became state subsistence subsidy recipients. By 1983, the cost of maintaining the border forces was about a billion D-Marks. In addition, there was the economic and political strain of having an increasing percentage of the employable workforce in prision.

The long-range total effect was disastrous for a totalitarian regime that already had erred, both ideologically and politically, and for years had clung to power. In the regime’s last year, state finances were so meagre that West Germany granted the country a loan of a billion D-Mark. Franz Joseph Strauss then was Minister of Finance. The decision was so controversial that a faction within his party broke out and formed a new party. The loan only prolonged the DDR's death troubles. Ironically, at that time, the DDR sent (or sold) some of its political prisoners to West Germany for a ransom payment. That cut the expense of keeping them in prison. From 1964 to 1989, 33,755 political prisoners were exchanged in that way, against a total cost of 3.4 billion D Marks for West Germany. The prices ranged from 2000 D Mark for a worker to 11,000 D Mark for a doctor. (about 1000 - 5000 USD)

Part of the fortified border preserved for historic record. The cross marks the place where a 34 year-old worker was shot in an escape attempt in 1982.

Many believe that it was principally the economic situation and not the ideological resistance that finally toppled the regime of Erich Honecker on 18 October 1989. The two German countries were reunified on 3 October 1990, and the DDR ceased to exist by being incorporated in the Federal Republic of Germany.

After reunification, most of the inner border was demolished, save for some parts that were preserved as memorials or exhibited in museums. In 2005, the EU Parliament declared that the entire stretch of 6,800 km from the Barents Sea to the Black Sea should be a "European Green Belt", in memory of the iron curtain that once separated the countries of Western Europe from the former Warsaw Pact countries.

Assessment

Hemming in an entire population is not entirely new. For hundreds of years, Japan forbid its citizens to have contact with the outside world, and a death penalty awaited those who returned after having been abroad. The Soviet Union and the Eastern European countries had extremely strict restrictions on travel abroad for the public who were not on legitimate errands for the party or the state.

Nonetheless, Ulbricht's and Hoenecker's experiment of physically imprisoning an entire population was an unique, ambitious project. It came about in desperation and by directive from Moscow, after many of the best educated and most resourceful people fled to the west. The authorities had no choice. The experiment showed that it actually is possible to imprison an entire population, in any case for a while, at an enormous economic, political and human cost.

Today, now that the Cold War is over and cooperation between east and west has been re-established, the project stands out as uniquely negative and unsuccessful. But perhaps that's reason to reflect on the counterfactual perspective. Did fortification of the boarder help stabilize high-level politics? What would have happened had the border not been fortified? Would the normalization between east and west have been more rapid? Or would Europe now be a gigantic radioactive cemetery?

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12. The Channel Tunnel - one empire's backdoor to another

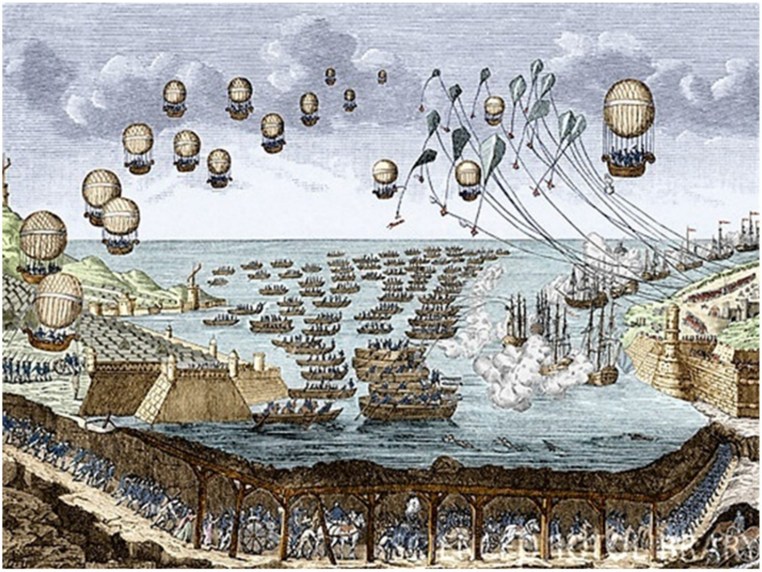
One of the largest and most spectacular investment projects of the 20th century was the building of the railway tunnel under the English Channel between England and France, known as "The Channel Tunnel", or popularly "The Chunnel". The Tunnel was built in six years, and now carries some ten million passengers and a great amount of goods a year.

As for most large investment projects, the historical background events that led to the decision to build and the final effects of the investment are perhaps the most interesting aspects of it. In this case, the historical background is fascinating and stretches over 250 years.

Nicolas Desmarest

In 1753, French geographer Nicolas Desmarest was the first to propose a fixed connection between England and France. He most likely was not the first to stand on shore, look out over the Channel and ponder the possibility. But he was the first to formulate the idea that attracted governmental attention. In 1802, French mining engineer Albert Mathieu put forth plans for a 29 kilometre-long tunnel under the Channel. It was overly optimistic. The tunnel was to be illuminated by oil lamps and ventilated by pipes sticking up above the channel surface. Horse-drawn coaches were to provide transport, and he envisioned an artificial island midway for changing horses.

At that time, Napoleon Bonaparte was head of state in France after having staged a coup d'état in 1799. He created a Consulate to be the Government of France and appointed himself First Consul. He became interested in the tunnel idea and discussed it with British statesman Charles James Fox, who was very positive and believed that the two countries could cooperate in realizing it. Thereafter, several different concepts were put forth, including a tube on the seabed between the two countries. But at the same time, relations between England and France cooled, and the idea was shelved.



Artist's impression 1802 of an imagined Napoleonic invasion of England, via an undersea tunnel, with ships and hot-air balloons. The British defence consists of warships and soldiers held aloft under kites to engage the enemy in the air.

In the 1820s, the first steam-powered railways were built. By 1850, one could travel by train most of the distance, from Paris to Calais and from London to

Dover. But many travellers feared crossing the Channel in poor weather on small ferries. The time was right to revive the idea of a railway tunnel.

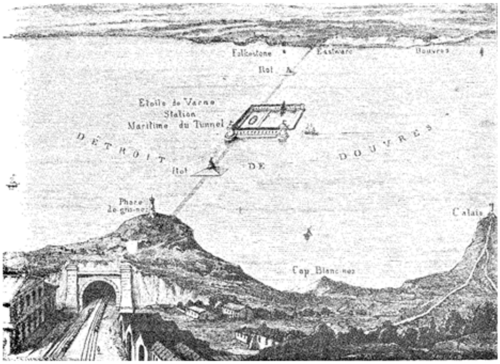
The first proposal for an undersea tunnel had been made with no knowledge of the relevant physical preconditions. It had been assumed that the limestone on both coasts also covered the intervening seabed. In 1833, a young French engineer and hydrographer, Aimé Thomé de Gamond, took up the challenge and worked for 34 years to compile a hydrographic survey of the seabed. He proposed various technical solutions, including a concept with five bridges. Understandably, the shipping trade opposed it. So he began exploring the geological conditions under the Channel, and is said to have dived down 30 metres or more to study the seafloor. He was convinced by his findings that a tunnel could be built under the Channel. De Gamond proposed a 34 kilometre-long tunnel with 12 artificial islands with airshafts. The shafts were to be designed to let water in to fill the tunnel, should war break out between England and France. This was intended to satisfy opponents of the idea. Particularly on the English side, people feared that should war break out, the tunnel could serve as a French invasion route. The tunnel was to cost 170 million Francs or seven million pounds at the time.

Aimé Thomé de Gamond

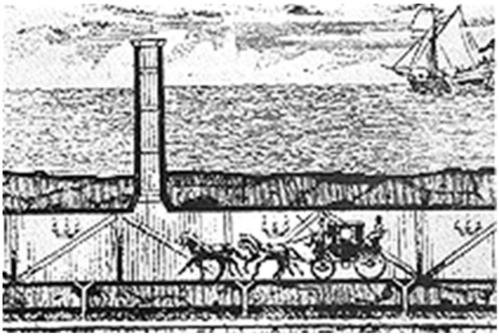
In 1856, Napoleon III granted Thomé de Gamond an audience and let a scientific commission evaluate the plan. The commission was favourable, but felt that more information was necessary for a decision to be made. Moreover, an agreement between the two countries must be in place before detailed planning began.

De Gamond secured the support of recognized engineers on the British side. Prince Albert, and Queen Victoria who suffered seasickness, were both positive of the idea, which gave it favourable publicity. During his visit to England in 1858, he was nevertheless confronted with an attitude that was common among British who didn't want a fixed connection but wished to keep Great

Britain's status as an island. In a meeting with de Gamond, Prime Minister Lord Palmerston is reported to have remarked “*What? You wish to make us contribute towards a scheme, the purpose of which is to reduce the distance we find already too short!*” That attitude didn’t change after Napoleon III suffered an attempted assassination where British-built bombs were used. In France, the attempt cooled relationships, and in England it triggered renewed fear of an invasion.



Thomé de Gamond’s sketch of 1856 for an undersea tunnel.

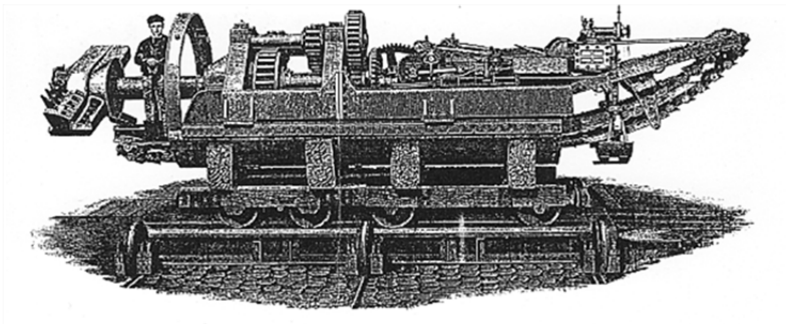


Cross-section of tunnel with a ventilation tower (Wikipedia)

However, technology had progressed considerably at the time. Railways had been well established both in England and France, which again made the tunnel topical. Many stretches of railway had long tunnels. A pedestrian tunnel under The Thames was opened in 1843. A submarine telegraph cable between England and France was operational in 1851. The Suez Canal was completed in 1869.

At the same time, smoke from locomotives had been found to be unbearable for passengers in a 500-metre long railway tunnel, England’s longest of the time. So passenger trains in a 30 km long submarine tunnel were unthinkable.

Later, interest in a tunnel under the Channel was renewed by an upswing in international trade and the successful building of railway tunnels under the Swiss Alps, including the 13.7 km long Mont Cenis tunnel opened in 1871 and later the 15 km long St. Gotthard tunnel opened in 1881. Then British engineer William Low, experienced in ventilating coal mines, suggested building two parallel tunnels, each with a single track, connected at intervals by cross-tunnels. In such a configuration, the piston effect of trains moving through the tunnels would make them self-ventilating. In fact that’s the basic principle of the configuration of today's Channel Tunnel.



The Beaumont-English boring machine used in 1881 to bore a test tunnel on the English side (Wikipedia)

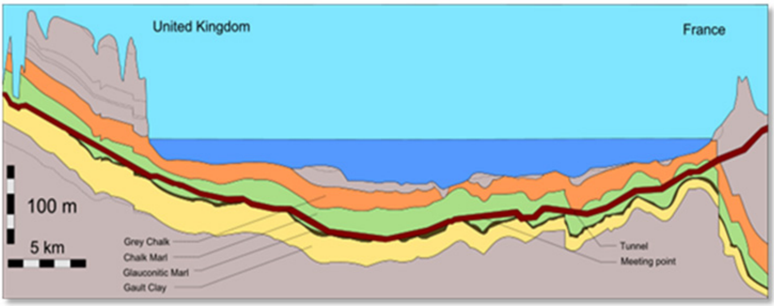
The authorities in both England and France supported Low's concept but were unwilling to financially commit to it. Geological surveys performed in the 1870s confirmed that the rock material under the English Channel was an unbroken layer of chalk marl (limestone). The lowest part of it was well suited for tunnelling, as it was easy to quarry, contained almost no flint and was nearly impermeable to water.

In 1876, an Anglo-French protocol was established to build a railway tunnel under the Channel. Railway entrepreneur and politician Sir Edward Watkin, who was also board chairman of Chemin de Fer du Nord on the French side, was fascinated by Low's concept. Together with Suez Canal contractor Alexandre Lavalley, he established the Anglo-French Submarine Railway Company that started test tunnelling on both sides of the Channel. A boring machine designed by Thomas English, driven by compressed air and advanced for its time, was used for tunnelling from the English side. The tunnel had a diameter of seven feet. Within two years, the tunnel had been driven almost two kilometres into limestone from both the English and French sides. The boring machine was so efficient and the limestone under the Channel so easily quarried that by using machines from both sides, breakthrough would come within three and a half years. The plans called for trains in the tunnel to be drawn by locomotives driven by compressed air, not steam. So there would be no need for extensive ventilation systems.

Sir Edward Watkin. Carikature, 1875

However, the project was stopped in 1882, in face of political opposition and financial difficulties. Despite Sir Watkin's repeated attempts to persuade leading figures, such as the Prime Minister, the Prince of Wales and the Archbishop of Canterbury, to resume tunnelling, the opposition was too strong. A tug of war went on for six years, and unauthorized tunnelling was started several times.

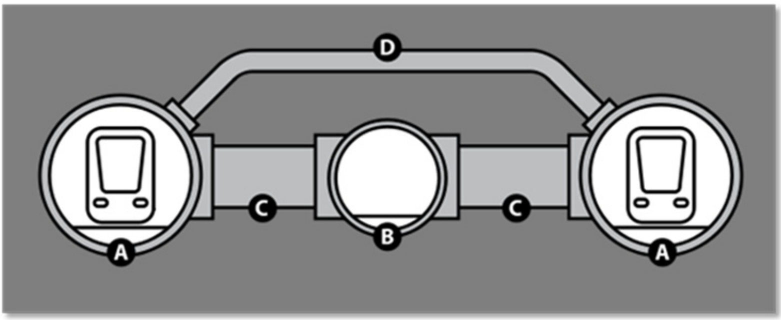
After Prince Albert's death, Queen Victoria had lost some interest in the scheme. Prime minister William E. Gladstone, had grave doubts about building a connection between cheerful England and the Continent. That reflected the attitude of the day. The Times warned that it saw the tunnel as a security risk, in spite of assurances that it could be built so as to be blown up before an invading army could reach England through it. *"To hang the safety of England at some most critical instant upon the correct working of a tap, or of any mechanical contrivance, is quite beyond the faith of this generation of Englishmen."* The Chamber of Commerce stopped all further work on Sir Edward Watkin's tunnel, even though its entrance was on his private property, because it was made clear that the Crown controlled the area and bedrock from the coast out about five kilometres in the Channel. However, Sir Edward continued his attempts to finance the project and didn't give up before the mid-1890s. In retrospect, he did manage to prove one thing, that the soil conditions were very suitable. More than a hundred years later, his tunnel remains intact.



Geological formations under the Channel. From C.J. Kirkland, Engineering the Channel Tunnel, 1995

Ten years later, a tunnel under the channel again was of interest. The relations between England and France had improved. Electric locomotives made railway tunnels feasible, as proven by the electric railway line under the Hudson River between New Jersey and New York City. At the same time, the breaking and transport of rock material had been considerably improved. But political opposition continued. The French put forth a proposal intended to lessen British fears. The entrance to the tunnel on the English side could be surrounded by a horseshoe-shaped aqueduct arranged so it could be punctured by artillery to flood the tunnel in case of war. But that didn't help. In 1898, the project was forcibly abandoned when building was restrained by order of the High Court.

But then came the First World War, in which aircraft were first used in warfare. England then found that its status as an island no longer offered the same protection as before. After the War, conditions were more favourable for resuming work on the tunnel. But the project had little priority in the harsh economic conditions of the post-war years. In the late 1920s, trial tunnelling was tried several times, but the project was thwarted by the military and politicians who were suspicious of France. Interest in the project then lapsed in the great depression of the 1930s.



Channel Tunnel cross-section. A: 7.7 m diameter rail tunnels. B: 4.8 m service tunnel. C: 3.3 m cross-passages. D: 2 m piston relief duct. Drawing by Arz, from Wikipedia.

During the Second World War, fears arose that the Germans might secretively build their own undersea tunnel to England. Others contended that if an undersea tunnel had existed, it would have eased British combat of Germans on the continent. After the war, the tunnel was not much mentioned. Reconstruction had higher priority. Moreover, The Channel Tunnel Company offices and documents had been destroyed in the bombing of London.

By the mid 1950s, when technological development had spawned atomic weapons and jet fighter aircrafts, the tunnel project was seen in a new light. The world had shrunk, and there was renewed interest in financing the tunnel. Private investors again considered the project. In 1957, a Channel Tunnel Study Group was set up to assess its various aspects. Geophysical studies were made with modern equipment, and deep test drilling was done. Market demand and profitability were estimated. Several alternatives were assessed. The Group concluded that the most suitable one was to build a railway tunnel through which cars would be carried on trains. That alternative was chosen.

The problems now principally were economic and financial. Protests were put forth by commercial interests, including ferry companies and would-be operators of hovercrafts. The initiative then was in the hands of private actors who sought to finance the tunnel without public support. But governmental approval on both sides was nonetheless necessary. In 1974 an agreement was made. The two companies, the Channel Tunnel Company and Société Française du Tunnel sous la Manche were to build the tunnel in cooperation with the railways in Britain and France. Profits were to be shared in the first 50 years of operation. Thereafter, ownership would be transferred to the two governments. Tunnelling began from both sides. In 1973, England and France entered the European Common Market. The two governments then agreed to reassess the project. But in 1975, after the Labour Party had formed a Government, the British withdrew from the project in the wake of the financial crisis created by the sudden explosive rise in oil prices.

Economic difficulties, rapidly rising cost estimates and uncertainties as regards EU membership were the grounds given. The French were frustrated.

Several attempts to restart the project followed. In the early 1980s, a new consortium of the two railway companies and the private Channel Tunnel Group was founded. In 1981, Prime Minister Margaret Thatcher and President François Mitterrand appointed a working group to look further into the project. Promoters were invited to submit conceptual solution proposals by the autumn of 1985. Ten proposals came in. Four of them were short listed: Eurobridge, an elliptical-shaped tunnel with roads at several levels, Euroroute, with tunnels, bridges and artificial islands, Channel Expressway, with four separate tunnels, and Europe Tunnel, in principle the same as the 1950s concept and quite like William Low's proposal 100 years earlier. Europe Tunnel was chosen.

In February 1986 in the Canterbury Cathedral, Margaret Thatcher and François Mitterrand signed an Anglo-French Treaty on the Channel Tunnel. In 1987, it was followed by a Concession Agreement that granted the French and English parties the right to finance the building and operate the Tunnel for 55 years. Later, the Concession was extended to 2086, that is, for 99 years. In 1988, work on the Tunnel began from both sides. Breakthrough came in just two years. On 6 May 1994, the Tunnel was formally opened by Queen Elizabeth II and President François Mitterand. It has been in daily operation ever since. The project then had been delayed by two years, and its cost overrun was considerable.

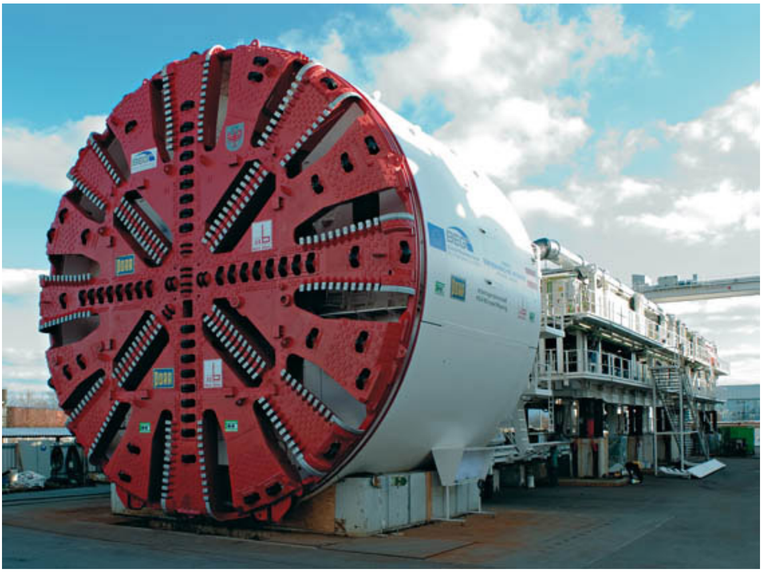
In November 2007, a high-speed rail link began service from London. The Tunnel is the world's next longest. It is about 50 km long, of which 38 km is under water, at an average depth of 40 m under the seafloor. Each year since its opening, trains in the tunnel have carried five to ten million passengers and 15 to 20 million tons of goods. In 1999, the operating companies showed a profit, after having operated at a loss for the first five years.

Today, opinion varies about the economic viability of the project. Cross-channel traffic has been shifted from boats to trains, and travel time has been cut considerably. Some passenger traffic has shifted from air to rail. However, the traffic patterns in the region are relatively little affected. Five years after it was opened, a Commission of the EU concluded that in the two countries, the economic impacts of the Tunnel itself had been few and small. Studies have shown that the British economy would have been better without the costs of the project and that the operating companies have had to ask for considerable support from the government to meet their financial obligations and maintain operations.

Assessment

Retrospectively, one might speculate as to the goal of the project. Looking back 250 years, it's doubtful that financial gain was a motive. Financial considerations came in the 1970s, more than 200 years later. Politics are an equally unlikely motive. On the contrary, politics and public opinion mostly hindered the project throughout most of its life. The motive most likely was vague. Perhaps the project was triggered by a quest to find what was possible, or by an inherent urge to surmount barriers. Indeed, the sea seems to be a barrier when one stands on a coast of the English Channel and gazes across toward the other side. Or maybe it comes down to the human penchant for building castles in the air.

The interesting aspect is that this vision or ambition survived for hundreds of years and finally was realized. Moreover, it was realized in a way much like the



original idea. We see that also in many other major investment cases.

In its long time span, the project illustrated the interplay between technology, politics and economics. The political scene shifted in a cyclic pattern over hundreds of years, from closeness to conflict between the two countries. The economic conditions have changed with macroeconomic cycles, particularly more recently, not least due to wars that subsequently depressed economic resources. The relevant technology developed in quantum leaps that determined what was possible and feasible: Initially, horse-drawn vehicles were to be used, which made the project nigh unthinkable. Then came steam locomotives that substantially cut travel time but also were so polluting that they could not be used. Then slight progress was made with a concept involving two separate tunnels that could solve the pollution problem. But then came a new breakthrough, the use of electric locomotives that eliminated the problem completely.

Throughout, national security considerations brought in political obstacles. At the same time, the project was so unrealistic that financial assessments didn't enter the picture significantly. Then came the 20th century, with two World Wars and quantum leaps in new military technologies. England no longer was protected by the sea. That broke down the last political barriers, so conditions favoured the project. Moreover, tunnelling became more efficient and much less expensive. The economic preconditions improved radically in the last half of the century, in step with a corresponding upswing in the needs for transport and trade across borders. So after 1980, it was only a question of arranging the organization and financing and of ensuring the profitability of the project.

Obviously, the project may have been realized in a hurried way toward the end of the 250 years. So perhaps the project was not adequately substantiated. From the standpoints of the governments of the two countries, it was probably more basically a question of realizing a historical dream, or for politicians, ensuring themselves a place in history. Both the Queen of Great Britain and the President of France attended the opening and consequently stood as guarantors for the project. In the final analysis, the guarantee implies that the responsible parties are absolved of much of the financial risk they assumed. The public/private consortia that operate the tunnel have been heavily subsidized by the governments of the two countries, and the concession period that assures their profit from operation has been nearly doubled from its original 55 years.

Consequently the conclusion, as often is the case, is that the State draws the short straw and realizes slim earnings from the extremely costly project, while the concessionaires grow and profit from it.

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13 SpaceShipOne - the civil society's first step into space

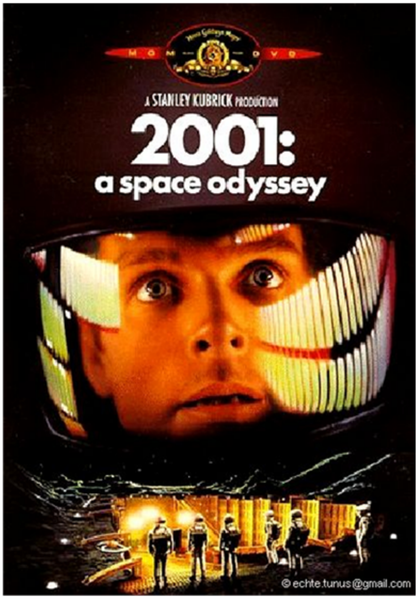
The space race between the Soviet Union and the USA during the second half of the 20th century had its roots far back in time. It is a story of the visions and ideas of individuals and the uninterrupted breakthroughs in technological development. But the common denominator in the story is the military motive, during many centuries of warfare, conquest and defence. Nations have been the actors. Enormous resources have been deployed, particularly in the past 60 years on something that almost exclusively had to do with military capability and political supremacy.

But on 21 June 2004, there came a break with that trend. A privately-financed space ship was launched. The vision this time was to develop a new market for experiences and tourism in space and to enable rapid transport over long distances. It happened 100 years after the Wright Brothers took to the air in a motorized flying machine.

Rocket technology

The phenomenon of rockets dates from 13th century China. In the 10th century, Chinese alchemists had invented gunpowder in their search for an elixir of life. That led to the development of bombs, cannons and rocket-propelled fire arrows. There are many records of the use of rockets in the 13th century. The Chinese used rockets against the Mongols, and the Mongols used rockets in conquering Bagdad. Military developments and uses of rockets are described in European texts of the 17th and 18th centuries. In 1792, rockets encased in iron tubes were first used in warfare. They were used in India, in battling British forces. The iron tubes extended the range of rockets up to two kilometres. William Congreve further developed the technology for the British. His first rocket had solid fuel, weighed about 15 kg, and was used in the early 19th century in the Napoleonic wars.

The use of rockets in warfare spread throughout the West. They were used in 1814 in the Battle of Baltimore and in 1815 in the Battle of Waterloo. Early rockets had control sticks and were inaccurate. In 1844, vanes were fixed so a rocket would spin about its axis, which improved precision.

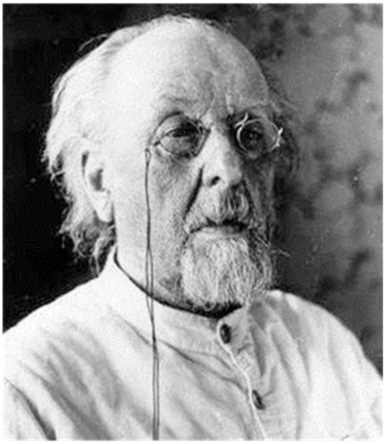


Poster for the film ”2001: a Space Odyssey”

The earliest visions of the phenomenon of space travel were put forth in science-fiction literature. The most famous pioneer of that genre was Jules Verne. In his novel “From the Earth to the Moon” of 1865, a group of people is shot in a projectile by a cannon aimed at the Moon. In 1895, H.G. Wells published "The War of the Worlds", in which Martian invaders attack the world with advanced weapons. In the beginning of the 20th century, there was a flood of fantasy literature that gave life to the idea of space travel. There were action stories, such as the "Flash Gordon" series, as well as visionary scenarios by Isaac Asimov, Ray Bradbury and Arthur C. Clarke. Most famously, Clarke triggered widespread interest in space travel when Stanley Kubrick’s film, “2001, a space odyssey”, which was partly based on Clark’s short stories, was a box office hit in 1968.

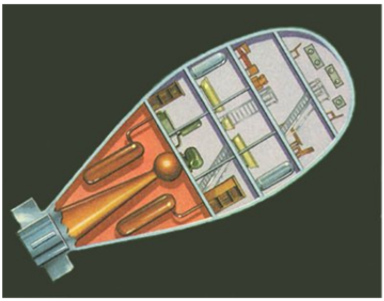
Military space travel

Modern space travel can be said to have begun in 1903, when Russian scientist Konstantin Tsiolkovsky published a fundamental book on the research of the cosmos using reaction-propelled devices. Tsiolovsky was born in 1857 to a middle-class family. At the age of nine, he became hard of hearing. So he was not admitted to elementary school and became self-taught. As he was growing up, he spent hours in libraries and was inspired by Jules Verne's books. He became skilled in mathematics, and went on to teach mathematics throughout his life. He published more than 400 scientific works of which 88 were on space travel and related topics. Inspired by the building of the Eiffel Tower, in 1887 he proposed a “space elevator” to transport material into space without using rockets. The space elevator was to be a cable stretched by centrifugal force on a counterweight outside the geostationary orbit.



Konstantin Tsiolkovsky, “the father of space travel ”

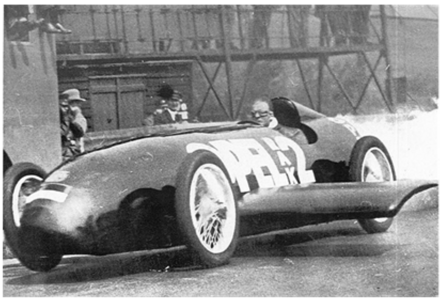
Tsiolkovsky worked in isolation from the existing sphere of knowledge. Nonetheless, he formulated in his own way the basis for the kinetic theory of gasses. He calculated the escape velocity from the gravitational pull of the Earth and worked on the principles of inventions including airplanes, hovercrafts and interplanetary travel. He lived his entire life in a log cabin near his home town. He was little recognized for his discoveries until 1921, when he was appointed member of the Socialist Academy and granted a lifetime pension. On the centennial of his birth, the world’s first artificial satellite, Sputnik 1, was launched. He also was honoured by being depicted on a 1 Rouble coin in 1987. The most prominent crater on the far side of the Moon is named after him.



Tsiolkovsky: manned spaceship (The Encyclopedia of Science)

The other early space travel pioneer was Robert H. Goddard, an American born in 1882. He was a physicist, professor and inventor who provided much of the basis for modern rocket technology. In 1919 he published a seminal work entitled "A Method of Reaching Extreme Altitudes". In it, he describes much of the mathematical basis for launching rockets and the results of his own experiments. He also discusses the possibilities for exploring the Earth's atmosphere and the space beyond it. Goddard's book and Tsiolkovsky's book of 1903 are regarded to be the basic works on space travel. But Goddard was not well recognized for his work. In 1926, he developed the world's first liquid-fuel rocket that led to other developments, such as the bazooka. Newspapers ridiculed his proposal to use multi-stage rockets to reach the Moon. The Army rejected his proposal for developing rockets. Later he worked in developing experimental aircraft for the Navy.

Robert Goddard in 1926 with the world's first liquid-fuelled rocket

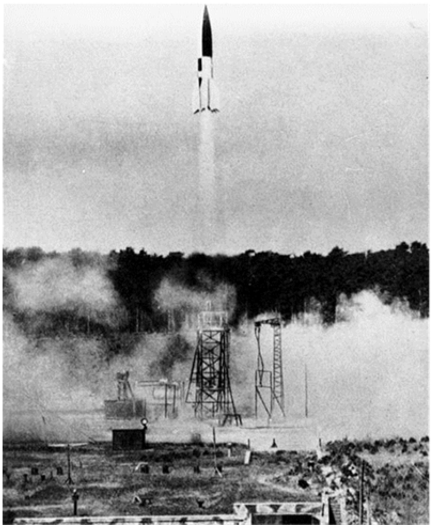


Fritz von Opel's rocket car that attained a speed of 230 km/h in 1928

Thereafter, he moved to Roswell, New Mexico, that later became known as the site of an alleged UFO crash. He then stopped working on the development of rockets.

Goddard was honoured by a commemorative stamp in the USA. He died on 10 August 1945, the day after an atomic bomb destroyed the greater part of Nagasaki in Japan.

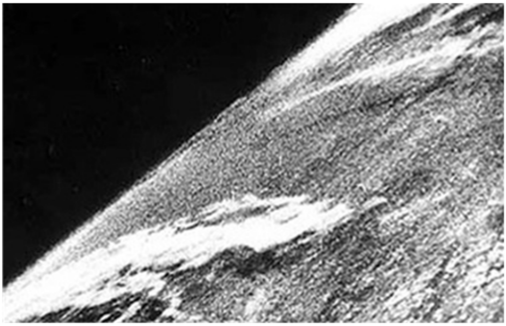
The great technological breakthrough came during the Second World War. The mastermind of the breakthrough was Wernher Magnus Maximillian, Freiherr von Braun. As a boy, the aristocratic von Braun was fascinated by the speed records attained in 1928 by Fritz von Opel's rocket cars. His mother gave him a telescope, which whetted his interest in astronomy. Later, in school he read a book by Herman Oberth on interplanetary travel by rocket. That prompted him to study mathematics and physics. He studied at the Technical Universities in Berlin and Zurich. At the time, the Nazis were gaining political strength, and rocket technology was on the agenda. Von Braun was awarded a research grant and did a doctorate on the subject in 1934. In 1937, he joined the party and in 1940 became an officer in the Waffen SS.



V2 rocket launch from Peenemünde in the summer of 1943 (Wikimedia)

Hitler saw the potential of applying rockets as vengeance weapons. That led to the development of the V2 ballistic missile that toward the end of the War was used against targets in Great Britain and then Belgium. The development was led by von Braun, who to a great degree based his expertise on Goddard’s publications. He worked at Peenemünde with Hermann Oberth and others. In 1942, the first V2 was test launched. Hitler was so enthused by the result that he personally appointed von Braun to professor, extremely unusual for a 31 year-old engineer.

Germany produced 5200 missiles up to its capitulation. Though its precision was poor, the V2 was a dangerous weapon that extensively damaged Britain.



The first photograph of the Earth from space, taken in an American launch of a V2 rocket on 24 October 1946, to the day a year after the United Nations was established.

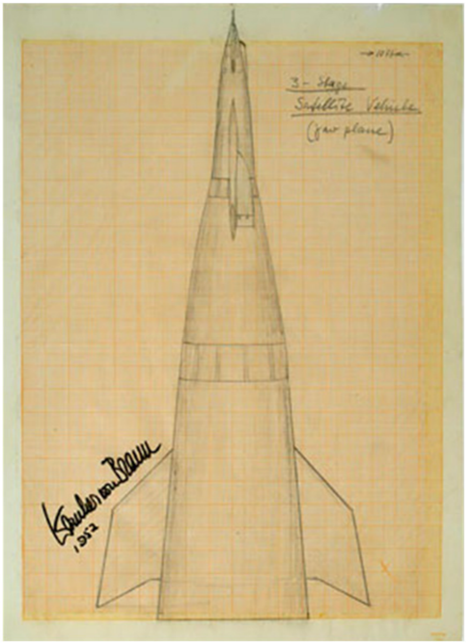
It also was advanced. In fact, neither the Russians nor the Americans were first in space. Hitler's Germany was first. In June 1944, a V2 rocket attained an altitude of 100 kilometres, known as the Kármán Line, the border between the atmosphere and space.

Wernher von Braun surrounded by German officers in Peenemünde 1941 (Wikipedia)

After Germany surrendered, the Allies scrambled to get German rockets and technology. The USA took out 300 trainloads of rockets and equipment and acquired 126 engineers and technicians. One of them was von Braun, who became a key figure in USA's military rocket programme. He later was appointed director of one of the space centres in the civilian space administration NASA.

The Soviet Union gained control of the key V2 production facility and took 30 missiles back to the USSR. The Soviets also captured and relocated many of the technical personnel with their families to the USSR. There the group of about 250 engineers developed the R1 missile, a copy of the V2. In 1951, the last of the German group left the USSR and returned home.

In the post-war years there was a breakneck race to develop rockets. The atom bomb was an irrefutable reality after Hiroshima. It had been dropped by a bomber. Clearly, rockets would be better for carrying such weapons to their targets. Likewise, artificial satellites were ideally suited for monitoring enemy territory, for supporting communications and guiding missiles.



Wernher von Braun’s sketch of a spaceship, 1952 (New York Times)

Gaining height always has been a key part of military strategy. In former times, high hills were used and high walls built to gain vantage and to exploit gravity in combating enemies. Later, watch towers on ships and hot air balloons were used for surveillance. Military ballistics evolved from bow and arrows and spears to firearms to long-range cannons to bombers to missiles. Warfare was revolutionized by the use of aircraft for attack and reconnaissance. Military aircraft operated at increasingly greater altitudes, gradually with computer-controlled precision weapons.

In the 1960s, space became militarized, with spy satellites and positioning systems that now give space nations great advantage compared to most other nations that operate only in lower airspace. Presence in increasingly higher layers of the atmosphere and above ensures military capability on the ground. Earlier, control of airspace was essential to winning a war. Today, control from space enables a country to use missiles to knock out an enemy's air defence. In 1961, Vice President Johnson said that "*Control of space means control of the world"*. So future wars between space nations probably will start by neutralizing enemy installations in space.

The ambition of consolidating increasingly higher levels led directly or indirectly to the enormous expenditures of the space race. On 21 August 1957, the Soviet Union successfully tested its first intercontinental ballistic missile (ICBM). In October 1957, it placed the world's first artificial satellite in orbit. Three years later, in 1961, Russian Yuri Gagarin became the world's first cosmonaut. That came as a shock to the USA and triggered a major effort that resulted eight years later in the first manned mission to the Moon, Apollo 11. By then, the Soviet Union had already sent space probes to the Moon and to Venus. Thereafter there were many expeditions to planets and celestial bodies within our own solar system. Then came a new international race to establish military communications and monitoring platforms in space. In 2009, General Xu Qiliang, commander of China's Air Force, is reported to have said that air force presence will inevitably have to shift from airspace to space and from national defence to attack capability.

President John F. Kennedy initiated the American effort to put men on the Moon within ten years. Wernher von Braun was one of his key advisers on space matters. Later von Braun remarked that he used Arthur C. Clark's book "The Exploration of Space" to persuade the President.

Civilian space travel

The major space programmes of course laid the foundations for the potential development of civilian space travel. But it's been long in coming, perhaps because the national programmes' unlimited access to resources and funding, which resulted in technologies and technical solutions that from a business viewpoint would be too expensive to become profitable. Already in 1969, Arthur C. Clark remarked on that as the Apollo 11 mission was on its way to the Moon. He wrote that in principle, an energy expenditure corresponding to about 400 kg gasoline and oxygen was sufficient to send a man to the Moon. At the prevailing price levels, the cost would be about 25 dollars. The Apollo mission used about a thousand tons of propellant per person and cost in all

200 million dollars[3]. That, he ironically remarked, indicated that there was considerable room for improvement.

The turning point for civilian space travel came on 21 June 2004, with the launch of SpaceShipOne. It was a financial as well as a technological breakthrough. The launch was a low-cost alternative that may spawn a new industry. The project came about through a coincidence of interests involving a brilliant aeronautical designer, an international contest and three enthusiastic businessmen.

The key person of the alliance was Burt Rutan. His background equipped him well for success in the venture. He grew up enthusiastically interested in flying and flew solo at age 16. He eagerly followed the space programmes, and Wernher von Braun was his hero. He took a degree in aeronautical engineering at a time when the USA lagged seriously behind the Soviet Union in the space race, and there was a great demand for engineers in the space programme. He then took a course in space technology at CalTech. That would have ensured him an engineering job with NASA. But he didn't want to be a small cog in a big wheel. He sought to do something more worthwhile.

He took a job with the US Air Force as a flight test project engineer, in which he took part in testing new types of aircraft in extreme conditions. Eight years on the job had given him valuable first-hand experience in developing aircraft designs. After two years as the director for a small aircraft producer, at age 32, he started his own company, Rutan Aircraft Factory.

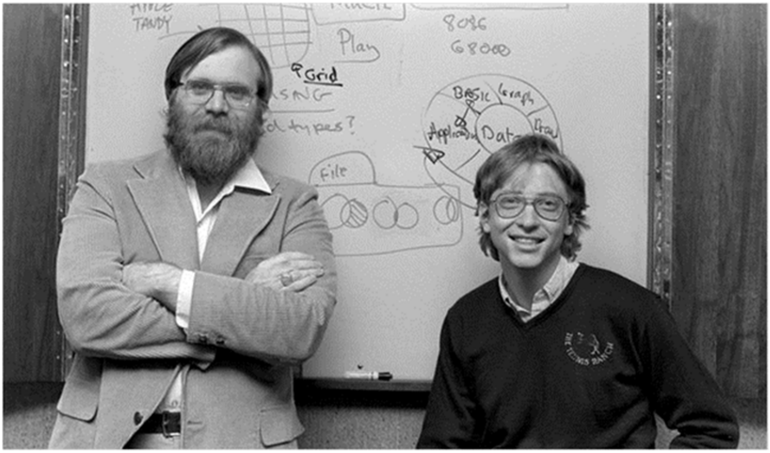
In his career, he has developed more than 300 aircraft concepts, of which 45 have flown. One of them was Voyager, that in 1986 flew round the world non-stop without touching down or refuelling. The flight took nine days. At that time, the company began to receive orders from NASA and major aircraft manufacturers for building and testing composite material prototypes. So he started a new company, Scaled Composites.

In 1993, he began working on a concept for building a spacecraft that could attain low earth orbit, or an altitude of 100 kilometres. It entailed designing a one-man rocket that would be air launched from a mother ship at an altitude of eight kilometres. At that time, Burt Rutan had begun working on another

[3] 1960-prices

concept together with Paul Allen, an investor. It entailed the use of aircraft as links for broadband communications on the ground. The craft were to circle over Los Angeles at extreme altitude. The subject of suborbital use of spacecraft came up, and Rutan suggested several technical concepts that interested Allen.

Paul Allen was no ordinary businessman. In the 1970s, he and Bill Gates had developed the MS-DOS operating system and started Microsoft. After a while, Allen left the company and started Vulcan Inc., an investment company. Today he's worth some 10 to 15 billion dollars. In the 1980s, he survived lymphoma. Today he is a philanthropist concerned with research and technological development.



Paul Allen and Bill Gates in 1982 (Barry Wong/The Seattle Times)

Allen and Rutan met over lunch at which Rutan sketched technical concepts on a napkin. Those napkin designs were prophetic, as the craft finally built were quite like them. The principle was simple and elegant. First and foremost, it took finances into account.

The costs had to be at a level sufficiently low to make the project feasible. Two technical problems had to be solved. First, the vertical launch from ground level requires an enormous amount of energy and uses giant launch vehicles. Second, the speed of re-entry into the atmosphere is so high that it causes extreme friction heating that in turn brings about a high risk of accident.

Rutan's solution to the first problem was to fly the spacecraft up to an altitude of 14 kilometres before it was let loose and its rocket engine activated. His solution to the second problem was to use feathered wings in which the wing and tail booms folded upward from the fuselage. The spacecraft then was stable in free fall, with the fuselage dragging. Speed was moderate. Upon descending to flying altitude, the wings were folded back out, and the spacecraft returned to land as a glider.

That apparently was enough to convince Allen, who invested 20 million dollars in the project. They established Mojave Aerospace Ventures. It aimed to develop in three tiers. Tier one was a suborbital launch of SpaceShipOne. If successful, tier two would aim to orbit a spacecraft round the Earth. A possible tier three would aim to leave Earth orbit and travel to the Moon or Mars.

A third person then got involved, Peter Diamandis, who held a degree in aerospace engineering from MIT. He had long wanted to be an astronaut. But he realized that the chances of becoming one were negligible, even if he got a job in the space programme. Nor could he ever manage privately. The first paying space tourist who visited the International Space Station (ISS) paid 20 million dollars for the experience. A single launch of the space shuttle cost 500 to 750 million dollars.

Diamandis had read about Charles Lindberg's crossing of the Atlantic and learned that it was an effort to win the Orteig Prize of 25 thousand dollars. The prize had been initiated in 1919 by New York hotel owner Raymond Orteig. Several teams had tried, and six pilots had died in the attempt. In 1927, Lindberg tried and won. It not only resulted in fame for Lindberg. The wider spin-off effects were astounding. His feat triggered a new gigantic industry, civil aviation. Its development was explosive: from 1926 to 1929, the annual number of air passengers in the USA went up from 6000 to 175,000.

Dimandis reasoned that a prize for civilian space travel could catalyse development in the same way. He called it the "*X-prize*" and began searching for sponsors. It was made public in 1996 at a ceremony attended by 20 astronauts, the NASA director, descendants of Charles Lindberg and Burt Rutan, who announced that he would be the first entrant in the contest.

The goal of the contest was to develop a low-cost alternative to conventional space travel. The rules were simple. The spacecraft developed must be reusable. It should attain an altitude of at least 100 km, twice in two weeks, have a carrying capacity of three people, be financed without public funds, and return its crew unharmed. The prize money was set at 10 million dollars.

Dimandis had great difficulty finding a sponsor. Then by chance, another space travel enthusiast, Anousheh Ansari[4], read about the prize on the Internet. Ansari was an information technology engineer and a successful businesswoman in telecommunications. She had been a teenage refugee from Iran. In 2002, the Ansari family began to support the X-prize foundation and in 2004 donated considerable funding so that the prize was renamed the Ansari X Prize.

In all, there were 26 contestants for the Prize. Burt Rutan probably had a good head start. The development, building and testing of SpaceShipOne took three years, and the design functioned as expected with no major problems.

On 21 June 2004, the development team had its first successful launch to an altitude of more than 100 kilometres. Three thousand spectators witnessed the launch at an airstrip in New Mexico. The pilot was Burt Rutan's best friend Mike Melville, originally from South Africa, a 63 year-old grandfather of four.

The spaceship was just ten metres long. Its hybrid rocket engine used 300 kg of a solid rubber for fuel and 500 kg of liquid laughing gas[5] as an oxidizer. The spacecraft was attached to a mother ship that took off from the airstrip at 6:47 a.m., circled upwards for about an hour, before the spaceship was released at an altitude of 15 km. The spaceship then glided briefly on its large wings before the rocket was ignited to send it nearly vertically upwards at an acceleration of 3-4 G for 76 seconds, to an altitude of 50 km.

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4 In 2006, Anousheh Ansari's fascination with space led her to be the fourth self-financed member of the crew of a Soyuz-launch to the International Space Station. When asked by the press for her reason, she replied that she went to inspire young women, particularly from the Middle East, where women have fewer opportunities than men, not to give the hope of attaining their goals.

5 hydroxyl terminted polybutadiene (HTBP) and nitrous oxide (N_2O)

At a speed of about Mach 4, it continued its upward trajectory with no power, in the increasingly thinner atmosphere, until levelling off at an altitude of about 100 km. Melville then had about three and a half minutes of weightlessness. He picked a handful of M&M button-shaped candies from his breast pocket and let them float freely in the cockpit before the craft began to fall back toward the Earth. Its speed then was about Mach 3.

SpaceShipOne being airlifted to launch altitude by mothership White Knight

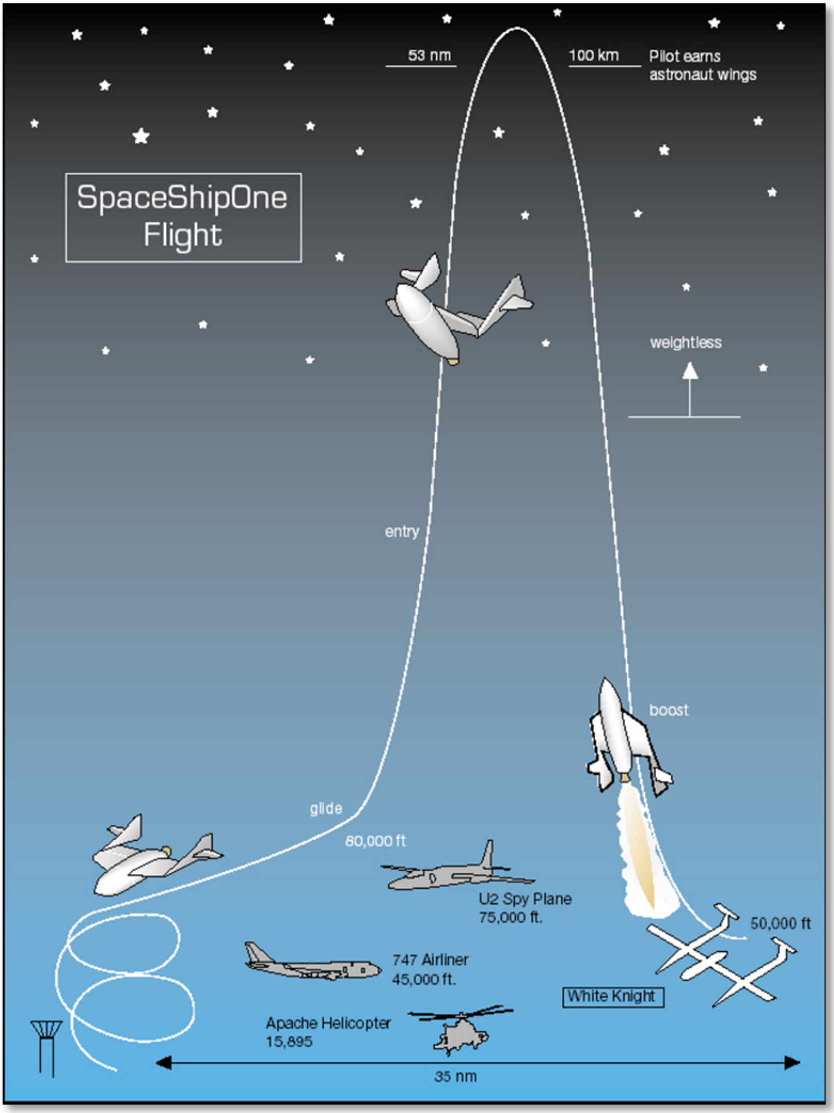
According to the pilot, the descent was amazingly smooth, though deafeningly noisy at the start due to the high speed. The flight finished unsurprisingly in an easy glide down to the airstrip, where the pilot and the team were cheered by spectators and more than 500 journalists.

British entrepreneur and investor Sir Richard Branson was among those on the ground. He had a business concept that he sought to realize. Branson headed the Virgin Group that consists of more than 400 companies. The most known of them are Virgin Records, that he founded when in his 20s, and Virgin Atlantic Airways. In 2011, Branson was the fourth richest person in Great Britain. In 2000, he was knighted for his entrepreneur activities. He's also known for several attempts to set world records in sailing and ballooning. He's an activist and support of organizations concerned with environmental issues, disarmament and development assistance.

SpaceShipOne with pilot Mike Melville after the first successful flight (Wikimedia)

On 25 September, after the successful launch and before the formal attempt to win the X-Prize, Richard Branson, Burt Rutan and Paul Allen entered an agreement to found Virgin Galactic. The intent was to exploit the technology of SpaceShipOne to develop space travel for the paying public. When that was announced at a press conference, the cost of a ticket was estimated at 200 thousand dollars.

On 29 September and again on 4 October, SpaceShipOne was launched to an altitude of more than 100 km in flights according to the X-Prize rules. Mojave Aerospace Ventures was declared the winner of the Prize of 10 million dollars. SpaceShipOne now is in the Smithsonian National Air and Space Museum in Washington DC, between Lindbergh's Spirit of St. Louis and the Bell X-1, the world's first supersonic aircraft.



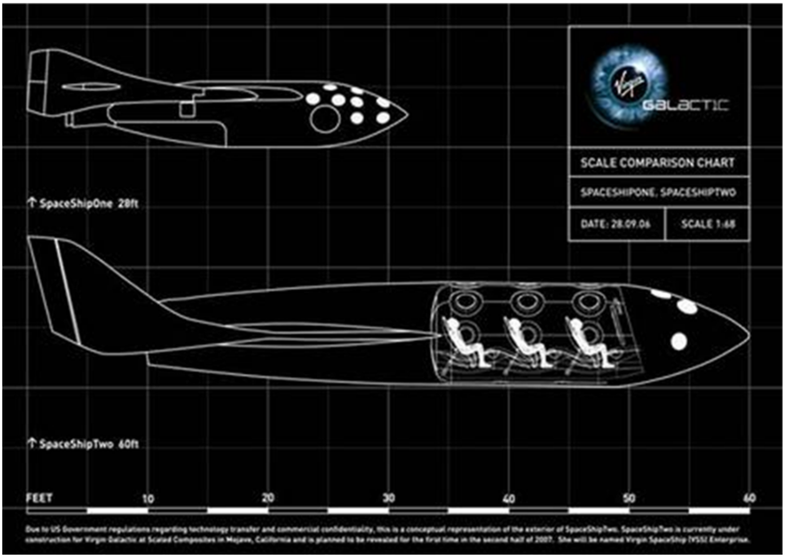
SpaceShipOne Flight
53 nm
100 km
Pilot earns astronaut wings
weightless
entry
boost
glide
80,000 ft
U2 Spy Plane
75,000 ft.
50,000 ft
747 Airliner
45,000 ft.
White Knight
Apache Helicopter
15,895
35 nm

The project continued immediately afterwards, to develop and test SpaceShipTwo. It will be 20 meter long and will carry two pilots and six passengers. It will be built according to the principles evolved for SpaceShipOne and will be launched to a higher altitude, so passengers will be weightless longer. Virgin Galactic has ordered five crafts. In December 2009, the prototype was made public at an event attended by New Mexico governor Bill Richardson and California governor Arnold Schwarzenegger. In October 2010, it test flew for the first time, without a rocket. There has been considerable interest in the new market sector, and more than 65,000 people have signed up as potential buyers of the first 100 tickets.

Sir Richard Branson and Burt Rutan with a model of the mother ship for SpaceShipTwo in the background

The run-up to the first commercial tourist flight has started. Passengers must undergo examinations that include being subjected to 6G forces in a centrifuge. The spacecraft must successfully complete 50 – 100 test flights before it's approved. The first launches are expected to take place in 2013. The spacecraft will be launched from *Spaceport America*, purpose-built in New Mexico and in part public financed. The Spaceport is in a desert area and is futuristically designed with a profile like a sand dune.

By the end of 2011, Virgin Galactic had booked deposits totalling 50 million dollars from passengers who had signed up, and had started planning SpaceShipThree, jointly with Scaled Composites. That project is expected to start if SpaceShipTwo is successful. The initial concept was to take passengers to far higher altitudes, to the location of the International Space Station, at an altitude of 240 km. However, the goal has been scaled back to providing point-to-point space travel, such as a two-hour trip from London to Sydney. Virgin Galactic has named Sweden as a possible location of a European Spaceport.



Comparison of the dimensions of SpaceShipOne and SpaceShipTwo

Assessment

SpaceShipOne is the only project in this book for which the ultimate effect cannot yet be assessed. That's a matter for the future. Will there be a new tourism sector? Will a tour via the Kármán belt be commonplace in intercontinental air travel? Or may we expect that Roald Dahl's vision of an international space hotel [6] soon will be realized?

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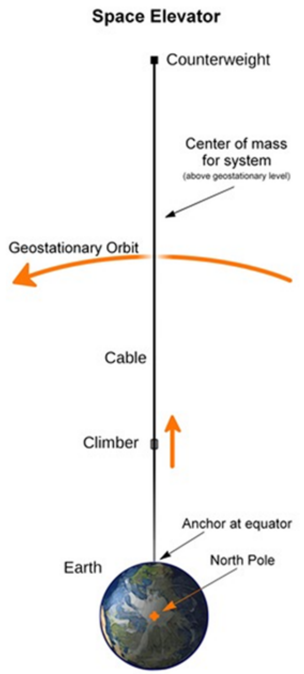
[6] In the book ”Charlie and the Great Glass Elevator”

On the other hand, like the other projects in this book, this project amply allows reflection backwards to set it in a historical perspective. Alone, SpaceShipOne appears to be a marginal or insignificant happening. But retrospectively, we may be at a paradigm shift in space travel. The bottom line is that the level of ambition has been cut back in favour of considerations of markets and needs. In turn, that inevitably brings economy and safety into the picture. In this case, that has been attained by technological concepts elegant in their simplicity. First, the spacecraft is flown to a high altitude before being launched. That saves enormous propellant costs. Second, the hybrid rocket engine uses a tyre rubber as fuel and laughing gas as an oxidizer. At high temperature, the oxidation of the rubber is violent, resulting in strong thrust. At low temperatures, both components are harmless. Finally, the technology of descent is unique. The feathering wings provide rapid deceleration, so the spacecraft descends through the atmosphere as does a badminton shuttlecock.



Space elevator based on the principle described by Tsiolkovsky

Together these innovations came about in part through an out-of-the-box approach involving thinking creatively and unconventionally. The results of such an approach can be fascinating.

It’s often been said that most technological developments for civilian uses are based on research for military applications. If so, SpaceShipOne is a good example. But the learning curve for it was long and not very steep. In principle what has gone on for hundreds of years is to build larger and larger rockets and managed to fly higher and higher and eventually farther and farther from the Earth. The evolution of space technology has come about thanks to unlimited budgets, overambitious attempts, and an obvious lack of clear goals and justification for many project other than their basic military motives. One might say that a childhood enthusiasm for playing with rockets has carried on in adulthood and progressed through decades with increasingly spectacular results. In 1965, mathematician and folk singer Tom Lehrer commented on the leading role of a former Waffen SS officer in the American space program by singing: “Vonce zee rockets are up, who cares vere zey come down – zat’s not my department, says Wernher von Braun”.

Artist’s impression of Spaceport America inMojave Destert

The gentle learning curve is most likely due to adhering to vertical rocket launching as the only concept. There’s obviously been much within-the-box thinking in the space race, even though many other concepts have been described and investigated by NASA and others. It’s ironic that more than a hundred years ago, Tsiolovsky sat in his log cabin and thought out-of-the-box to come up with the idea of a space elevator that today is being seriously considered.

SpaceShipOne does not embody new technologies. In the 1950s, the experimental X-15 aircraft attained an altitude of 106 km after being released from a B52 bomber at high altitude. It was financed by NACA (the predecessor of NASA). But the concept was not developed further when the race to reach the Moon started. The interesting aspect of SpaceShipOne is that it came about in a price competitive situation in which the framework conditions had changed radically to permit civilian participation. The project is interesting to the degree that it can lead to new technological developments and new standards and principles in space travel, which should be possible within the new paradigm that has been created.

Literature

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2. Various Internet sources.
3. Tim Harford, Adapt. Why success always starts with failure. London, Little Brown, 2011, ISBN 9781408701539.

14 Summary and conclusions

The project as a phenomenon is a way of organizing work that particularly over the last decades has become increasingly significant. In the past, specialized institutions were set up to address key tasks in society. Today, work is organized to a greater degree in projects. We do not have one organization that builds airports and another that builds hospitals. Tasks such as these are so large and involve so many disciplines than individual organizations lack the resources and expertise to conduct them. By definition, a project is an organization temporarily established to conduct a specific task. A project is a link in a strategy. It manages a budget for its goal, shall complete its enterprise within a specific period of time and deliver a stipulated result. Projects often are conducted using the resources of several independent suppliers and institutions.

Arranging an initiative as a project often is practical but is no guarantee of success. Highly innovative projects conducted in trying conditions are in particular exposed to considerable uncertainty and risk.

The problems that arise in a project vary in seriousness and in the durations of their consequences. The most common problems that attract the most attention yet often are the least serious are that a project is delayed or is more expensive than expected. Cost overruns can be sizeable compared to a budget. But in many cases, they may be small compared to future income and benefits and consequently have little effect on long-term viability. Is there then cause to say that the project is unsuccessful?

Success in the short term is a question of whether the delivery is satisfactory and on time without significant cost overruns. In the long term, success rests on questions of whether the agreed goals are fulfilled, the utility attained and whether it has unintentional negative effects.

The study of historical projects provides a unique opportunity to illustrate what happens in the long-term perspective. The railway built in East Africa more than 100 years ago was twice as expensive as expected. If that had been known in advance, two questions would have been raised: (1) would the project still be economically viable? The answer would probably be negative – with an operational period of a hundred years, there would have been no problem to break even. (2) Would the project been started had the budget been twice as large? May be not, but in that case, the colonization project would not have been carried out. More likely it would have been postponed. In retrospect, it's obvious that the repercussions of the project were enormous, both political in the form of colonization and economic in the form of access to extensive resources in the areas. On the negative side, the project had dramatic consequences for the original population, both during its implementation and particularly afterwards during colonization, in the form of suppression and exploitation.

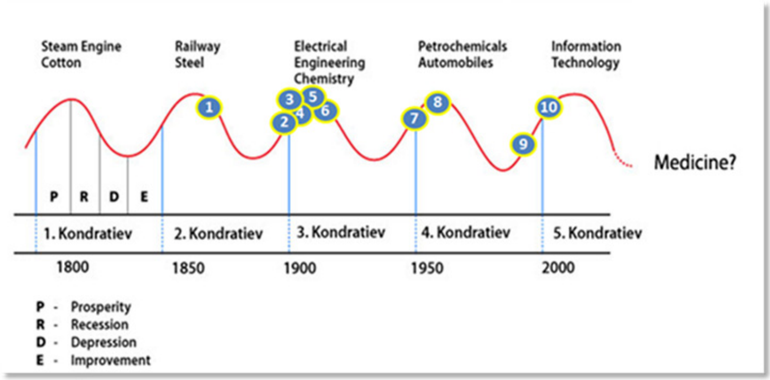
In other projects, for example Laugstol and Larderello, relatively small investments led to great gains in the use of renewable resources. The projects were successful, both from the narrow financial perspective and also when seen as pilot projects or catalysts of processes with national and international impact.

The Eiffel Tower is in a class by itself – a gigantic project, completely purposeless with no other function than becoming a symbol. The conduct of the project was exemplary, and in retrospect, the investment has turned out to be a major financial success with enormous spin-off effects for the country. Who among the supports or opponents could have guessed that 125 years ago, before the tower was built?

In this Chapter, we'll look more closely at what we can learn from these projects. From the idea arises, through the conceptual phase, implementation, and afterwards when it all can be revealed in retrospect. Were the projects relevant when they were designed? What is the situation today? What kind of spin-off effects have they had? To what degree would their initial conceptual design have met today's quality assurance requirements? And not least, to what degree would such an assessment been right in light of the utility and spin-off effects of the projects as evidenced today?

One of the striking features in this study is that the projects initiated in the period of 1885 to 1890 appear to have been the most successful. That was a golden age in world history, in France named *La Belle Epoque*. It was marked by technological progress and by peace between France and its neighbours in Europe. Economies flourished, and class gaps grew. Conflicts on rights to territories in Africa were resolved at the Berlin Conference in 1884. The first automobiles appeared. There were telephones and the telegraph, and street had electric lamps and gas lights. Dynamite had been invented. Art, design and architecture reflected the sophisticated *Art Nouveau* style.

It was the period in which the Eiffel Tower was built, energy was exploited at Laugstol Works, Summerland and Larderello, and the railway in East Africa was built. The First World War put an abrupt end to the period.



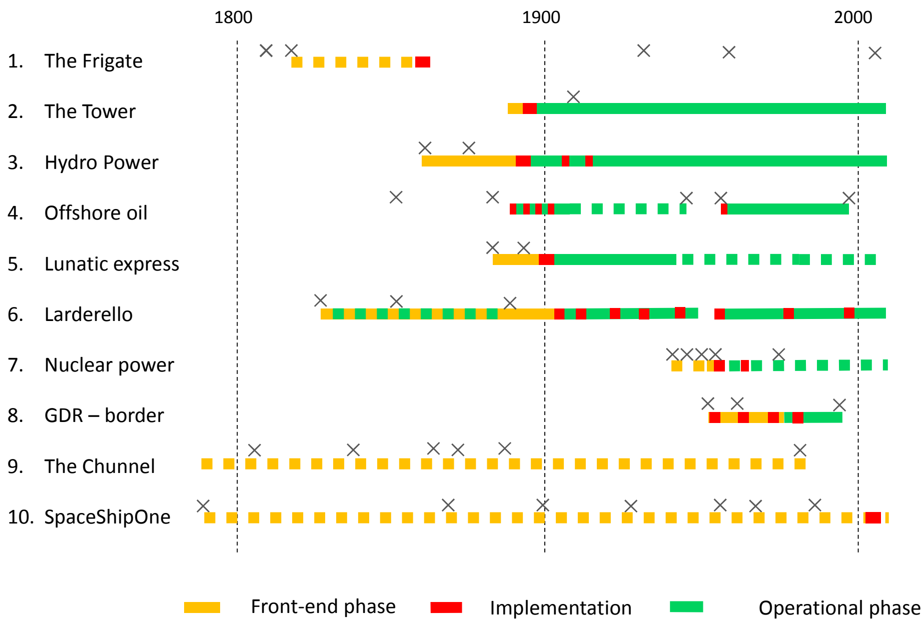
Economic cycles in history according to Kontradiev. As can be seen, the projects in this book were all initiated in favorable periods in history.

In this respect, the projects conform to a theory put forth in the 1920s by the Russian economist Nikolai Kontratiev. He described development in a capitalist system as having economic cycles of about 50 years, as shown in the following figure. At the end of the 18th century there was a peak. Then came two World Wars that led to a low in the 1940s. All the projects selected for study in this book were started at or near the cyclic peaks shown below, around 1850, 1900, 1950 and 2000. That was not intentional, though perhaps it's not by chance that the choice of projects coincides with the peaks of the Kondratiev cycle.

Earliest history and front-end phase

The time lines for the ten projects in this book are shown in the following figure. The front-end phase is in yellow, the project implementation in red and the operational phase in green. The dashed line indicates that a series of events leading up to the project and its implementation have taken place. As can be seen, most of the projects have had a front-end phase that lasted several years or decades. In two cases, the line stretches back hundreds of years. The first proposal for the Channel Tunnel was made in the 18th century, and throughout, the basic concept remained essentially unchanged. SpaceShipOne involves successive new technologies and their various uses, principally military.

The earliest histories of the ten project are all interesting and rather dissimilar. If they have one thing in common, it's that they all came about by chance:



- Three influences coincided in the building of the Eiffel Tower. The economy was in a period of boom. Technology permitted new breakthroughs. A dynamic actor took the initiative. The actor in this case was an ambitious, entrepreneurial businessman who had gained an international reputation and was on the offensive. He had built the support frame for the Statue of Liberty in New York. Then came the International Exposition in Barcelona. He submitted a proposal that was rejected. He tried again in Paris and successfully sold a gigantic structure. Those involved most likely didn't appreciate the full extent of it.

- The Channel Tunnel was an idea that had circulated for more than 200 years. It was technologically and politically unrealistic. It involved two countries occasionally in conflict. A hundred years later, when Eiffel was active, the technological feasibility of the idea was reassessed. Again a single actor, railwayman Sir Edward Watkin, promoted the process to the degree that he set up a company that started tunnelling on both the English and French sides. However, the project was only realized a hundred years later, after two World Wars. The political situation had then stabilized. The state of technology and the economy were more favourable to the implementation of the project than ever before.

- The inner German border resulted from the victors' conflicts over the spoils of war. Developments were marked and driven by the escalating antagonism between two major political alliances. There were large military forces on both sides of the border. One of the alliances set up a puppet regime that was ordered to execute the project.

- The three energy projects, Laugstol, Larderello and Summerland, were started by men to make money. They exploited existing resources and used new technologies. The originators were enterprising, privileged, visionary men who saw a way to wealth. The breakthroughs in these three projects were that they employed new technologies that led to repercussions lasting to the present day and probably the time to come. Summerland was a sequence of coincidental happenings. The other two projects were purposeful initiatives in processes under way.

- The story of the King Sverre took place in the years after a peace settlement and the severance of Norway from Denmark. The fleet was to be rebuilt. A poor but proud country sought to build a warship larger than any other. But the country's military leaders had not kept up with the times. The ship was obsolete before it was finished. The financial loss was enormous.

- The reactor at Halden also came about after a war. The country was to be rebuilt. Two persons audaciously sought to make Norway a nuclear power and gained approval of their project. Again, new technology was involved and the expectations were vague or at least unrealistic. The enterprise started in little Norway could hardly match the far greater military and civilian efforts of the major powers. An entrepreneurial spirit and political ambition, though not much realism, led to the project.

- SpaceShipOne is a project technologically ripe after decades of publically-supported space travel during the cold war, mostly motivated by military considerations. A foundation concerned with furthering new technologies and improving development aimed to take space travel into the civilian sector and announced a contest. Four people, all in business and all dedicated enthusiasts, joined to secure an incentive, find funding, realize the project and further it as a business concept. Results tumble in.

Project implementation

Seen in an historical perspective, the implementation periods of all the projects were short, as shown in the above figure. In no case was the implementation of the project itself problematic. Capable project management was as important then as now. All the projects were praised for their rapid progress.

- That's particularly the case for the Lunatic Express that was built in five years in Africa under extremely difficult conditions.

- It took just three years for the first civilian entrepreneur to reach near-Earth space.

- The exception is the King Sverre. After its launch, three years passed before it was commissioned and went on its first and only mission.

- The Eiffel Tower was rapidly built in less than two years, within budget and with only one fatality. That's certainly very successful, even by today's standards, 100 years later.
- The Channel Tunnel had a cost overrun of about 80%, which is abysmal. That led to major problems for operations, investors and several banks. But even considering the delays in the projects, it's nonetheless a gigantic and impressive accomplishment. Its operation in the years to come will determine whether the investment has been profitable.
- The inner German border was built efficiently and certainly with German thoroughness. But whether or not it incurred cost overruns remains unknown. In a totalitarian system, that sort of information is withheld from the public.

At the same time the projects show that capable project management first and foremost concerns delivery and the realization of short-term goals. The quality of implementation, in terms of costs and time, is relatively unimportant when assessing the long-term effect and utility of the projects.

Operational phase – utility and relevance

Five of the projects have had an operational phase of a hundred years, with extensive direct and indirect impacts. Only one of the projects failed completely in that respect: the King Sverre frigate that went on just one sortie before it was laid up and then broken up 70 years later.

The projects illustrate that utility is relative and not easily characterized or quantified. An evaluation at a point in time may change, as needs may differ ten years or a hundred years later. The converse also holds. An investment viewed as bad at a point in time may later turn out to be a gold mine.

- What was the utility of the Eiffel Tower? Initially it was intended to be an exhibition object to be dismantled in 20 years. It was a gigantic one. Fortunately so, one might say, as it remained standing. It's difficult to understand how the Tower could have been justified as an investment when it was built. Obviously, the project was relevant for many who wished for a strong image of France at the World's Fair in Paris. But it's reasonable to assume that due to its sheer size, the project hardly could have been regarded as useful or relevant from a broader economic perspective. There was no need or overriding social priority calling for so large an exhibition object. Its history is otherwise.

- The Channel Tunnel, however, came about in response to a specific need. The urgency of that need 100 to 200 years ago, when realization of a tunnel was first attempted, remains unknown. But today the need is considerable. The Tunnel efficiently transports many people and great volumes of goods between England and the Continent and has shifted transport from boats and airplanes to trains. Travel time has been radically cut. Only the future can assess utility relative to investment.

- The utility of the inner German border can be assessed from the standpoints of the parties in the project. Was the border fortified in response to the needs of the East German people? Obviously not. Did it fulfil a need for the regime in power? Probably only to the degree that it adhered to what has been recognized to be a political delusion. Did the Soviet leaders need it? Obviously. They saw it as the front line in a conflict between major powers. How relevant was the project as seen from the West? Could the border have contributed to stabilizing a latent conflict that otherwise could have broken out? Or without it, could German reunification and East-West stability come about sooner? We'll never know. But it's easy to see that the normalization of relationships between archenemies in Western Europe, such as Germany, England and France, came about amazingly fast after the Second World War. Many believe that happened first and foremost because borders were opened and trade was stimulated.

- The King Sverre frigate was also a project implemented in response to a need, even though it took place in peacetime after a war. The country obviously needed a navy. But staking everything in one venture wasn't equally obvious. A large, poorly manoeuvrable, unarmoured ship could easily lose in engaging smaller, faster ships armed with grenades. It was a lame duck. But perhaps the military leaders cannot be blamed for that oversight. It first became evident four years later that naval warfare had entered a new technological phase, in the decisive engagement of the American Civil War between two iron-clad ships, the USS Monitor and the CSS Virginia.

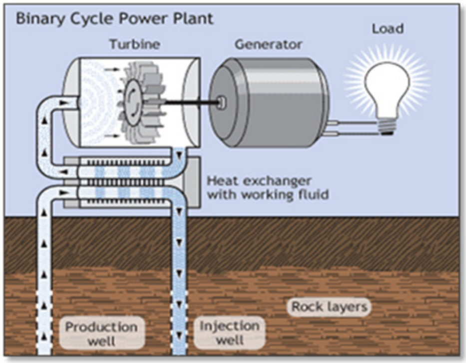
- Businessman Gunnar Knutsen was not taking chances when he took an initiative and became part owner of Laugstol Works. There was a market for wood pulp. The investors already had forests and energy. The same was true for the next step in the process. The factory was located in the middle of the city of Skien which had an appreciable market for electricity. The technology was available. It only needed to be applied. So the project was a certain winner from the day it s
t

Summerland with railway line and the first oil piers into the sea

- That wasn't the case for Summerland. The starting point was the need that the Spiritualists may have had to group together with like-minded people. It was a gamble. It could have succeeded even if oil had not been found. But with oil, the project acquired a new dimension and new actors. The original intent was forgotten in a struggle for the black gold.

- The Lunatic Express didn't come about in response to a specific need and consequently wasn't relevant. A Scottish shipowner saw an opportunity to make money in gaining access to the interior of Africa. It was uncertain and quite speculative. The government in London was mildly put reluctant, but ended up with the short end of the stick. If the British hadn't taken possession of the area allocated by the Berlin Conference, the Germans probably would have. When the railway was finished it clearly was relevant for the colonization of Kenya and Uganda. Europeans moved in. The sales of British goods increased, and raw materials flowed out of the area.

- Like the two other energy projects, the Larderello project had a goal other than the production of energy. It was the production of boric acid. Initiator de Larderel had a market and an apparently inexhaustible supply of raw material. He needed only more efficient production. Then came the next generation that also employed a new technology. The true value in Larderello was its enormous thermal energy, not its boric acid. The market for electricity was expanding rapidly. So the project was highly relevant and destined to succeed.



The principle in a binary cycle geothermal plant. Heat is transferred in a heat exchanger to avoid breakdown from corrotion in the primary part of the system

- From its start, it was obvious that the Halden reactor was not relevant. The concept followed up on the first reactor, Jeep 1, where the mission originally was military. At Halden, the reactor was to demonstrate civilian applications of nuclear power. It would require the import of nuclear fuel. Long before the project started, it was clear that the reactor could not compete pricewise with cheap Norwegian hydroelectric power. If the Sawmill Association had not come in as a buyer of the waste heat, the project may never have been executed. Most likely, governmental prestige was first and foremost at stake and led to starting the project.

Entrance to the nuclear power plant in Moon Mountain

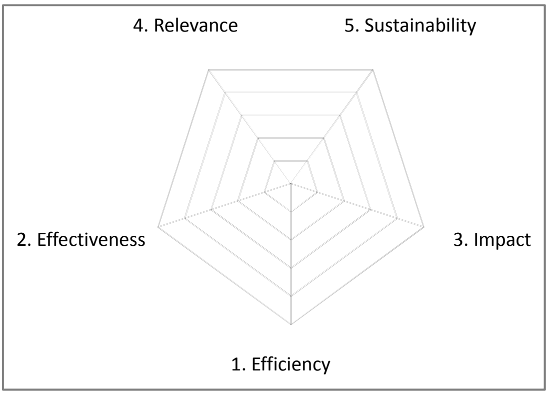
- It's difficult to say whether the space travel project is relevant. It's not about discovery or transport. It's about experiences and tourism, an extension of a fairground roller coaster to the heavens above. Thus far the venture has shown that a considerable number of wealthy people may make up a market. In time it may prove profitable or even very profitable. But it's difficult to see the utility of it. The economics of taking a quick trip via space in flying between continents are questionable, in any case in terms of energy consumption per person-kilometre, even though there are many passengers willing to pay for the experience.

Degree of success

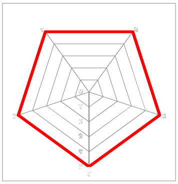
The obvious conclusion is that the degrees of success of the projects varied. There were three success stores: The Eiffel Tower, the Laugstol Works and Larderello, and there were two fiascos, the King Sverre and the inner German border. The remaining projects were either successful or conditionally successful.

In the following table, the degrees of success are depicted in spider diagrams using the five success criteria of the OECD composite indicator model discussed in Chapter 1.

1. Project *efficiency*, that is whether the project is completed on time, within budget and efficiently uses resources.
2. *Effectiveness*, that is the extent to which agreed goals or first-order expected effects are realized.
3. *Impact* of the project, that is any other effects of the project, foreseen or unforeseen, positive or negative.
4. Project *relevance*, that is whether the goals correspond to user needs and priorities in society.
5. Sustainability, that is the extent to which the positive effects will be sustained during the operational period after the project is completed.

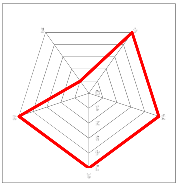


The spider diagram in the figure above indicate success score for each of these criteria in five axes. The area between the points gives a visual indication of how successful the project is as a whole. The area is marked in red in the table below.



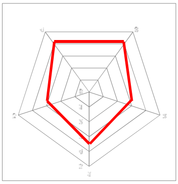
Laugstol Works and Larderello Geothermic

These two energy projects are success stories that score fully on all criteria. Both were goal-oriented business initiatives that exploited renewable resources and produced something that society needed. Little could or did go wrong. The subsequent electrification had far-reaching economic and environmental significance.



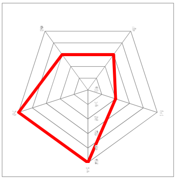
Eiffel Tower

Paradoxically, the Eiffel Tower was one of the winners among the projects. This nearly purposeless and meaningless project resulted from one man's conceit and ambition and can hardly be said to have been relevant to society's needs. Subsequently, the Tower proved useful. It's been a unifying symbol with which the country identifies. It has had considerable income from more than 200 million visitors and indirectly has contributed income for Paris and France in the form of tourism many times larger. And that's not by chance. The Tower drew attention when it was built more than 100 years ago and still does today. It's an amazing structure, in the middle of a big city, more than twice the height of the tallest pyramid in Egypt.



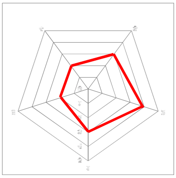
Channel Tunnel

The Tunnel was expensive, but its construction broke barriers. If all beneficial effects are included in the calculation along with the transport gain, in the long term the project may prove to be very profitable or successful - not least because of the environmental effect.



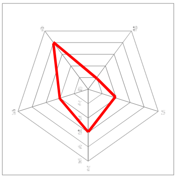
SpaceShipOne

Obviously, it is too early to say whether the space travel project is a success. Thus far, the implementation of the project has been successful. And the State of Mexico has come in and has built the infrastructure for civilian space travel, the Spaceport America. That must indicate that several visionaries believe that it will be profitable in the years to come.



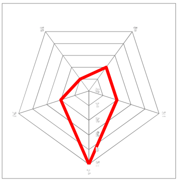
East African Railway

It's difficult to classify the Lunatic Express. Its cost overrun was considerable relative to an inadequate initial budget. But it's not equally certain that the cost overrun was large relative to what was realistic. The project had extensive repercussions in the form of colonization and nation building, which also has its dark downside. For the past 30 years, the railway has been of limited significance, particularly in Uganda.



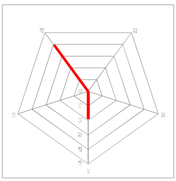
Summerland offshore oil drilling

This project may at best be considered conditionally successful, and then only in the short term. It came about as the result of chance happenings. It was profitable in a short and hectic moment in history. In the long term it’s incidental. It only scratched the surface. Its society collapsed and disappeared. Others came later and took out the real profit. But the incident was the world’s first offshore oil drilling. For that it earned a place in history.



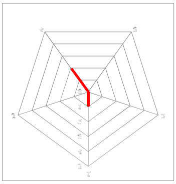
Halden reactor

The Halden reactor also was conditionally successful. It was obviously not relevant, and opposition to it has grown with time. Nuclear power never was practicable in Norway, the only country in which 99% of its electricity comes from a renewable source, hydroelectric power. The energy produced by the Halden reactor is insignificant. Research conducted there is mostly in testing equipment and reactor fuels for other countries. Today the reactor is criticized for having contributed to reducing industrial safety by prolonging the lifetimes of the existing equipment and for having contributed to the international spread of nuclear technology.



German border

No matter how one views the inner German border, it's an unsuccessful project that never should have been executed. It was relevant though relative to the country’s brain-drain. But first and foremost, it was relevant to the international conflict that had arisen. It's not unlikely that the border helped prevent provocations and situations arising between the forces on each side of it.



The King Sverre frigate

This is an example of aiming too high and initiating a project that strategically was a mistake. That didn't come about by chance. The decision-makers had neither acquired nor used existing information.

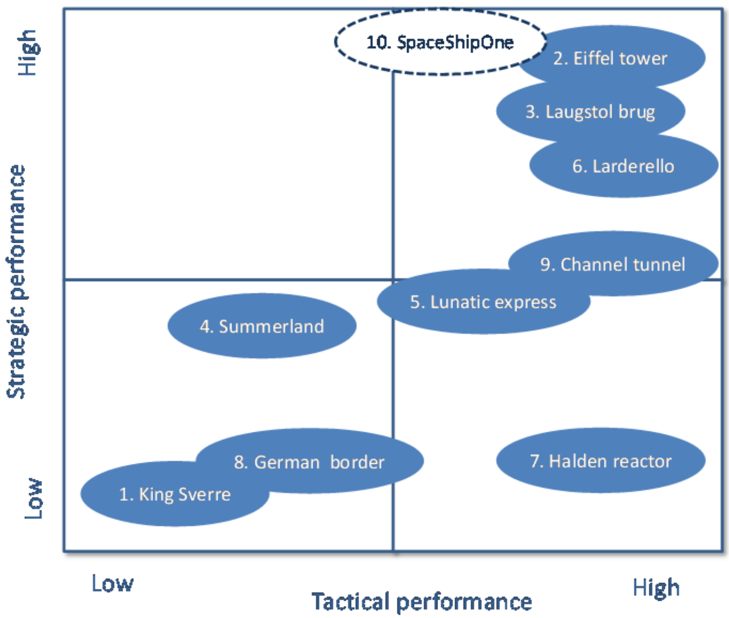
Tactical and strategic performance

The analyses above may be simplified by looking into the extent that the projects were *tactically* and *strategically* successful. The tactical perspective is short-term, first and foremost the implementation of the project. It's evaluated on the basis of whether the project was delivered as planned with regard to extent, quality, cost and time. In other words, whether the implementation has been efficient. This was the case, for instance, when the Eiffel Tower was planned and built.

The strategic perspective is long-term. It is assessed by considering if the effects expected from the project were realized as intended after it was completed. Obviously, the effects of a project can be both positive and negative. So strategic performance must be assessed in terms of the aggregate effect that to a reasonable degree can be attributed to the project. In the case of the Eiffel Tower, one sees a sequence of almost exclusively positive effects that continued through more than a hundred years. In the case of the Lunatic Express, the picture is more complex. The project was considerably important for colonization for half a century with positive repercussions for the colonial power but also with oppression and ethnic conflict in society. After half a century that is solved by withdrawal of the colonial power. But in the years thereafter, the utility of the railway diminished.

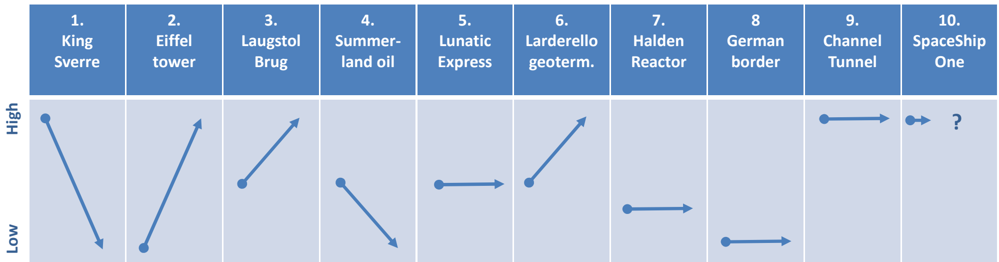
The figure below provides an overall picture of the degrees to which the projects were tactically and strategically successful, in the light of today's knowledge. What it suggests is that the projects that in the long term were strategically successful also were executed in a successful manner. Those with a less successful implementation phase have not been strategically successful. In the case of SpaceShipOne, all that can be concluded at this early stage is that the implementation was excellent and that only time will show the repercussions the project may have, as in transport and tourism.

Whether a project is strategically successful depends on the time at which it is assessed. For example, in many cases the rewards on an investment are long in coming. Often returns peak and then decline. Consequently, prospective and retrospective assessments of the strategic success of a project may differ.



At the time the decision to build the King Sverre frigate was made, presumably it was an incentive of great strategic importance, as it was to be the largest European vessel in its class. Retrospectively it is clear that was a false assessment. Particularly in this case, the military decision-makers had or should have aquired adequate information to cancel the project before it was started. However, the result was as indicated in the following figure, where the total lack of success for the King Sverre is indicated by an arrow that goes from high to low in terms of strategic performance.

As indicated in the figure, the King Sverre and the Eiffel Tower were the greatest surprises, in that their respective realities were completely opposite to their initial expectations. The Laugstol and Larderello energy projects started with limited visions. That said, they triggered significant spin-offs in the form of electrification based on water power in Norway, and exploitation of geothermal heat in Italy, which probably is still in its infancy. On the other hand, the oil extraction in Summerland was short-lived, a chance gust that quickly went away and had no significant spin-offs.



There were no surprises in the other four projects. The Lunatic Express and the inner German border were the results of politically difficult situations and their effects were questionable. The reactor at Halden was realized in spite of strong industrial and scientific opposition. It also has failed to meet the expectations of its originators. The Channel Tunnel was and still is regarded to be strategically important. For SpaceShipOne, we have no more to go than to observe that industry seems willing to invest and public authorities are willing to build the infrastructure for space travel activities, which indicates a belief in the project as strategically important.

What can be learned from these projects?

1. Vision is vital

The first lesson is that *vision* is decisive to success. The Lunatic Express started with the grandest vision of all the projects, the colonization of part of a continent. The Channel Tunnel entailed a vision that went beyond political and technical bounds and set a new standard for what is possible. The vision in the case of the Eiffel Tower wasn't about the Tower itself, but about the pride of a nation. Its initiator had hardly thought it thoroughly through. If Eiffel found himself in Heaven and could look down on the project today, he probably would be astonished.

The business projects, Larderello, Summerland and Laugstol, had no greater visions beyond making money. That said, the dream of making money and the willingness of investing one's own money often assures realism and relevance with respect to market demand may well ensure at least short-term success.

Modern Norwegian Fridtjov Nansen Class Frigate

The King Sverre had no vision. It was only a replacement for vessels owned earlier, even though it was far larger. The reactor at Halden amounted to a test of a new technology. The vision of unlimited, cheap electricity had already been realized in Norway by hydroelectric power. The vision of little Norway as an atomic power was merely naïve. Finally, the inner German border also lacked a vision, and the project was doomed to fail. Lifetime internment of an entire population is hardly a vision. In any event it's a certain recipe for economic and ideological ruin.

2. Implementation is not decisive

The second lesson probably is that in the long term, the *implementation* of a project is not decisive. In most cases, it is a minor happening when seen in a larger picture and long-term perspective.

3. Much results from chance

The third lesson leads to the conclusion that *chance* plays a leading role in the drama of the prelude to most on the large projects. The ideas behind were conceived in expansive times that economically and technologically permitted vision. However, that didn't help the King Sverre and the Halden reactor, because they implemented the wrong technical solutions. The inner German border created an economic and political enclave in which the opposite happened.

The handling of chance and uncertainty is basically what the discipline of project management is about. The goal is to ensure that implementation takes place as planned, in terms of costs, quality and time. Today we do well at that, save for individual exceptions in cases when uncertainty is very high.

These projects illustrate that the uncertainty in events before implementation often is greater and also far more decisive for the outcome of a project in the long term than the uncertainty that arises during implementation. That applies also to the Lunatic Express, even though the implementation was something of a nightmare. The uncertainty of colonization was far greater. A few decades later, the British lost all their colonies and investments.

So the big question associated with projects is what may be done to reduce uncertainty in the initial phase to ensure a better choice of project. And of course, the extent to which that is at all possible in a world always subject to chance.

What if not? The counterfactual perspective.

A project represents one of several possible concepts that could be realized. In advance, other concepts may have been assessed but discarded in favour of the one preferred. Afterwards, when a project has been completed, it is evaluated relative to the planned and expected goals and effects and relative to the situation in which it was implemented. But projects are seldom evaluated relative to the counterfactual case of what would have happened had the project not been implemented.

A project is an intervention initiated to change an existing condition into something else. The task of the project is to conduct the intervention, while society is mostly concerned with the change of conditions. The contemplated change is expressed at an early point of time as a strategy. It can be more or less well justified. Only time can tell the degree to which it is attainable. The effect of the intervention can be determined only retrospectively. It results from not just the project but also from the influences of external factors on the way. Normally, several aspects other than the project contribute to the effect that can be observed. Consequently, only part of the observed changes can be attributed to the project.

Attack by man-eating lion. Manipulated scene from a movie picture about the Tsavo incident

Strategy is prospective and depends on two principal questions: (1) should one invest or not, and (2) which investment alternative should be chosen. In many, if not most cases, the situation is that these two questions are overruled because an alternative has already been chosen in advance.

In most cases, prospective decisions are based on assessments of the type *What if? (investments A, B, C)*. Retrospective assessment, when a project is evaluated, should take place sufficiently long after completion so the effect may be evaluated. In most cases, such evaluations are not made. And seldom is the duration sufficiently long and the analysis sufficiently extensive to assess the effects of external factors. That makes it difficult to assess the degree to which the effect observed can be attributed to the project as well as identify the side effects resulting from the project. In hardly any cases is there a counterfactual assessment: that is asking *What if not?*

Hindsight is said to be our most exact science. That is meant ironically, but it is also obvious that a subject matter is more easily assessed in retrospect than in advance, when the situation is clarified and the facts are on the table. What is the case in the nine projects described here?

- What would have happened had the Eiffel Tower not been built? The World's Fair in Paris would have been held with another eye-catcher that probably would have been quickly forgotten. Pavilions at exhibitions seldom are reusable. France undoubtedly has mounted many campaigns to build national identity and promote itself internationally, no single structure has had an impact approaching that of the Eiffel Tower. It has symbolized technological progress, national pride and Paris as the country's centre. And it has had an enormous, almost incomprehensible effect on tourism in France and in Paris. It was a key symbol of unity during the German occupation. The outcome of the Second World War would have been the same without it. But without the Eiffel Tower, Hitler and the Nazis would not have lost face in Paris, which was of high symbolic value for the resistance.
- If the Channel Tunnel had not been built, the two countries would not have had a construction that the American Society of Civil Engineers (ASCE) identified as one of the seven wonders of the modern world. The big question is if the countries would have been poorer without it. Today, after 20 years of operation, there have been no major economic spin-offs of the venture in the form of commerce or development. But without the Tunnel, the transport volume between the two countries probably would have been less. Transport by sea would have been more extensive, with the environmental problems it creates. National security has not been affected. Should war break

out between the two countries, the Tunnel most likely would not be a route of attack.

- Laugstol works, Larderello and Summerland, are not essential projects in this respect. The course of events would have been the same without these three projects. Norway would have been electrified, and sooner or later, somewhere somebody would have begun utilizing geothermal energy to produce electricity. And offshore drilling for oil would have started sooner or later, perhaps in a more professional and less polluting way.
- Norwegian defence probably would have been better off without building the King Sverre. It would have had the financial leeway to build smaller, more efficient warships adapted to the warfare of the day, with grenades and armoured ships.
- Without the Lunatic Express, Britain might have lost out to Germany, which had the same ambition in Tanganyika further south.
- And without the Halden reactor, the energy situation would be the same as it is today. Moreover, as some critics claim, the security at existing nuclear power plants may have been better because their decommissioning dates would not have been extended.
- However, without the inner German border, the world may have been different today. One scenario might have been an exodus from East Germany, an escalation of Soviet presence in the country and military border conflicts that could have been catastrophic during the Cold War. That might have triggered the Third World War with atomic weapons. On the other hand, it might have led to a more rapid disbanding of East Germany.
- To date there's no basis for evaluating the contrafactual aspect of the space travel project, as neither its continuation nor its spin-off effects have yet become apparent. So we must speculate on what the results might be. Certainly, the world would have continued in its haphazard way without the project. Likewise, it’s obvious that the project could lead to some business activity. The most interesting and edifying aspect of the project is that it has shown that economic incentives in the civil sector may be more suited to finding simple, elegant solutions to specific problems than are the public sector’s massive infusions of money in big projects.

Would the projects have passed the QA1 review?

In 2006, the Norwegian Ministry of Finance introduced a requirement calling for external quality assurance of major public investment projects prior to decision-making by politicians. It is termed quality assurance 1 (QA1). Under this scheme, the Ministry involved is required to conduct a choice of concept study where at least two conceptual solutions of the problem in question are identified, as well as the zero option alternative of doing nothing. All alternatives shall be studied to the same depth of detail before the Cabinet and the Parliament decide whether the project shall be endorsed and if so which alternative shall be chosen. The arrangement is intended to ensure that the necessary over-all assessments are made, that all aspects of the problem are studied and that the starting point for decision-making is the best. This is the acid test for large investment projects in the public sector.

Each year, some 20 of the largest public investment projects in Norway are subjected to the QA1 arrangement. They include transport projects, major military procurements, large cultural buildings, etc. Aspects evaluated include the economic viability, the degree to which the investment is relevant to social and market needs and whether the investment is sustainable with time. The question now is: at the times when decisions were made to initiate them, would the projects described in this book passed the QA1 requirements?

A subjective assessment based on the information included in this study implies that only four projects would have passed. The four would have included two of the energy projects, Laugstol and Larderello. The Channel Tunnel would have been approved, despite its uncertain socioeconomic profitability. SpaceShipOne also would have been approved.

This means that there would have been six losers, firstly the inner German border, the King Sverre and the Halden reactor. The Lunatic Express railway is in a grey zone. In its time, the project was based on the long-term vision of colonization and future utility. So it may have been approved under corresponding requirements today, depending on a realistic assessment of uncertainty and total costs. The fifth is Summerland, for which the assessment would have been that it would not be sustainable, the resources would be depleted as they had previously at many other places elsewhere in the country.

The inner German border and the King Sverre score negatively in all parameters. Again, the big surprise is the Eiffel Tower, selected in this book as the most successful of the projects described. Obviously it would have been rejected at the start, as economically unviable and completely irrelevant to needs and the market. Moreover, it absolutely wasn‘t sustainable, as it was commissioned to stand for only 20 years before being torn down.

These conclusions are encouraging concerning the likely effect of the Norwegian quality assurance scheme. The sample of projects here is too small to permit generalization. But it means that four of the five projects that scored best over time would have passed the QA regime test. At the same time, the five poorest scoring would have been stopped. That amounts to a success rate of 90%.

But in one case the QA1 scheme would have missed the mark. The Eiffel Tower, which eventually became a smashing success, most likely would have been rejected.

And what might that mean? Well – in any case it points to the truth of what's so often been said: It is difficult to predict, especially about the future.

Conclusion – a project must be relevant

More than anything else, the examples in this book show that the origins of projects are important. The front-end phase often is long and complex. That said, it is decisive that history be considered and that a project is assessed in an broad and long-term perspective to enable sensible choice. This is difficult and consequently often not done sufficiently. The front-end phase is marked by chance and coincidence, deliberate action and entrepreneurial spirit, personal ambition and political events and motives, technological opportunities and economic cycles, and so on. It is constrained by the information that is at your disposal at any time and the processing and analysis analysis of it.

Above all, the conclusion must be that an assessment of a project's *relevance* apparently is decisive in its success. In practice, this means that the goal of a project should correspond to the needs and priorities in society such that there is a demand and willingness to use and further the result of the project. If this is not the case, the project almost certainly will fail. Only the unexpected can make it succeed.

Accordingly, the simple recommendation of today is the same as it always has been: Before decisions are made, ensure that adequate studies have been made and the project is proven relevant. If this is not the case, look for something else.

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This is the story of the tower that few would permit, but which proved to become the world's perhaps best known landmark. About the men who set out to make a nuclear bomb, but ended up producing steam for a paper mill. About a regime that would imprison the country's entire population. About the greedy spiritualist who perished in his own oil well. About a warship that never fired a shot but ended up as wooden floor tiles in Oslo. About Africa's Black Iron Snake which conquered an entire territory. About an industrial entrepreneur who became prime minister of a nation. About a tunnel that took 200 years to build. And about a clever engineer with a daring ambition to help ordinary people get closer to the stars.

In short – these are stories about historical projects and their outcome in the years that followed, as seen from the present. The result is often highly surprising – in one way or another.

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