Chapter 2

History of Guided Missiles

Module 1: Lecture 2
History of Guided Missiles

Keywords. History, First World War, Second World War, IGMDP

Use of guided missiles has become an essential feature of modern warfare. Though such missiles have been in use only during the past few decades, their evolution from more primitive weapons has taken place over a period of many centuries. This evolution can be traced through history under various periods of development.

2.1 Early History

The idea of using *arrows and spears*, which can be thrown from a distance for hunting or warfare, has been there since pre-historical times. Such weapons served only a limited purpose since their range and destructive power was limited. Obviously enough, to increase the effectiveness of these weapons, subsequent developments concentrated on the task of overcoming these limitations. It is a historical fact that the *Greeks* used *flaming arrows* against the Arabs in the *war of Constantinople* in the 7th century. These were essentially arrows or spears with lighted torches tied to them. The *Chinese*, in the 10th century, were known to use *bamboo tubes filled with explosive powder* which was used to propel the tubes to some distance. This is perhaps the first recorded instance of

solid-propellant rockets being used in warfare. These rockets were later used in Europe in the 14th century in the *war between Venice and Genoa*. During this time people like *Albert Magnus* in Germany and *Roger Bacon* in England, in the 13th century, and *Leonardo da Vinci* and *Giovanni da Fontana*, both from Italy, in the 15th century, had begun investigating the design of such rockets. Some documents and drawings testifying to their imaginative approach to the problem still survive. Subsequently, a German engineer *Conrad Haas*, in the 16th century, sketched a *multi-stage rocket* in which the first stage burns itself out, thus saving the trouble of separating this stage from the missile body. Haas also proposed a *swept-back fin arrangement* to improve the stability of the rocket.

2.2 Before World War I

In the 18th century the *British and French forces* were battling the *armies of various kingdoms in India*. During this time the Indian soldiers were reported to be using *incendiary rockets* which caused much discomfort to the European soldiers. These rockets weighed about 3 to 6 kgs and could be fired either in a *ballistic path* or in a *horizontal path* close to the ground. This kind of rocket essentially had a cylinder filled with gunpowder and a stick attached to the side and extending to the rear (Figure 2.1(a)). The destructive capability of these rockets was somewhat limited but they provided a *certain strategic advantage* to the Indians since the weapons were new to the enemy and in addition to scaring the horses in the cavalry they also created a fear among the soldiers. These rockets were of *simple design*, could be *easily transported, easily operated*, and were *readily producible* - properties which are desirable even for modern missiles.

A British army colonel, *William Congreve*, was impressed by these Indian rockets and began experimenting with them in the early 19th century. He was able to stabilize the rockets further by *extending the stick to the rear* and *later moving it to the center of the cylinder* (see Figure 2.1(b)), so that the rockets could be inserted into a tube and launched. He was also able to increase their weight to about 150 kgs, and designed them to carry a warhead of about 25 kgs at the nose-end. He recognised the fact that the weight and the center of gravity of these rockets change during flight and a good design must account for these changes. The *Congreve rockets* became popular with the British and were used extensively against the French in the *Napoleonic wars* in the beginning of the 19th century. It is reported that in 1807 the *city of Copenhagen* was completely

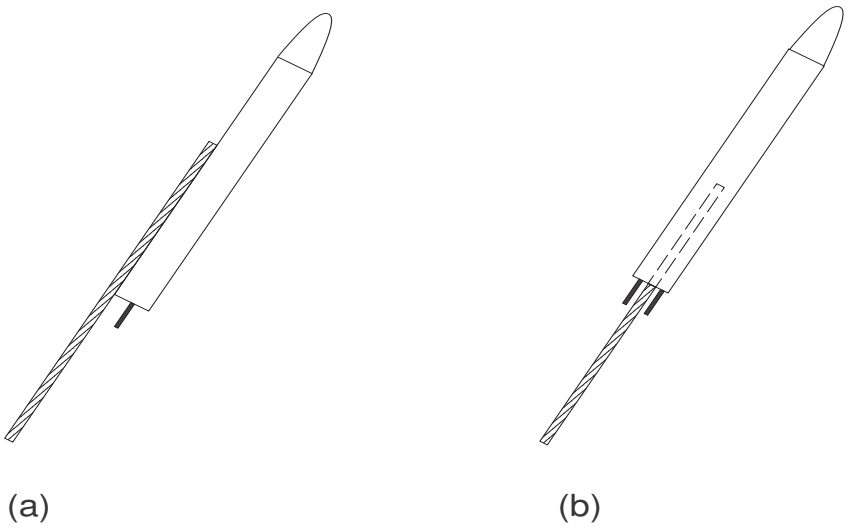


Figure 2.1: *(a) Indian rocket (b) Centrally mounted stick in Congreve rockets*

destroyed by about 25,000 to 40,000 such rockets fired during a three day siege.

Further developments in these rockets occurred in 1839 when *William Hale*, an Englishman, discovered that the stick, which was the cause of serious problems during launch, could be entirely eliminated and stability can be achieved by *spinning the rocket*. This was done by *directing the propellant exhaust* through some *slanted exit holes* at the rear of the rocket. During the end of the 19th century *Wilhelm Unge*, a Swedish engineer, carried out extensive research on rocket designs and propellant fuels. His research was financed be *Alfred Nobel*, the inventor of dynamite. Unge also found that spinning stabilizes a rocket in its flight, but in his design the spin was imparted to the rockets by *spinning the launcher tube* itself. In spite of these advances in rocket design the Swedish army did not show any interest in Unge's work and in 1908 the German company Krupp bought all of Unge's patents.

2.3 World War I and After

Towards the end of the 19th century interest in rockets had almost died down since these weapons were losing their *novelty* value and the consequent *psychological advantage* they gave to an army. However, the beginning of the *first world war* (1914-1918) changed everything and rockets were found to be useful against small but strategic tar-

gets. The French did successful air launchings, especially against enemy balloons and *German Zeppelins*.

During this time a British professor *A.M. Low* designed a small radio controlled monoplane called the *Flying Target* or *FT*. These were to be launched from a lorry using compressed air catapults. The Royal Aircraft Factory produced six of these FTs. They were found to perform satisfactorily but for some inexplicable reasons they were never used. Low is also credited with the design of *radio-controlled rockets* during this time. In 1918, *Charles Kettering* in the USA designed a similar *unmanned airplane* intended to serve as an *aerial torpedo*. Nicknamed the *Bug*, it had a range of 100 kms and flew at a speed of about 150 kmph. The flight direction was controlled by *preset vaccum relays* and after a certain time, when the Bug was expected to be above the intended target, its engine was automatically shut off and the wings were released so that the Bug with its payload fell onto the target in a ballistic trajectory. Experiments with the Bug were quite successful but again it was never used in any war.

Soon after the end of World War I and the defeat of Germany, the primary center of activity in rocket research shifted to Germany. Perhaps the reason for this was the *Treaty of Varsailles* which had imposed a number of overly restrictive conditions on German research and development activities relating to military weapons. The Germans soon realised that rocket research was one of the areas which did not find an explicit mention in the treaty and could be carried out without attracting too much attention. Consequently, they started a top secret research establishment at *Kummersdorf* in 1932 and the 20 years old *Werner von Braun*, the famous German rocket scientist, was made its chief. Apart from rocket development, he was also given permission to write his doctoral thesis in physics which he completed in 1934 and was awarded a doctorate degree by the *University of Berlin*.

Apart from von Braun, many other famous German scientists contributed to rocket research during this time. They were *Hermann Oberth*, *Johannes Winkler*, and *Rudolf Nebel*, who had first inducted von Braun into his research team. During this time *Robert H. Goddard* in America and *Tsander* and *Kondryatyuk* in Russia had also begun research in this direction.

2.4 During World War II

Adolf Hitler came to power in Germany in 1933. He recognized the potential of rocket research and set up a top secret research establishment at *Peenemunde*. Von Braun was made the technical director of the establishment at the age of 25. The Peenemunde laboratories were equipped with a number of wind tunnels and other elaborate test facilities. This was perhaps the first time when such a systematic and concerted research effort was devoted to the development of a flight vehicle. This intensive research activity, prior to the World War II, led to the development of the famous *vengeance* missiles *V-1* and *V-2*. The V-1 missile had an *inertial guidance system* to guide it on its path. The V-2 missiles were the weapons which laid waste vast portions of the *city of London* during the war. The Germans used to launch these missiles from France across the English channel. In October 1942, during an experiment, one of these V-2 missiles achieved a height of 116 miles and left the atmosphere. This was perhaps the first instance of a *man-made object penetrating the atmosphere* and enter space. During this time, a winged version of V-2 called A-9 was also developed.

Apart from the famous vengeance missiles, a number of other missile programmes were initiated and some of them completed successfully. A number of surface-to-air missiles were produced and flight experiments conducted with them proved to be successful. The *Wasserfall* surface-to-air missile, designed by *Ludwig Roth*, was one such missile which reached the stage of test flights but was never actually used in the war. Another such missile was the *Henschel HS-293* missile which was a *radio-controlled air-to-surface missile* and was used in August 1943 to sink the British warship *HMS Egret*. This incident is believed to be the first instance of a guided missile being used in war successfully. The Henschel missile weighed about 1200 Kg and had a length of 3.7 meters.

During this time the USA, UK, and the USSR did carry out developmental activities in this area but these were not as successful as the German missile programmes.

2.5 After World War II

During the spring of 1942, when the defeat of Germany and its allies became inevitable, and the Russian army was poised to occupy Peenemunde, von Braun and his team of

scientists escaped from there and were later captured by the Americans. The Americans were delighted with their catch and they flew the whole team of scientists back to the USA where they were persuaded to continue their experiments.

The first US missile programme *Hermes* was conducted by von Braun in association with the *General Electric Company*. The design of this missile was based on the *Wasserfall* missile. Hermes was a surface-to-air missile with a range of 250 kms and carried a warhead weighing almost 450 kg. Although a number of test flights were conducted the missile never came to the operational stage. However, it served as the base level design for many ballistic missiles developed later. The German scientists were also involved in developing many surface-to-surface missiles, e.g., *Corporal* (Range 130 kms, length 15 m, launch weight 5500 kgs), *Sergeant* (Range 40-140 kms, length 11 m, launch weight 4500 kgs), and *Redstone* (Range 400 kms, length 22 m, launch weight 30,000 kgs). Both the Sergeant and the Redstone carried an *onboard inertial guidance system*. About a 1000 Redstone missiles were produced and deployed in the West Germany till about 1963 when they were replaced by the *Pershing* missiles. The Redstone also provided the basic system which launched the first American astronaut into sub-orbital flight in May 1961. One of the first guided missiles to be built and tested in the US was the *Convair MX-774* which was modelled on the German V-2. Its testing gave valuable data which was used in the development of *Atlas*, the first ICBM to be built in the west.

The Russians were not far behind in this race. They too used the basic V-2 design to build a missile called *M-101* which in turn was the forerunner of many huge Russian ICBMs. The booster rocket that placed the world's first satellite, *Sputnik*, in space in October 1957, was also based on this initial design.

The design of the German V-1 missiles were also exploited by both the Soviet Union and the US to develop *cruise missiles* - the *JB (jet-bomb)* series of cruise missiles were developed by the US, while the *J-1, J-2,* and *J-3* cruise missiles were developed by the Russians.

From 1950 to 1970 several missile programmes were launched in the USA and many were successfully completed. Notable among them were the *Gorgon* series of missiles, *Firebird* (AAM), *Kingfisher* (anti-ship/anti-submarine), the *Bumblebee* programme (under which were developed the *Terrier/Tartar* shipbased SAMs, *Talos* air defense SAM,

Triton SSM, and the *Typhon* shipbased area defense SAMs), *Sparrow* (AAM), the *Nike* family of air defense SAMs, *Hercules* (SAM), *Falcon* (AAM), *Phoenix* (long range AAM), *Maverick* (ASM), *Sidewinder* (AAM), *Chaparral* (SAM), *Northrop SM-62 Snark* (cruise missile), *SM-64 Navaho* (cruise missile with nuclear warhead), *Pershing* (SSM), *Hawk* (SAM), and the *Patriot* (SAM - made famous by its much trumpeted performance in the recent Gulf war).

Subsequent research and development on missiles involved a multitude of R&D defence organisations in the US and some reputed institutions like the *Jet Propulsion Laboratory* at *California Institute of Technology*, and the *Applied Physics Laboratory* at the *Johns Hopkins University*.

2.6 The Indian Missile Program

The Integrated Guided Missile Development Program (IGMDP) was launched by the Indian Government in 1983 under the stewardship of A.P.J. Abdul Kalam with the intention of indigeneously developing several missiles of various types. These were the *Akash* [Length 6.5m, Launch Weight 700 kg, Range $>$ 20km] and *Trishul* [Length 3m, Launch Weight 130 kg, Range $>$ 8km] surface-to-air missiles, the *Nag* anti-tank missile, and the *Prithvi* [Length 8m, Launch Weight 14500 kg, Range $>$ 120km] and *Agni* [Length 20m, Launch Weight 16000 kg, Range $>$ 1400km] surface-to-surface missiles. Some of these missiles have been successfully test-flown and some have reached the deployment stage as well.

2.7 Concluding Remarks

The above account of the major events in the history of guided missiles is somewhat slanted towards the American contributions, especially in the period after the Second World War. This does not mean that the European, Russian, and the Chinese contributions were not significant. In fact, these countries also took up and successfully completed a number of missile programs of their own. The erstwhile Soviet Union was, till very recent times, the world leader in the production of ICBMs. However, the devel-

opments that took place in the US are much better documented and easily available.

Assignment

1. Collect information about the Indian missile program that started in the early eighties. There are books and internet resources that provide information on this program. Write a term paper (something like a magazine article) of about 5-6 pages in your own words consolidating this information and data. Make the presentation as attractive as you can with pictures of missiles, organizations, and people involved in the program. As in the earlier assignment, please do not forget to credit sources from where the material has been obtained. This is an absolute must. Also, make sure that the writing is your own and not copied.

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