

MASTER

Dodging UCAVs censured

how organizations assess the potential of new technologies : a case study of RNLAF and the unmanned aircraft

van der Laan, J.

Award date:
2007

[Link to publication](#)

Disclaimer

This document contains a student thesis (bachelor's or master's), as authored by a student at Eindhoven University of Technology. Student theses are made available in the TU/e repository upon obtaining the required degree. The grade received is not published on the document as presented in the repository. The required complexity or quality of research of student theses may vary by program, and the required minimum study period may vary in duration.

General rights

Copyright and moral rights for the publications made accessible in the public portal are retained by the authors and/or other copyright owners and it is a condition of accessing publications that users recognise and abide by the legal requirements associated with these rights.

- Users may download and print one copy of any publication from the public portal for the purpose of private study or research.
- You may not further distribute the material or use it for any profit-making activity or commercial gain

Dodging UCAVs censured

Dodging UCAVs



How organizations assess the potential of new technologies.
A case study of RNLAf and the unmanned aircraft.

Jacob van der Laan

ID: 481013

Supervisors: Dr. Alessandro Nuvolari, Faculty Technology Management
Mr. Ir. Ing. Ies Biemond, Faculty Technology Management

Faculty Technology Management,
Technology & Policy,
University of Eindhoven, Netherlands,
June 2007.

**niet
uitleenbaar**

TBM

Dodging UCAVs censured

Preface

When I started with the four-year study Technology Management, as it was called back then, it never occurred to me that it could take me twice as long to finish it. If I would have known this before, I probably would never have started it. In these eight years I got married, my wife gave birth to three beautiful children, I changed jobs three times, changed from position three times within the RNLAF, my current employer, and did a four-month 'tour of duty' at Kandahar Air Field, Afghanistan. The only thing missing in this list is a move to a new home, although this is one of the items that are still on our 'things to do' list....

The idea of doing a graduation study of the UCAV crossed my mind at an early stage. The RNLAF is a technological and society orientated organisation, while the UCAV is the latest development at the combat aircraft stage. All elements of Science of Technological Innovations are present, so how hard could it be? Well, speaking with almost the same words as Prof. Gray wrote in his preface of "Another Bloody Century", I sometimes wondered why I ever started his survey. The amount of literature in books, magazines and the Internet was huge; it was hard to find a good starting point. Together with my tutor, dr. Alessandro Nuvolari, we finally did, although we sometimes wondered whether the subject wasn't just too complex for 'just' a graduation study.

I have to thank my tutor, dr. Alessandro Nuvolari for his support and, maybe most of all, his patience as this graduation lasted somewhat more time than expected.

And I love to thank my wife and children for their patience. The times I had to spend my time in the attic should be over, so I can spend more time with them in the future.

This report does not reflect the official position of the Royal Netherlands Air Force. The conclusions and opinions expressed in this document are those of the author.

Dodging UCAVs censured

Summary

As with every technical artefact, the combat aircraft has to be replaced after a period of time. Either because of the end of technical and/or economical lifespan was reached, or it is outclassed by enemy aircraft. The Royal Netherlands Air Force's present fighter aircraft, the Lockheed Martin F-16, is due to be replaced around 2020. The intended successor is the Lockheed Martin Joint Strike Fighter (JSF). But technological developments enabled aircraft to be operated without an onboard pilot. Hence, many people wonder whether it is wise to acquire the JSF, which may be outdated by unmanned combat aircraft (UCAV) within a few years. *But will a pilot orientated organisation like the RNLAf ever choose for an aircraft that doesn't need a pilot?*

This study tries to answer this question by using the theory of Social Construction of Technology (SCOT). First the history of Air Power was studied, followed by the present developments on waging war. Next the role of the RNLAf in these affairs was examined. To have a clear picture of the UCAV, the past, present and future technological developments are described. Further all actor networks that are involved in the process of acquisition of a new combat aircraft, are made clear. And finally the situation concerning combat aircraft development was studied. This last item may perhaps not be an issue for SCOT, but during this survey it became clear that the circumstances within the combat aircraft industry could play an important role within the future of the combat aircraft.

In just more than 100 years the combat aircraft evolved from flying crates to a formidable weapon over the battlefield and beyond. Although initially believed the aircraft could win wars, this proved not to be true during WWII. British Bomber Command almost suffered defeat against the German night fighters, while the US daylight bombers could enter the German airspace relatively safely only when escorted by long range fighters. The real power of the combat aircraft was shown by the Germans during the Blitzkrieg. The German Wehrmacht could make swift advances while supported closely by the Luftwaffe. During the last year of WWII these tactics were improved by the Allied air forces by destroying all enemy logistic lines before starting a ground attack. An absolute requirement for these tactics is air superiority. The US forces achieved this by wearing out the Luftwaffe during their daylight bombing raids. Since WWII these tactics haven't changed much.

Since the decline of the Soviet Union, the world situation has changed dramatically. Many thought the World would become a much safer place because the threat of a Mutual Assured Destruction had gone. But instead the World has become much more instable. Terrorist threat, natural resources becoming scarce, global warming, new arising superpowers; all these facts can cause a worldwide instability. Armed forces from the USA, Canada, Europe and Australia are employed all over the world to conquer these threats.

Since WWII technological developments made possible what every general had been dreaming of since the beginning of warfare; complete situational awareness. Network Centric Warfare (NCW) is the new credo of present warfare. Although this theory may not be as revolutionary as it is said to be, it has proven to be very successful during the last decade of warfare. NCW does have some disadvantages; for one its data transfer is vulnerable to distortion. Enemies, armies or terrorist groups, that don't have NCW

Dodging UCAVs censured

technologies at their disposal, will have to adopt asymmetric tactics to encounter the NCW technologies. These tactics are hard to defeat as the situation in Iraq shows.

In this ever changing world the Royal Netherlands Air Force RNLAF evolved from an air force waiting for the Warsaw Pact to attack Western Europe to an air force capable of operating worldwide. Mainstay of the RNLAF is still the F-16 swing-role fighter. The F-16 is due to be replaced by the JSF, a multi-mission fighter. Being a small air force, the multi-mission (capable of several different missions) or swing-role (capable of changing the purpose of its mission during the mission) is a very important concept for the RNLAF. This means it can operate with only one type of fighter aircraft, but is still able to perform every essential mission.

Technological developments made it possible to operate aircraft without an onboard pilot. Although many had tried to achieve this since WWI, only the Vergeltungswaffe I and the Cruise Missile can be regarded as successful. But these were only one-way crafts. New technology made it possible to arm light reconnaissance aircraft, look for the enemy, fire and destroy him and return to the base. When this technology could be used in aircraft with the size of an F-16, manned aircraft could be replaced by unmanned ones. These Unmanned Combat Aerial Vehicles, or UCAVs, have the advantage of being able to stay in the air much longer and would be much cheaper than the manned counterpart. And in the event a UCAV was shot down, no life of a pilot was to be regretted. There are some disadvantages as well; the bandwidth available to send data to control the UCAV remotely is limited, the data link is vulnerable to distortion, there are some major questions about collateral damage and legal matters. Furthermore it is still unclear for which missions the UCAV is best suitable, although missions that require persistence might suit the UCAV best. And finally, the promise of being cheaper might not be kept.

According to the theory of Social Construction of Technology (SCOT) technological development is mainly a sociological process. This means the development depends on the actors involved and their interest in the artefact. Although many actors are involved in the process of acquiring new combat aircraft, only a few are involved in the decision making process of whether this will be a manned or unmanned aircraft. The main actors in this process are the RNLAF and the Dutch politicians. The need for a combat aircraft is defined by (RNLAF) fighter pilots, and therefore manned aircraft will be preferred. The view of the politicians is more diverse; some, most right wing parties favour a strong and well equipped air force, while other, most left wing parties, prefer a smaller air force, or no air force at all.

There is one threat however the RNLAF may find much harder to cope with. The latest generation fighter aircraft have become extremely expensive. As a result the lifespan of these aircraft may expand to 50 years or even more. Furthermore, with the decline of the Soviet Union the need for ever more advanced fighter aircraft seems to have collapsed as well. In contrast with life in nature, lacking a natural enemy may lead to the extinction of the manned combat aircraft. As a result the military may look for cheaper, smaller, mission specific and unmanned(?) aircraft.

Table of Contents

Preface.....	3
Summary	5
Table of Contents	7
1 Introduction	9
2 History of Air Power.....	12
2.1 The Inter bellum	14
2.2 World War II	18
2.3 The Cold War	24
2.4 Sub Conclusion.....	31
3 New Wars?.....	32
3.1 Revolution in Military Affairs	34
3.2 Asymmetric warfare	38
3.3 Dutch Wars	39
3.4 Sub Conclusion.....	40
4 Royal Netherlands Air Force.....	41
4.1 Pre Second World War.....	41
4.2 Post Second World War, entering the Cold War	41
4.3 Post Cold War.....	43
4.4 The 21 st Century	44
4.5 Sub Conclusion.....	46
5 UCAV; Past, present and Future Developments	48
5.1 Why UCAVs?	48
5.2 A Pilotless History.....	50
5.3 UCAVs Today	53
5.4 Future developments	58
5.5 Sub Conclusion.....	61
6 Dutch Defence Material Process.....	62
6.1 Acquisitioning New Combat Aircraft	62
6.2 Social Construction of Technology (SCOT)	63
6.3 Actor Network.....	64
6.4 Phases	72
6.5 Ministry of Defence	74
6.6 Deciding Actors.....	77

Dodging UCAVs censured

6.7	Sub Conclusions	79
7	<i>Developing Combat Aircraft</i>	80
7.1	Combat Aircraft	80
7.2	Fighter Aircraft Manufacturers	86
7.3	Sub Conclusions	88
8	<i>Conclusions</i>	90
9	<i>Bibliography</i>	92

1 Introduction

In 100 years, manned combat aircraft did evolve from unarmed flying crates fluttering around to very sophisticated weapon platforms, flying beyond the speed of sound, capable of destroying whole cities or just one single bridge with one bomb, or downing aircraft beyond the line of sight. Battles are won by the use of air power; both Gulf Wars showed that armies which are not supported by air power do not stand a chance against an army that is supported.

The role of the aircraft during war wasn't clear from the start. Although the destructive capacity of bomber was quickly realised, these aircraft were very vulnerable for fighter aircraft attacks. Previous to the Second World War, air power theorists thought that air power alone could win wars; during the Second World War it became clear that this theory was wrong. The on-land battle was also changed; air power, together with the main battle tank, made fast manoeuvre warfare possible. The doctrine of static lines of defence was made completely out of date.

Today the manned combat aircraft still plays a decisive role during; it eliminates the enemy air power, paralyses the enemy command by destroying its communication networks and decimates the enemy ground force.

But the man in the cockpit might become obsolete.

Already during the 1950s in Great Britain missiles were thought to make the combat aircraft obsolete. In his White Paper the Defence minister, Duncan Sandys, stated that the RAF would not purchase combat aircraft any longer and he stopped almost all development programs on combat aircraft in 1957¹. These thoughts lasted only for a short period time; the manned combat aircraft was rehabilitated. In the mean time however the British military aircraft industry suffered a severe set back which they never really recovered from.

Combat aircraft have become very sophisticated weapon platforms. During the Second World War the destruction of one factory needed a fleet of four-engined bombers, each having a crew of 8 or more. Today one single aircraft operated by just one pilot can destroy that same factory. One major drawback of this development is that these aircraft have become very expensive. During the last 40 till 50 years the costs of a fighter aircraft did raise tenfold.

To reverse the costs of combat aircraft; engineers, strategists and politicians hope to be able to achieve the same with, cheaper, unmanned combat aircraft; the UCAV or Unmanned Combat Aerial Vehicle. All major aircraft manufacturers have some demonstration U(C)AVs on their drawing boards or already flying.

Dutch politicians are also aware of the developments on the UCAV. In 2006 there was some talk about purchasing only half the number of F-35s initially. If in the meantime suitable unmanned combat aircraft become available, the Dutch government may prefer purchasing them in stead of the remaining F-35s². This point of view is off; the total number of 85 JSFs are to be bought.

¹ http://psychcentral.com/psypsvch/Duncan_Sandys

² Defence's Secretary of State, Mr. Van der Knaap, at a NIID conference October 2005.

Dodging UCAVs censured

In the field of fighter strategy The Royal Netherlands Air Force (RNLAf) is a (fighter) pilot orientated organisation; they are the ones that fly the fighter aircraft and engage the enemy. Such an organisation may prefer a manned aircraft, in stead of an unmanned version, making pilots obsolete. Like the British RAF in 1957 who sought for a reason to build and operate a manned aircraft³, the RNLAf may be expected to prevent the procurement of UCAVs. So, apart from technological developments that might make unmanned combat aircraft possible, will the RNLAf management, which for a large part consists of pilots, accept the UCAV replacing manned aircraft within the RNLAf? In other words, *will a pilot orientated organisation like the RNLAf ever choose for an aircraft that doesn't need a pilot?*

Within the field of Science and Technology Studies the theory of Social Technology of Technology is a popular theory to explain the development of technological artefacts. Supporters of SCOT argue that human action shapes technology rather than technology is shaped by engineers. Furthermore, how and why a technology is used, cannot be understood without understanding how that technology is embedded in its social environment. The theory of SCOT will be used to try to predict the future (if any) of the UCAV within the RNLAf.

So, the problem is not only about actors. The combat aircraft can be considered an artefact. An artefact is not an isolated case; it is part of a (larger) system. This system is influenced by its environment⁴. Before anything can be said about the actors, the artefact and its network have to be made clear. This means the combat aircraft has to be illustrated from several different angles. First of all, what's the use of combat aircraft? During WWI fighter aircraft were mainly used to fight the war in the air; the Air War. But the predicate is no longer "Air War"; today manned and unmanned combat aircraft have to act in the "Air Power" theatre. So then, what is air power? How did it evolve since the arrival of the aeroplane over the battlefield?

But as we want to predict the future, looking back into history is not enough; the future has to be explored too. During the last decennium of the 21st century the world did change dramatically by the decline of the Soviet Imperium. The East – West strained relations disappeared and according to the beliefs of many people a clear and present enemy had gone. Hence, many people don't see the need of spending large amounts of money to maintain a large military force. But has the world changed for the better? What is the environment the combat aircraft will have to operate in? Scholars like Gray⁵, Hirst⁶ & Kaldor⁷ may give an answer to this question.

The RNLAf is just a small air force in a big, ever changing world. How did the RNLAf evolve since it was established in 1913? And what are its (possible) future scenario's?

³ John Law & Michel Callon; *Engineering and Sociology in a Military Aircraft Project: A Network Analysis of Technological Change*; *Social Problems*, Vol. 35, No. 3, Special Issue: The Sociology of Science and Technology, p284-297; June 1988

⁴ A system is constituted of related parts or components. These components are connected by a network or structure. Because components are related by the network of interconnections, the state or activity of one component influences the state or activity of other components in the systems. A system can have its components arranged vertically or horizontally. When arranged horizontally, components of the same kind, or function, are interconnected. When components are joined in a functional chain, these components are arranged vertically. All of the system's components share the characteristic of interconnections; a change in one impacts on the other components of the system. Systems can vary over time and from place to place. Parts of the world, no subject of a system but influencing it are called environment. Hughes, Thomas P.; *Networks of Power*; Electrification in Western Society, 1880 – 1930; The John Hopkins University Press, Baltimore 1983

⁵ Prof. Colin S. Gray; *Another Bloody Century*; London; 2005.

⁶ Prof. P. Hirst; *War & Power in the 21st Century*; Cambridge; 2001

⁷ Prof. Mary Kaldor; *New & Old Wars*; Cambridge; 2001.

Dodging UCAVs censured

And of course, we have to take a look at the artefact itself. All major aircraft manufacturers are working on UCAVs. What are the developments so far?

When the above questions are answered we can finally draw up our actor network. The Dutch Defence Material Process will be the guideline in this part of the survey. As the RNLAF is in the middle of the Joint Strike Fighter procurement process, this process will serve as an illustration of the DMP, as are the events during the procurements of the Lockheed F-104G *Starfighter* and the General Dynamics F-16. Law & Callon's and Pinch & Bijker's⁸ articles will be the instruments in handling this matter.

Change is the law of life. And those who look only to the past or present are certain to miss the future (John F. Kennedy)

Law & Callon and Pinch & Bijker described the history of the development of an artefact; the British TSR2 strike aircraft and the bicycle. Armies historically have been criticized for preparing for the last war. With this study I hope to predict the future for the UCAV within the RNLAF, not on technological grounds only but on the basis of (social) networks. It is however, not the intention of this study to determine which aircraft the RNLAF should acquire in the future.

⁸ Trevor J. Pinch & Wiebe E. Bijker; *The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other*, Social Studies of Science 14 (1984): 399-441.

2 History of Air Power

"The duty of the fighting pilot is to patrol his area of the sky, and shoot down any enemy fighters in that area. Anything else is rubbish." Manfred von Richthofen.

The discussion on air power started already before WWI. Some recognized the possibilities of reconnaissance while others thought aeroplanes would fly too fast for the pilots to be able to see clearly. Anyway, back then the aeroplane technology was still in its infancy.

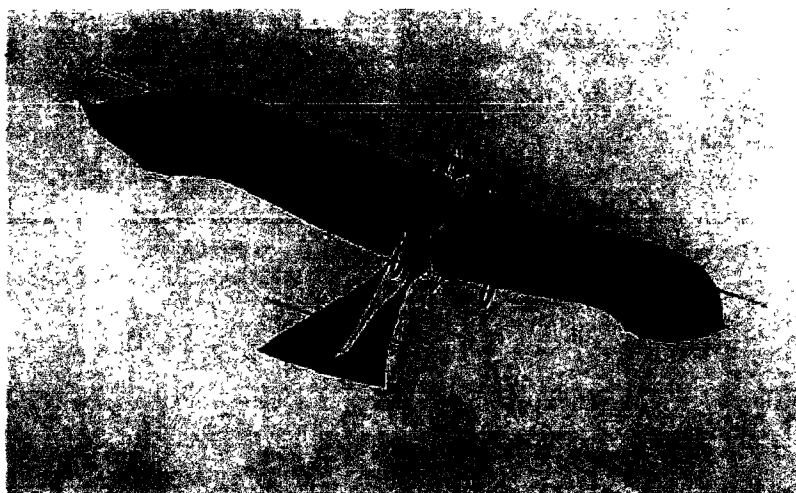


Figure 1: Air Power?

A 1909 design; the Etrich
Taube

During WWI aeroplanes were initially used for reconnaissance spotting the movements of enemy troops. In the beginning the aircraft had no identification markings, but as the infantry began shooting at them with rifles, the British and Germans began more or less simultaneously painting national markings on their aeroplanes. A day or two after the battle at Mons, 24 August 1914, a British pilot drew his revolver and fired at the pilot of an approaching German aircraft. Soon others followed using revolvers, rifles and, when aircraft got more and more powerful, machineguns. The Air War had started.

The use of machineguns raised problems, however. The easiest way of using them was to bring the direction of fire in line with the aircraft's direction of flight. By doing so, the propeller would be hit by the bullets. To overcome this problem several solutions were brought to practice; a pusher aircraft with the engine behind the pilot, a second man as gunner or a machinegun on top of the upper wing. All these solutions had some disadvantages; a pusher aircraft had inferior performances and the engine moved forward during a crash landing. A second crewmember meant extra weight and therefore a decrease in performance and a wing-mounted machinegun proved (too) difficult to reload during air combat.

The first aircraft capable of shooting through its propeller was the French Morane-Saulnier. The propeller blades were fitted with steel deflector blades. The bullets hitting the propeller blades would bounce off and not shatter the blades. One of the pilots using this aircraft was Roland Garros, who was immediately successful, shooting down five enemy aircraft in April 1915. However, within a month he was forced down behind enemy lines and his aircraft came in the hands of the Germans. The Germans asked Anthony Fokker to improve this French innovation. Fokker produced an aircraft similar to the Morane-Saulnier. But instead of deflector blades, he developed a synchronised

Dodging UCAVs censured

interrupter gear. This gear interrupted the machinegun whenever a propeller blade appeared in front of the gun. The Fokker EIII was an instant success and became known as the 'Fokker Scourge'. This Fokker single-seater aircraft was designed for one thing only; destroying enemy aircraft. It was the first classic fighter aeroplane.

Aeroplanes could not be armed with guns only. With increasing engine power, the payload increased allowing bombs to be taken aboard. Initially the bomb load was hardly sufficient to distress the soldiers in the trenches. But later during the war the bomber became, theoretically, a weapon of some importance. The Germans were using Zeppelins for the first bomb raids against London. They chose London as a target, so they did not need to cross the trenches in northern France to reach French targets. A Zeppelin filled with hydrogen gas was too vulnerable to cross these well armed lines. But Zeppelins proved to be vulnerable to fighter planes too, so the daylight raids against London were halted. Night raids proved to be unsuccessful. In the summer of 1917 the Germans restarted the daylight raids against London with Gotha bomber aeroplanes. Losses in aircrew and aircraft became too high, so the Germans called off the bombing campaign in May 1918⁹.

These raids had caused a call for retaliation by the London citizens. It was not only the call for retaliation, also the idea to end the war with strategic bombing made the British and French start long distance strategic bombing. From July 1916 and April 1917 the Royal Naval Air Service (RNAS) No. 3 Naval Wing unit launched 18 raids into Germany and territory occupied by Germany. By bombing German soil, the Navy wanted to increase their war effort¹⁰. No. 3 Wing cooperated with French air forces in a series of aerial attacks against German iron works and blast furnaces in the Saar valley. With these attacks they hoped to damage the German weapon industry.

Between Field Marshal Sir Douglas Haig and the British government a divergence of view existed on the use of (strategic) bombers. While Field Marshal Haig wanted every available combat aircraft to support the war effort on the ground, the British government thought strategic bombing would shorten the war. They hoped to achieve this by either directly inflicting damage to the war industry or, when the damage would be only minor, to shake the morale of the industrial population. Because of the night raids the population would not sleep and as a result would become exhausted. This would have an adverse effect on the output of munitions of war. Supported by reports from the bomber squadrons, British government made up plans to build up a large strategic bomber force.

The effects of these bombings were rather minor¹¹. Because of faults in navigation the targets were often missed. Also the bomb technology proved to be unreliable. Not all of the bombs dropped detonated. Furthermore, aeroplane technology, still being in its infancy, could not provide the power to carry substantial bomb loads.

⁹ Meilinger, Phillip S., Col USAF; *The Paths of Heaven, The Evolution of Airpower Theory*, p172; Air University Press; Maxwell Air Force Base; Alabama

¹⁰ Edgerton, D.; *England and the Aeroplane*, p15; Centre for the History of Science, Technology and Medicine, University of Manchester; 1991.

¹¹ Williams, George K.; *Biplanes and Bombsights, British Bombing in World War I*; Air University Press; Maxwell Air Force Base, Alabama; May 1999.

2.1 *The Inter bellum*

The Great War had taught many that wars would shed much blood and cost many lives. Machineguns made it almost impossible for soldiers to advance. It would be almost impossible to defeat armies and by doing so, win the war. Main battle tanks showed up too late in the Great War and were used in the wrong way to prove they could make a difference, as they would do in the next 'Great War'. Despite the modest results of the combat aircraft in WWI, some people believed air power would be able to win wars without the need of ground forces. One of them was Giulio Douhet, an Italian general. He thought that bombing an enemy country's "vital centres", the key industries and structures that allowed a state to function, as well the bombing of citizens, would end wars. Aeroplanes could do so because they could travel in any direction, at any altitude, and at any time, they would enjoy the advantage of tactical surprise. To his opinion aeroplanes could not be intercepted or stopped. In those days this was all but an unrealistic scenario. Aeroplanes were small in size and had to be detected by eyesight as radar did not exist yet. So, chances of being intercepted were rather small¹². Because of this he thought no more wars would be fought, for countries would not attack out of fear for enemy retaliation from the air¹³. Douhet had witnessed the misery in the trenches during WWI. In his wish never having to see this again may lie the origin of this idea that bomber aircraft could prevent wars or end them without the same suffering by so many, by killing a few(?) citizens. Apart from whether Douhet's strategy would be successful, aircraft and bombing technology had not proved themselves capable yet of inflicting damage to such an extent.

In line with the ideas of Douhet, but not been influence by his ideas¹⁴, the British developed a similar air power strategy. Strategic bombing would bring the enemy on his knees, either by destroying his strategic industry or by demoralising the enemy population, which would cry for an end to the war. The RAF's Chief of the Air Staff (CAS), air marshal Trenchard, said in 1923 that it would be better to add four bomber squadrons to hit the French than four fighter squadrons to defend Great Britain. He thought 48 more bomber aircraft would employ a strong impact on French morale, while shooting down of a few bombers "would have very little effect"¹⁵. At that time Germany was not seen as an enemy (yet). Trenchard advocated "moral bombing". Moral bombing did not imply the bombing of citizens, like Douhet had preached and Bomber Command would actually practise during WWII. It was about bombing the military industry and infrastructure. The morale of the public would be broken by the fact that their industries were bombed, which would have a shattering effect on the workforce, for they lost their income¹⁶. Even in the late thirties the RAF's Chief of Plans on the Air Staff, Sir John Slessor, argued that the coming war would be nearly all fought in the air. Great Britain could only achieve and sustain air superiority through a "resolute bombing offensive" against enemy cities and industries. The enemy would be forced to use his air strength in a defensive, not offensive, role. He would redirect strength away from the primary task

¹² Mets, David R.; *The Air Campaign, John Warden and the Classical Airpower Theorists*, Revised Edition, p13; Air University Press Maxwell Air Force Base, Alabama; April 1999

¹³ Meilinger, Phillip S., Col. USAF; *Airmen and Air Theory, A Review of the Sources*, p104; Air University Press, Maxwell Air Force Base, Alabama; 2001

¹⁴ Murray, W.; *Strategy for Defeat, The Luftwaffe 1933-1945*, p324; Air University, Maxwell Air Force Base, Alabama; January 1983

¹⁵ Murray, p324

¹⁶ Melinger, Phillip S; *Airwar, Theory and Practise*, p49; Portland, Oregon USA; 2003

Dodging UCAVs censured

of "strategic" bombing, "which alone would be decisive". Ground operations would seldom occur, and armies would mostly serve as frontier guards while the bombers flew overhead¹⁷. In 1937 Prime Minister Neville Chamberlain forced an unwilling Air Ministry to invest substantial resources in air defence. Only then the British started with a high level production of air superiority fighters as the Spitfire and Hurricane. Furthermore, Thomas Inskip was the new minister for the coordination of defence in 1937. He had the supervision over the rising defence budget. Inskip reorganised military aircraft production. As three fighters could be built for every bomber, he gave priority to the production of fighter. With the new radar technology bombers could be detected, intercepted, and stopped. The belief that bombers could strike virtually anywhere, anytime, from any direction, and achieve tactical surprise was no longer feasible. Why the British were focussed for so long on strategic bombing only, could be explained by their history as a naval super power¹⁸. Naval wars could be seen as economic wars; although battles take place, the primary goal is applying pressure on a country's trade and economy to "force a change in policy". Strategic bombing has in a sense the same intend. In fact, the first more or less successful bomber squadron was No. 3 wing of the Royal Naval Air Service¹⁹.

One of the best known US air power theorists was William "Billy" Mitchell. In February 1918, as chief of Air Service, I Corps, he stated that the first mission of offensive airpower must be the destruction of the enemy's air force. Once air-superiority was achieved, bombing operations could destroy the enemy's vital centres. Those centres were great cities where people lived, factories, raw materials, foodstuffs, supplies, and modes of transportation. But gaining air-superiority requires fighter aircraft or pursuit aircraft as they were named in the US. According to Mitchell the ratio of pursuit aircraft should be 60%, for bombers, as well as reconnaissance aircraft, the percentage was 20%. In the late 1920's however, a new strategy was developed; High Altitude Daylight Precision Bombing (or HADPB). This strategy was developed at the Air Corps Tactical School. Precision because the government wanted the biggest bang for the buck, daylight because the navigation instruments and bombsights were too primitive to guarantee success during night attacks²⁰. Bomber aircraft could be armed sufficient to defend themselves, especially when they would fly in close formations at high altitude and high speed. These tactics meant they would need no fighter escort. The USA hold on to this doctrine till 1943.

Having learned from experience, former Russian pilot Alexander P. De Seversky knew that bomber aircraft were vulnerable to enemy fighter planes. De Seversky understood the need for fighter aircraft with a range equal to escort bombers. He developed the P-35 the first mass-produced United States all-metal monoplane fighter. It was extremely fast for its days and it was designed for long range. It was, in fact, the forerunner of the famous P-47 Thunderbolt, one of the first fighter planes to escort US bombers into Nazi Germany in 1943. But in the late 1930's (and still in the early 1940's) people thought it was not possible to design a single-engined long range fighter. Long range meant more

¹⁷ Murray, p326

¹⁸ Meilinger, Phillip S., Col USAF; *The Paths of Heaven, The Evolution of Airpower Theory*, p41; Air University Press; Maxwell Air Force Base; Alabama

¹⁹ Williams.

²⁰ Faber, Peter R., Lt Col, "Interwar US Army Aviation and the Air Corps Tactical School: Incubators of American Airpower"; in Meilinger's *The Paths of Heaven, The Evolution of Airpower Theory*.

Dodging UCAVs censured

fuel, which meant a larger aeroplane, which meant two engines, which meant more fuel, etc.²¹.

Another interesting country in view of air warfare doctrine was Italy. Although this was Giulio Douhet's native country, the Italians practised a different doctrine than he had propagated. Amedeo Mecozzi put the pith of his theorem on tactical aviation. He preached an air force divided into three segments; a strategic bomber force, a naval segment and, the largest, a tactical air force to oppose the enemy army and to support the Italian army. Mecozzi managed to influence Air Marshal Italo Balbo, Italian air minister from 1926 to 1933. During the Spanish Civil War (1936–39), Mecozzi's theories were put into practise. With these tactics the Italian air force performed rather well.

Russia was also involved in the Spanish civil war. The most noteworthy early theorist of Russian aviation was Gen A. N. Lapchinsky. He wrote a book and a series of articles in 1920 in which he described how strategic bombing would become a major weapon of modern warfare. In the early 1930's The Soviets, largely under the influence of Lapchinsky, began building the largest strategic bomber force in the world, In that time the Soviets formed a special heavy bomber air corps for strategic operations. Marshal Mikhail Tukhachevski, another Russian theorist, is said to be one of the most original and influential military theorists of the twentieth century²². He enunciated the theory of deep battle. With deep battle airpower prepared the way for the breakthrough of motorized and mechanized troops and supported the advances of mobile forces deep into enemy territory. In contrary of other air power theorists, Tukhachevski considered aviation as an integral part of a joint force, with the objective of driving deep into the enemy's rear with the intention of destroying his armed forces. Other than his colleague theorist in the early 1930's he thought the time was not ripe for strategic bombing. But when improved aerodynamic design enabled aircraft to fly fast, at great range and high altitude, he predicted that strategic bombing, coupled with airborne drops, could seize the enemy's rail systems and paralyze the mobilization of enemy forces. Although the Soviet Union had created a large strategic bomber force , the main doctrine within the Red Air Force became the concept of joint air-ground operations , as advocated by Marshal Tukhachevski. From 1936 to 1939, the Soviet Union became involved in the Spanish civil war by supporting the Spanish Republic. During this war the Soviets showed the advantages of the use of airpower against ground forces²³. The Soviets, with these experiences, placed greater accent upon ground-attack tactics. There was, however, another, more pragmatic reason for choosing ground-attack tactics. The soviet industry was capable of manufacturing simple and rugged aircraft. Strategic bomber called for sophisticated items as navigation instruments and bombsights. Unfortunately for the Red Air Force Stalin had 75% of the officers arrested and executed between 1937 and 1939. Marshal Tukhachevski and general Lapchinsky were among them. Fortunately, their doctrines and tactics survived.

²¹ Meilinger, *The Paths of Heaven*, p244.

²² Dr. Corum, James S.; *Airpower Thought in Continental Europe between the Wars*, p163; in Meilinger's *The Paths of Heaven, The Evolution of Airpower Theory*.

²³ In March 1937 Soviet aircraft and pilots flying for the Republic during the offensive at Guadalajara won one of airpower's most dramatic victories. Between 9 and 21 March 1937, Soviet airpower attacked and pushed a force of 50,000 motorized Italian troops into a rout. Up to 125 Soviet-piloted, Loyalist aircraft attacked Italian columns. Italian losses included five hundred killed in action, two thousand wounded and five hundred taken prisoner. The Soviets destroyed approximately one thousand vehicles and 25 artillery pieces. Air attack caused most of the damage and casualties.

Dodging UCAVs censured



Figure 2: Inter bellum Air Power Theorists; Giulio Douhet, Hugh Trechard, Billy Mitchell, Alexander P. De Seversky, Mikhail Tukhachevski and Walter Wever.

2.2 World War II

2.2.1 Nazi Germany

During WWI Germany created an independent air force, the Luftwaffe, with a centralised command. During this war the Luftwaffe was rather successful and functioned well until the end of this war. After WWI, Germany was forbidden to have an air force by the Versailles Treaty. Right after the war the German officer began analysing the German tactics. Although they performed well, the German air force had used a defensive strategy during WWI. German pilots hardly ever crossed the enemy lines and rather waited for the Allied pilots to cross it. With this strategy the Germans achieved a three to one kill ratio, but they never had the initiative during the war. The initiative lay with the Allied air force and once they gained air superiority they were able to maintain this superiority. The Germans concluded that air superiority could only be achieved by an offensive strategy and that the duty of an air force was to win air superiority by attacking enemy forces on the ground and in the air. During the 1920's strategic bombing became also an issue for the Germans. With their bad experiences with the bombing raids against London, they had a deep respect for defensive aircraft, like fighters. To overcome the threat of fighter aircraft, the thought escorting fighters should protect the bomber force. In the early 1930's the strategic bomber doctrine became the most important issue for the new to be established Luftwaffe. The first chief of staff of the Luftwaffe, Lt Gen Walter Wever was a great supporter of strategic air war. The first goal of the Luftwaffe was to gain air superiority²⁴. Next it would carry out strategic bombing on "the sources of the enemy's strength". It was forbidden to bomb civilian targets, as this would be counterproductive and contrary to the law of war²⁵.

However, the German technology showed not being capable of developing and manufacturing a suitable and reliable engine for a four-engined long-range strategic bomber²⁶. But also the supply of raw materials needed for manufacturing aircraft played an important role. Germany still suffered from the recession at the time the Nazi's came to power. Except for charcoal, all other raw material had to be imported. Lacking sufficient finance, the supply of these materials was very limited. Another factor playing a role was the Nazi's obsession for numbers²⁷. As large four-engined bombers required more material than one- or two-engined fighter planes, the choice was made for the last two types of aircraft.

During the Spanish civil war, the Germany sent several hundred aircraft and about 20,000 men to Spain to support Gen Franco's Nationalist armies. The tactics of close air support were perfected during this war; in which especially dive-bombing played an important role. They played such an important role that the new head of the technical department, Ernst Udet, wanted all bombers to be designed as dive-bombers. This dogma caused production delays for new to build bomber aircraft. In the meantime the Germans had lost Gen. Wever, who died in a plane crash. His successors did not have the strategic insight and prestige Wever had. They were not capable of challenging the ideas of Göring and Udet. Although very good tacticians, they missed the strategic thinking and did not perform long-range planning. The

²⁴ Crevel, M van.; *Air Power and Manoeuvre Warfare*, p28; Air University Press; Maxwell Air Force Base, Alabama; 1994.

²⁵ Ibid.

²⁶ Meillinger; *The Paths of Heaven*, p173.

²⁷ Murray; p13.

Luftwaffe turned into a force that reacted to day-to-day political and operational pressures²⁸.

In spite of these shortcomings, long-distance strategic bombing was still a matter of interest to the Luftwaffe. During the Spanish civil war they discovered that finding and hitting a target during bad weather or the night proved difficult. They experimented with radio direction systems to find their target. The "Knickebein" system was the result, which was used to help the German bomber crews on their strategic bombing missions during the Battle of Britain.

The Germans, however, faced a different kind of war than Great-Britain and the United States. These last two were protected by water from a direct enemy invasion. Germany had to fight battles on land to defeat their enemies. But the Germans did not fight just 'a' battle. With the use of space and time, they wanted to fight a decisive battle²⁹. This would be achieved by using armoured vehicles (tanks) and close air support by aircraft, which acted as fast moving artillery. So, the Germans emphasized on the support of the ground forces. Furthermore, in the late 1930's Adolf Hitler did not intend to fight a war against Great-Britain. In fact, even in 1940 he hoped that Great-Britain would ask for peace.

With their tactical close air support, the Germans surprised the world. In the month of September 1939 they overran the Polish army and air force. In May 1940 they did the same in the Low Countries and France, defeating France's and Britain's armies. The British and the French had ignored the lessons from the Spanish civil war and the Polish campaign³⁰. The Germans seemed unbeatable with their Blitzkrieg. Ground forces were continuously supported by bombers and dive-bombers. Fighter aircraft escorted the bombers and attacked enemy fighters and bombers. But the victory did not come cheap. At the time of the ceasefire, the Germans had lost 753 tanks or nearly 30 percent of their armoured forces and almost 30%, or 1428 in numbers, of their aircraft as well.

Unfortunately for Hitler, the British did not intend to surrender. Great-Britain would fight on and so had to Germany. As the Germans lacked a long term strategy, they had not prepared themselves for a long war, nor did they recognize that they had to in the summer of 1940³¹. The victories they gained so far were gained by a close cooperation between the Wehrmacht and the Luftwaffe. Now the Luftwaffe had to fight Great-Britain on its own. It had to conquer air superiority before the Germans could deploy an invasion force to England's beaches. For this, it had to defeat the Royal Air Force. In fact, the Luftwaffe was convinced that defeating the RAF would be sufficient to bring victory.³²

Alfred Jodl, second in charge in the Ober Kommando de Wehrmacht (OKW) issued a memorandum in June 1940, in which he posed two possibilities for German strategy against England. The first was a direct attack on the English motherland, or second, extend the war to peripheral areas, such as the Mediterranean and trade routes. The direct attack had three stages: (1) an offensive by air and sea against British shipping combined with air attacks against centres of industry, (2) attacks by air against population centres, (3) finally, a landing operation aimed at occupying England. Before the Germans would succeed air superiority was required. Also British aircraft

²⁸ Murray; p12.

²⁹ Creveld; p22

³⁰ Murray; p329.

³¹ Murray; p69.

³² Murray; p45.

manufacturers had to be destroyed, preventing a recovering RAF. Air superiority meant also the British bomber force had to be attacked. Once the British import was stopped and the population exposed to bombing attacks, Jodl thought the British willpower would be broken. The landing on British beaches would only be a final blow³³.

The capabilities of the German fighters and bombers proved to be inadequate. The range of the main German fighter, the Messerschmitt Bf-109, was very limited. It could only protect the German bombers over South-East England and for just a short time. This meant only one group of the RAF (Group 11) would be attacked. When fighting for air superiority, the whole RAF should have been attacked. Another disadvantage for the Germans was the fact that British aircraft industry and other military industries were located in central England, which meant beyond the range of the Bf-109. So it could fight RAF 11 Group, but could not destroy the RAF's supply lines³⁴. The longer-range Messerschmitt Bf-110, the pride of Göring, proved inferior the British fighters. Further to the disadvantage of the Germans was the existence of a British radar network. The British experienced attacks on the homeland (London) during WWI, so the need for an early warning system was eminent. This network detected German aircraft when they were flying over the French coast and allowed the British to deploy their aircraft just in-time, saving fuel and gaining therefore operating time. Furthermore, every pilot being shot above England was either killed, wounded and/or captured and therefore lost for the Luftwaffe, while British pilots, if not killed or severely injured, could rejoin their squadron.

When RAF's Fighter Command did not show any signs of weakening, the Luftwaffe started attacking London 07 September 1940. It was Hitler's response to British bombing of Berlin. The Nazi's hoped to break the moral of the British population and that they would finally ask for peace. But they didn't, instead it hardened the British. This change of tactics gave relief to the RAF ground personnel and air field infrastructure. In a way, it helped Fighter Command, although it still had to fight the Luftwaffe. With ever growing losses, the Germans decided to change daylight operations for night raids. Although these raids were much less successful, the Luftwaffe could not endure the attrition during daylight missions much longer³⁵. British night anti-aircraft defences were ineffective, so German losses decreased. Anyway, the moment city of London was chosen as the main target, the Battle of Britain was actually lost by the Germans³⁶. Adolf Hitler did not seem to mind, as he had turned his attention to the East; Russia.

2.2.2 Bomber Command against Nazi Germany

With the end of the Battle of Britain the war in Western Europe was not over. The RAF, and in particularly Bomber Command, attacked Nazi Germany. What the Battle of Britain and some own experiences over Germany had learned Bomber Command was that there lay no future in daylight bomber raids against Germany. Losses suffered would be too high. So instead, they turned to night raid bombing. With their pre-war doctrine of strategic bombing they hoped to end the war by striking German industry and breaking the moral of the German population. Initially oil plants and transportation systems were the main targets. But as the accuracy of night bombing

³³ Murray.

³⁴ Dr. Chun, Clayton K. S.; *Aerospace Power in the Twenty-First Century, A Basic Primer*, p81; United States Air Force Academy, in cooperation with Air University Press; July 2001

³⁵ Murray; p55.

³⁶ Dr. Chun, Clayton K. S., p83.

proved disappointing, Bomber Command changed to “area bombing” in 1942. In practise this meant bombing whole cities. In 1942 the leader of Bomber Command, Sir Arthur Harris, believed that only firm and constant bombing of Germany could end the war. Any diversion of aircraft, protecting British shipping, supporting the army or attacking Axis forces in the Mediterranean was a “gross misuse” of airpower³⁷. Even sending bomber aircraft to Coastal Command attacking German U-boats “was merely an obstacle to victory”; while in 1942 the U-boats were the biggest threat to Great-Britain.

The direct effects before 1942 were not very significant; but it was the only way that Great-Britain could attack Germany at all³⁸. In 1942 Bomber Command had the disposal of Gee, a navigational aid. Initially they had some successes with it, by the destruction of Lübeck and Cologne, but in August 1942 the Germans managed to jam Gee. As a result, the bombers were as accurate as they were before Gee. Daylight attacks were no option, as the loss rate was too high, while escort fighters were seen as “a myth”. “A fighter performing escort functions would, in reality, have to be a high performance and heavily armed bomber”³⁹.

During the first year of WWII the Germans fought the British night bombers mainly with Flugzeug Luft Abwehr Kanone, or better known as Flak. To Hitler they were more suitable for the job than aircraft. As he had a rather big finger in the pie about decisions, this situation did not change very quickly⁴⁰. Despite Hitler’s vision, in July 1940 a night fighter division was established. This division grew rather slowly, from 116 aircraft in September 1940 to 345 aircraft in 1942. The British bombing raids had too little effect to worry the Nazi’s. Furthermore, in 1941/1942 everybody’s attention was focussed on the campaign against Russia. Despite a not optimum air defence, during 1942 the Germans shot down 1,404 aircraft and damaged 2,724. The strength of Bomber Command in 1942 was maximal 500 aircraft, so the Germans managed to shoot down almost 300%⁴¹

In 1943 the British introduced Oboe, a directional aid and H2S, a radar target locator. Also four-engine bomber became more and more available. Despite these the technological aids, Bomber Command could only act “as a bludgeon” in 1943⁴². Maybe area bombing in 1943 did more collateral damage to German industry than would have been the case when Bomber Command had waged a campaign directly aimed at destroying German industry⁴³.

In the second half of 1943 the Germans increased their night fighter corps. They also changed their tactics. They directed the night fighters into the British bomber formations and let them fly with the bombers, shooting down aircraft until fuel or ammunition ran out. Later during the war their radar systems improved and the German night fighter inflicted great losses to Bomber Command. In fact, Bomber Command lost the battle for Berlin in 1944. During this battle Bomber Command lost 1128 4-engine bomber. From January 1943 till May 1944 they lost 5881 aircraft⁴⁴. With this loss rate, night raids became as dangerous as raids by daylight. By now it was clear that Bomber Command could not defeat by night bombing raids.

³⁷ Murray, p129.

³⁸ Prof. Mets, David R.; *The Air Campaign, John Warden and the Classical Airpower Theorists*, Revised Edition, p28; Air University Press Maxwell Air Force Base, Alabama; April 1999.

³⁹ Murray, p131.

⁴⁰ Murray, p132.

⁴¹ Murray, p166.

⁴² Murray, p166.

⁴³ Murray

⁴⁴ Murray, p220.

2.2.3 America joins in

In the mean time America had joint Great-Britain in their bombing raids against Germany. The Americans had a different approach though. They hoped to defeat the Germans with precision daylight bombing on vital targets. There was no need of long range fighter escort. The US commanders had the opinion this could be achieved by the heavily armed bombers as the Boeing B-17 Flying Fortress and the B-24 Liberator, both four engine aircraft. However, at least 300 bombers were needed to make this possible⁴⁵. From June 1943 they started their 300+ bomber raids. The main targets were German submarine yards and bases, the German aircraft industry, the ball bearings industry and oil. Second on the list of priorities came the synthetic rubber and tires industry and military motor transport vehicles, while the German fighters were intermediate targets⁴⁶.

The absence of long range escort fighters proved to be costly. From June till the end of December 1943 the US Eight Air Force lost 958 bombers. Per month they lost an average of more than 19% of its bomber fleet⁴⁷. Although the Luftwaffe suffered from heavy losses, the American losses were much higher, they were in fact "less supportable than the Luftwaffe's"⁴⁸. After the second defeat over Schweinfurt, a city containing major ball bearing industry, the US changed their doctrine. From February 1944 long range fighters escorted to bombers over whole Germany. Till then, the Luftwaffe could wait until the escort fighter had to return to base. Then the Luftwaffe would attack and cause havoc amongst the US bombers. But then the Americans had sufficient drop tanks available to extend the range of the P-38 Lightning to escort the bombers over whole Germany. From March 1944 the bombers were escorted by the North American P-51D Mustang all the way to Prague. With 1944 came also a new aim in the air war against Germany. The US eighth Air Force had to destroy the Luftwaffe; "in the air, on the ground and in the factories"⁴⁹. In February 1944 the US Air Force attacked the German aircraft industry. German fighter losses increased sharply to an average of 50% per month. The air war was a war of attrition at a rate Germany could not withstand much longer.

In the build up to the invasion in Normandy, the targets to be attacked were some what changed. In stead of the German industry, the transport system in France had to be attacked. To be able to keep on fighting the Luftwaffe, the Americans attacked the oil industry in Germany as well. Destroying this industry meant a decrease of German transportation capabilities. Furthermore, it meant the Germans had no fuel to fly aircraft and to train new pilots. The railroad system was attacked by Bomber Command at night and during the day by the US Air Force four-engine strategic bombers and 'tactical' bombers, mainly two-engine aircraft. American and British fighters attacked locomotives. Although it was a motorized army, the bulk of its infantry was 'horse powered' and had to be moved over long distances by train. Destroying the rail system meant that the Germans could not move large troop formations to Normandy when the Allies invaded.

The attrition air war over Germany had worn out the Luftwaffe. It was no longer capable of fighting the invading armies and air forces once the invasion had begun. The Allies had gained air superiority and the battle in Western Europe had been

⁴⁵ Murray, p170.

⁴⁶ Murray, p170.

⁴⁷ Murray, p175.

⁴⁸ Watts, Barry D.; *The Foundations of US Air Doctrine, Friction in War*, p63; Air University Press; Maxwell Air Force Base, Alabama; 1984.

⁴⁹ Murray, p236

decided once the Allies had gained a solid bridgehead on the Normandy beaches. The rest was, more or less, a matter of time.



Figure 3:Wearing out the Luftwaffe, B-17s and P-47s on their way to Germany

2.2.4 Epilogue

World War II had taught the military strategists that the first task of Air Power was to gain air superiority by destroying the enemy's aircraft and to sustain this by destroying its aircraft factories and oil industries, so the enemy could not rebuild its air power. Next the interdiction of its armaments industry (strategic) and its armed forces and supply lines (tactical) could be started. Or, as Gen. Momyer⁵⁰ states:

- (a) Strike the source of the war material;
- (b) Concentrate the attacks against the weak elements of the logistical system;
- (c) Continuously attack, night and day, the major lines of communication supporting the army in the field;
- (d) Inflict heavy losses on enemy logistics and forces before they approach the battlefield where the difficulty of successful interdiction is greatest;
- (e) Keep continuous ground pressure on the enemy to force him to consume large quantities of logistics.

WWII proved that 'strategic bombing' alone could not win wars, as predicted during the Interbellum. In fact, Bomber Command was almost defeated by the German night fighter force. Nor could large formations of heavily armed bombers enforce air superiority. They needed escort fighters for protection. Together they defeated the Luftwaffe by shooting them out of the sky and bombing the aircraft factories and oil industry. But this could not end the war either. Ground forces were still needed for the final blow. And these needed the air force for (close) air support to destroy (large) enemy forces and to destroy their logistic lines.

⁵⁰ General Momyer, William W.; *Air Power in Three Wars*, p187; Air University Press; Maxwell Air Force Base, Alabama; April 2003

2.3 The Cold War

2.3.1 The Nuclear Era...

The dropping of the atomic bombs on Hiroshima and Nagasaki ended the war against Japan, or it at least contributed to the ending. It did, however, restart the discussion about strategic bombing and ending (winning or preventing) wars. The Russians dropped an atomic bomb in 1949, the British theirs in 1952. One atomic bomb was capable of inflicting the same damage on a city as a raid of hundreds of heavy bombers. The death toll on Hiroshima and Nagasaki was nothing new during WWII; it was the fact that only one single bomb could cause so many casualties. In the 1950s the hydrogen bomb was developed which had a power equalling thousand similar seize 'conventional' atomic bombs. With this damaging capacity, the theory of Douhet made its appearance again. But instead of the inevitability of war as Douhet had predicted, nuclear weapons should generate so much deterrence that wars never would occur. The destruction caused by dropping nuclear bombs was such that no country could afford risking a nuclear war. When a nation could assure devastation to any enemy, it would be very unlikely this nation would be attacked. When both parties could assure these destruction capabilities, Mutual Assured Destruction (MAD) was accomplished. Both parties would not attack each other, because an attack would have no other result than both being almost completely destroyed. In the mid 1950's the United States had developed an assured destruction capability against the Soviet Union, while the latter had this capability a decade later⁵¹.

During the 1950's the bombs were delivered by large, high altitude, four, six and finally eight engine bombers (the Boeing B-52 Stratofortress). But with the ever improving (Russian) Surface to Air Missiles (SAM's), in the 1960's the accent came to supersonic aircraft like the Convair B-58 Hustler (during the 1960s) and fast and at low altitude flying aircraft like the Rockwell B-1 Lancer (from the 1970s). Parallel with the development of these new bombers, missiles were developed capable of increasing distances and higher payloads. When the Russians launched Sputnik 1, they showed the world, and especially the United States, that it was capable of launching missiles that could reach the US. Missiles carrying nuclear loads with a range from continent to continent were called Inter Continental Ballistic Missiles (ICBMs). They could not be intercepted and were more economical than manned bombers. Smaller missiles, which had a shorter range, were developed for the use on submarines; the SLBMs, Sea Launched Ballistic Missiles. They had one big advantage; they were launched from platforms (submarines) that were difficult or impossible to detect. This meant they could not be attacked before the launched their missiles. This is very important in case of an enemy's first strike. This enemy could try to knock out the nuclear arsenal by a surprise attack. But when the SLBMs could not be destroyed, they would surely be destroyed by these missiles. In the late 1980s the Cruise Missiles were deployed. They could be launched from land vehicles, submarines, ships and from aircraft like the B-52. It had a low altitude terrain following capacity what made it possible to hit targets very accurately and made them almost invulnerable for interception.

⁵¹ Dr. Mueller, Karl P.; "Strategic Airpower and Nuclear Strategy: New Theory for a Not-Quite-So-New Apocalypse", p295 in Meilinger's *The Paths of Heaven, The Evolution of Airpower Theory*.

2.3.2 ... with Conventional Wars

Apparently the deterrence did work, for neither nuclear wars nor conventional wars on a large scale were fought after WWII. This does not mean no wars were fought at all. Many countries were involved in small conventional wars.

The first major war was the Korean War. As in WWII gaining air superiority was essential, especially because the Chinese armed forces on the ground outnumbered the UN forces. To keep the North Korean air force neutralized so they could not attack Allied ground forces, the airfields in North Korea were suppressed by the combined efforts of the Allied air forces. North Korean fighters diverted into Chinese territory and could not be attacked, as a full out war with China had to be avoided. To prevent enemy fighters to appear again, the Allies held fighter sweeps and screens close to the Chinese border. Thanks to this tactic enemy fighters could not attack allied fighters or ground forces and the allies had gained and sustained air superiority over the main part of Korea⁵².

Initially, when North Korean forces crossed the 38th parallel on 25 June 1950, South Korean and US armed forces had to retreat all the way to the Pusan perimeter. By that time the allies had built up sufficient air power and had gained air superiority. The North Koreans suffered from long supply lines and were vulnerable for air attacks. The allied air forces imposed a heavy toll on the North Koreans. The advance stopped and this gave the Allies time to build up sufficient ground forces to repel the North Koreans. Only with the help of Chinese forces invading North Korea, the advance of the UN forces could be halted and be forced to retreat. Close air support was used once again to help the UN forces and interdiction of the enemy logistics lines to slow down enemy advance. On 22 December 1950 the Chinese forces were stopped. The damaging of the enemy supply system contributed most to stopping the Chinese advance⁵³. Although not as successful as hoped to be (like during WWII in Northern France), the interdiction of supply lines disrupted the operations of the Chinese and North Koreans⁵⁴. UN airpower withheld the Chinese from deploying 1,000,000 men they had in reserve⁵⁵. Although the Chinese ground forces had significantly more ground forces than the UN, the UN air power convinced the Chinese the best they could do was to agree with the settlement as proposed by the United Nations negotiators⁵⁶. Finally the war was ended by negotiations on 27 July 1953

The next 'interesting' war was the war in Vietnam. This was a complete different war than the Korean War. At least on the ground; while during the Korean War the battle was fought along one, clear front, during the Vietnam War there were much more areas of battle and several, not that clear, fronts. The US soldiers did not fight against a regular enemy army (at least not in the beginning of the Vietnam War), they fought against Vietnamese guerrillas, better known as the Vietcong. Airpower was used the same way as it was during WWII and the Korean War. While the fighting on the ground took place in South Vietnam, vital centres in North Vietnam were attacked. Unlike WWII or the Korean War no full-scale attacks would be made on North Vietnam targets. US political leader decided for a "slow squeeze", as they feared for an intervention by the Chinese or a nuclear war with the Soviet Union⁵⁷. The air

⁵² Momyer; p129.

⁵³ Momyer; p191.

⁵⁴ Dr. Chun, Clayton K. S.; *Aerospace Power in the Twenty-First Century, A Basic Primer*, p138.

⁵⁵ Momyer, p197.

⁵⁶ Ibid

⁵⁷ Prof. Drew, Dennis M.; "Air Theory, Air Force, and Low Intensity Conflict: A Short Journey to Confusion"; p295 in Meillinger's *The Paths of Heaven, The Evolution of Airpower Theory*.

campaign against North Vietnam was called "Rolling Thunder" and lasted from 1965 till 1968.

The objectives of the bombing campaign were:

- (1) To reduce the flow and/or increase the cost of infiltration of men and supplies from North Vietnam to South Vietnam;
- (2) To make it clear to the North Vietnamese leadership that as long as they continued their aggression against the South, they would have to pay a price in the North;
- (3) To raise the morale of the South Vietnamese people.

Of these three, only the first is a military objective. The other two are psychological; they result from gaining or failing to gain the military objective⁵⁸. Rolling Thunder could be divided into four segments; the North Vietnam bombing campaign, destroying the Ho Chi Minh trail, attacking the supply lines in South Vietnam and attacking the lines of communication⁵⁹. This task (or tasks) was not as easy as it seemed. North Vietnam was not a very sophisticated country in a technological sense, so it was not that vulnerable to bombing. The logistic supply lines ran through thick jungles and could not be seen from the air. Furthermore, the targets in North Vietnam were limited by the US government. The US government feared a confrontation with China and that they would risk a major (world) war⁶⁰. The strategy was incorporated in name of the campaign; Rolling Thunder, a continuing bombing campaign, gradually destroying vital targets in North Vietnam. It was not a one all out bombing attack destroying all vital targets in North Vietnam at once. The war continued and in 1968 Rolling Thunder was succeeded by Commando Hunt (as was Lyndon B. Johnson by Nixon as president), with more or less the same strategy. To cope with the increasing threat of surface to air missiles (SAMs) and MiG fighters, the USAF used electronic counter measures, or ECM. Aircraft with ECM equipment would jam the radars of the North Vietnamese, so the US aircraft would not be detected. Later on the strike aircraft were equipped with ECM pods, because the aircraft initially used for ECM tasks only, proved to be vulnerable for MiG and SAM attacks.

Another novelty was the laser guided bomb. Till 1972 it was only used over South Vietnam. A combat aircraft would drop the bomb, while another aircraft would direct the bomb to its target by a laser beam. The chance of damage with a single bomb was 80-90%, if the target was visible and could be destroyed by bombs⁶¹. P266

Air power was not only used for bombing campaigns. Close air support was another prime task of air power. There was no clear frontline in South Vietnam; the enemy was present in the bushes as in the villages. Pilots were unable to distinguish between normal civilians and enemy forces. For this reason Forward Air Controllers were established. Aircraft that would strike an area were under control of the FAC, he could tell the pilot if he could strike and where. But before the FAC allowed the fighters to attack, he had to verify the exact position of friendly forces. The ground forces ground had to indicate their forward line with smoke markers. Then the FAC would mark the target with a smoke rocket and allowed the fighters to attack.

⁵⁸ Momyer, p194

⁵⁹ Momyer, p195.

⁶⁰ Momyer, p23.

⁶¹ Momyer, p266.



Figure 4: Close Air Support in the Vietnam War

Together with ground forces, air power attacked the Vietcong and North Vietnamese forces. The Americans had a superiority in (air)firepower, which gave the USA a great potential to withstand heavy combat. The combined arms of infantry, artillery, and airpower had weakened the North Vietnamese forces seriously all over South Vietnam. In 1968 the North Vietnamese, however, launched their 'Tet offensive'. They lost this campaign against the US forces from a military point of view. About 45,000 out of 85,000 men were killed⁶². The North Vietnamese may not be able to win the war on the field; they had won an important psychological victory. The US public opinion was against this war and the anti Vietnam demonstrations intensified. President Johnson announced he would not stand for the re-election campaign. He also postponed the bombing campaign. The succeeding president, Nixon, planned a withdrawal of the US forces from South Vietnam.

By 1972 most of the US ground forces were withdrawn from South Vietnam. Hoping to benefit from the absence of these forces, the North Vietnamese launched their Spring Offensive March 1972. The USA reacted by helping the South Vietnamese ground forces with close air support and a new bombing campaign called Linebacker. The close air support helped the South Vietnamese to withstand the Northern attacks. Instead of during the years before, when North Vietnamese Army and the Vietcong fought a guerrilla war, the NVA invaded with tanks and were fighting a conventional war. By doing this, they exposed their forces to the US airpower. The losses on the attackers' side were that high, that in fact they were defeated⁶³. With the Linebacker bombing campaign, this time there were fewer restrictions to which targets to attack in North Vietnam than during the Rolling Thunder campaign. Furthermore, laser guided bombs were used which meant that fewer aircraft could cause more direct damage. Another novelty was the appearance of the General Dynamics F-111 which had terrain following radar. This meant these aircraft could fly below the effective range of the SAMs at high speed. When the negotiations dragged on and were stalled by the North Vietnamese, the US increased the bombing intensity, naming it the Linebacker II campaign. Finally, the continuing air attacks to

⁶² Momyer, p355.

⁶³ Momyer, p372.

Dodging UCAVs censured

their economic, political, social, and military life decided the North Vietnamese to accept the peace agreement on 15 January 1973⁶⁴.

The wars in Korea and Vietnam were fought under restrictions, because an escalation with the Soviet Union and/or China was feared. Without these restrictions these wars might not have taken this long to fight. But than again, interference by the Soviet Union or China might have created a completely different war⁶⁵. During the Gulf War no such restrictions existed. August 2nd, 1990 Iraq invaded Kuwait. The UN demanded an immediate withdrawal of the Iraqi forces. The UN later authorized the use of force to drive out the Iraqis from Kuwait. Saudi Arabia called on the United States for aid because of a potential invasion of this country. The US responded quickly. The loss of the oil fields of Kuwait was important, but additional loss of Saudi Arabian oil would be a catastrophe for the whole world (economies). To eject the Iraqis out of Kuwait, the US forces developed a four-phased offensive campaign⁶⁶:

- Phase 1: Strategic air campaign against Iraq.
- Phase 2: Air campaign against Iraqi air defences in Kuwait.
- Phase 3: Attrition of Iraqi ground-combat power to neutralize Iraq's deployed ground forces and isolate the Kuwait battlefield.
- Phase 4: Ground attack to eject Iraqi forces from Kuwait.

The day before phase 1 began, cruise missiles with conventional loads were launched from B-52's and battleships. These had to destroy or disable well defended targets, like radar control centres and electricity power stations. Furthermore, helicopters executed low altitude attacks on Iraqi radars, so coalition aircraft could enter Iraq without being detected. These aircraft attacked the Iraqis' air defence C² network, military airfields, Scud missile sites, communications lines, electricity, presidential office complex, the Ba'ath Party headquarters and other targets. The goal was to isolate Saddam Hussein from his military forces and paralysing the air defence. The Iraqi population had to be so impressed by the force of the coalition attack, that they would have no faith in the Iraqi leader any longer. The strategic air campaign started on 17 January and ended on 25 January. This campaign immobilized the Iraqi air force, disrupted Iraqi air defences and made communication between the Iraqi military and their forces in Kuwait almost impossible. New technologies, like cruise missiles and precision guided weapons, helped to get good results, but the majority of the weaponry was of conventional nature. The strategic air attack did not end the war, but was crucial for the preparation to liberate Kuwait.

The next phase was to eliminate the Iraqi air defence in Kuwait. This was done by attack aircraft like the F-16, the A-10 and attack helicopters like the Apache. Once this was disabled, phase three could be executed; the attrition of Iraqi ground forces without having to fear from ground-to-air attacks. A-10 ground attack aircraft and attack helicopters had a free hand of eliminating Iraqi tanks, armour and trucks. Once phase four started the Iraqi forces were no match for the coalition forces. Many fled before these force could reach them, but they were caught on the highway from Kuwait to Baghdad by coalition air forces.

The mandate of the coalition forces was to eject the Iraqi forces out of Kuwait. Once this was accomplished, they did not advance towards Baghdad to eliminate Saddam Hussein's authority. In 2003, more than 10 years later, the next generation Bush administration did just that. Initially the US tried to bring down Saddam Hussein's

⁶⁴ Momyer, p274.

⁶⁵ China and Vietnam had been enemies since centuries. China would not have helped Vietnam as they did with the Koreans; former Secretary of Defense Robert McNamara in the movie "Fog of War".

⁶⁶ Dr. Chun, Clayton K. S.; *Aerospace Power in the Twenty-First Century, A Basic Primer*, p110.

administration by strategic bombing. The theory of Colonel John Warden was the philosophy of this campaign. John Warden created his 'five strategic rings' model, see figure below.

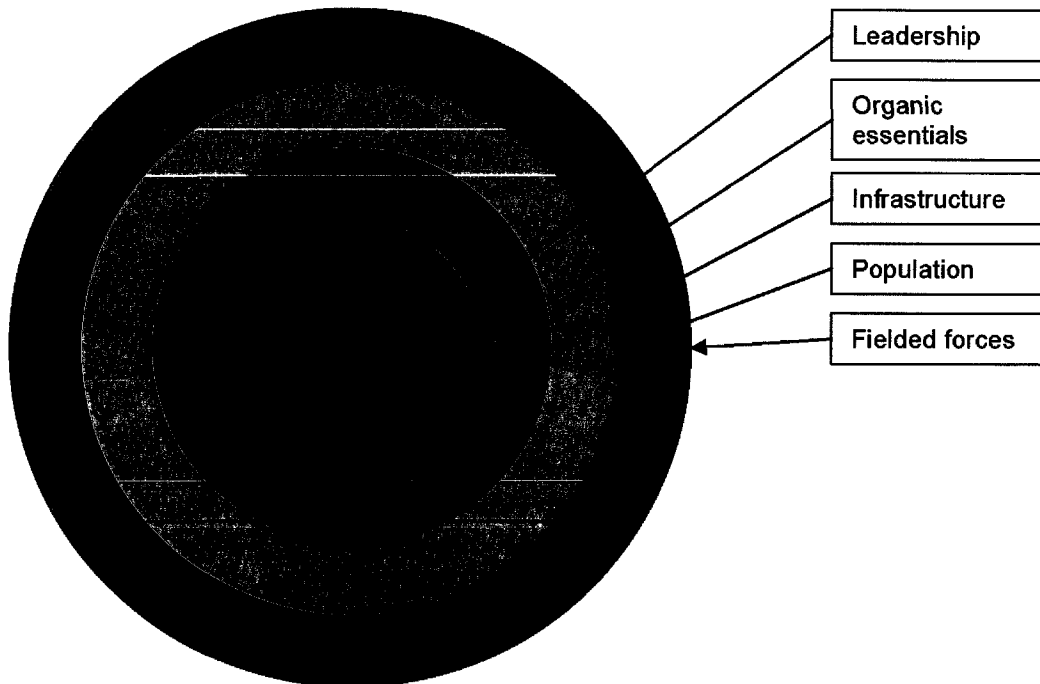


Figure 5: John Warden's five strategic rings

According to Warden each enemy organisation could be divided into five rings. Each ring consists of one or more Centres of Gravity (COG), which represents "the hub of all power and movement" for that ring⁶⁷. If a COG is destroyed or neutralized in one of the rings, this ring will stop to function. This will have its effect on the rest of the ring. The more the ring is situated to the middle, the more effect this will have on the whole system. During the second Gulf war, the coalition forces (in fact only the USA and Great Britain) were aiming at the middle two rings. They hoped that when the Iraqi population would see the Saddam Hussein government would be powerless, they would revolt against the dictator. The coalition forces tried to spare the infrastructure, as Iraq as a country should be rebuilt swiftly. Unfortunately, after weeks of bombardment, destroying government buildings and Ba'ath party headquarters and communication lines, Saddam Hussein did not surrender, nor did the Iraqi population revolt against him. Saddam may not have been able to reach his military power, his power over the population and their fear for his tyranny was strong enough to keep him in charge. As a result the coalition forces had to invade Iraq by ground forces. Close air support played a major role once more. Air superiority was achieved during the first Gulf war in 1991. The Iraqi air force never recovered from this. As soon as Iraqi divisions showed themselves to the open, they were attacked by B-52 bombers. Next F-16, F-15E and Tornado strike aircraft would take over. A-10 attack aircraft and Apache attack aircraft would finish the close air support. The leftovers were for the ground forces main battle tanks. The Iraqis stood no chance.

In the years between the both Gulf wars, civil wars were fought in Yugoslavia. Yugoslavia was formed by Marshal Tito after WWII. His dictatorial regime and, after his death, the fear for a Soviet invasion kept the different Slavonic states, with their

⁶⁷ Lt Col. Fadok, David S; "John Boyd and John Warden: Airpower's Quest for Strategic Paralysis", p372; in Meilinger's *The Paths of Heaven, The Evolution of Airpower Theory*

memories of mutual crimes in the past, together. Almost as soon as the Soviet Union collapsed, the Western powers lost their interest in Yugoslavia and their investments stopped. The Yugoslavian standard of living dropped 40% in six years⁶⁸. As a result the most prosperous republics tried to separate from Yugoslavia. While Slovenia managed to separate without much bloodshed, the civil war in Croatia was more severe. This war was finally settled January 1992 and the United Nations Protection Force (UNPROFOR) was sent over to protect the peace. The war between Bosnians, Muslims and Serbs was seen by the international society as a threat to fragile peace on the Balkans and therefore international order. In October 1992 NATO interfered as international negotiations failed to reach peace. The United States, United Kingdom, France, Italy, the Netherlands, Spain, Turkey, and the multinational NATO airborne early warning force provided aircraft for Deny Flight, as this air campaign denying combat aircraft, other than NATO flying over Bosnia-Herzegovina, was called in April 1993. Later that year, in August, also Close Air Support missions were added to protect NATO ground forces. The Yugoslavian air force was no match for NATO, so right from the beginning the NATO forces had air superiority. From July 1995 the attacks got more and more extensive, trying to force the (Serb) forces ending the hostilities and forcing the Bosnian Serbs to accept NATO's peace plan. The shelling of a marketplace in Sarajevo, presumably by the Bosnian Serbs started the campaign Deliberate Force. With this campaign NATO aircraft attacked Bosnian Serb targets. Deliberate force started on 30 August and ended on 14 September 1995. During these two weeks, NATO aircraft flew 3535 sorties and dropped over eleven hundred bombs, three-quarters being precision munitions. Many targets were destroyed, but only slightly more than two dozen Serbs died by these attacks⁶⁹. This show of force succeeded in convincing the Bosnian Serbs to comply with NATO's demands. This campaign does show also that the war in Bosnia-Herzegovina could not be ended by air power only. It took diplomacy to end the hostilities⁷⁰.

The ethnic clean-up in Kosovo, in which people of Albanian origin were forced to leave by Yugoslavia in 1999, forced NATO to interfere once again. The Western powers did not want to send ground forces to Kosovo, as they remembered the troubles Nazi Germany had in this area during WWII. So, they decided to apply air power to end this ethnic conflict. It took 78 days before President Milosevic of Yugoslavia finally surrendered to NATO demands on 3 June 1999.

Today, air power is used in the war against terrorism in Afghanistan. While ground forces are looking for Taliban or Al Qaida forces, they sometimes are attacked by these forces. Close air support is called in to support the friendly troops and eliminate or chase away the enemy troops. Taliban and Al Qaida forces practise classic guerrilla tactics; they hardly show themselves in the open in large numbers. Furthermore, the desolate mountainous territory of middle Afghanistan is ideal for these guerrilla tactics. In the 1980's the Soviet army never succeeded to defeat the Mujahideen in this same area. This war is going on since 2002 and although the Taliban is repelled into a small area in Afghanistan, they are not defeated by far. Air power can only support the ground forces in this war by close air support. Strategic

⁶⁸ Dr. Mueller, Karl; "The Demise of Yugoslavia and the Destruction of Bosnia: Strategic Causes, Effects, and Responses", p6; in *Deliberate Force, A Case Study in Effective Air Campaigning. Final Report of the Air University Balkans Air Campaign Study*, Edited by Col Robert C. Owen, USAF Air University Press Maxwell Air Force Base, Alabama; January 2000

⁶⁹ Lt Col Conversino, Mark J.; "Executing Deliberate Force, 30 August-14 September 1995", p168; in *Deliberate Force, A Case Study in Effective Air Campaigning*.

⁷⁰ Maj McLaughlin, Mark C.; "Assessing the Effectiveness of Deliberate Force: Harnessing the Political-Military Connection", p196; in *Deliberate Force, A Case Study in Effective Air Campaigning*.

bombing, air superiority, the classic issues during the previous wars are no issues here.

2.4 Sub Conclusion

Evolving from flying crates dropping rather ineffective bombs to supersonic high tech machines, capable of destroying every possible target, air power has proven to be a decisive element during conventional wars. The early theorists saw the potential of the flying machines at their time, but they were somewhat optimistic about their capability of winning wars on its own. In all wars ground forces were needed to finish the job. Although the air campaign in Kosovo seemed to prove that air power alone could end conflicts, reality proved somewhat different. Diplomatic negotiations isolated president Milosevic, which made him to withdraw Yugoslavian forces out of Kosovo⁷¹.

Air power came of age during the Second World War. By wearing out the Luftwaffe during the daylight bombing campaigns, they could destroy logistic lines and lines of communication, isolating the enemy troops from supplies. Bombing these enemy ground forces would be the next step, before friendly troops would engage. Finally, close air support would be given when these troops would run into trouble.

During the last few decades warfare seems to have changed very rapidly, some speak even about a revolution. The next chapter will illustrate the changes in warfare and some future scenarios armed forces may be faced up to.

⁷¹ Hinen, Anthony L., Col USAF; Kosovo: "The Limits of Air Power II"; *Air & Space Power Chronicles*; May 2002; <http://www.airpower.maxwell.af.mil/airchronicles/cc/hinen.html>; (accessed 06may2006)

3 New Wars?

"War is merely a continuation of politics by other means" (Carl von Clausewitz⁷²), while "Politics is the art of feasibility" (Otto von Bismarck⁷³) to agree on "who gets what, when, where, and how" (Harold Lasswell⁷⁴). These quotations can be put in a reverse order; when no agreement can't be made, politics have to be made feasible by other means; war.

According to Von Clausewitz a battle could be regarded a duel. From the end of the WWII, in Europe this duel would be between the democratic states of Western Europe and North America (NATO) against the East European states and the Soviet Union (the Warsaw Pact. Or the Western capitalist ideology against the communist ideology. This battle was not fought by bloodshed, at least not in Europe⁷⁵, but it was fought on the field of technology development. Many historians think one of the major causes of the fall of the Soviet Union was the massive spending on military technology, in response to NATO's increased armament in the 1980s⁷⁶.



Figure 6: Warsaw Pact's plan of attacking northern Germany and the Netherlands
(www.nrc.nl/buitenland/article417436.ece)

With decline of the Soviet imperium the fear of Soviet conquest and hegemony that dominated world politics for more than a generation had dissipated⁷⁷. The Cold War, which almost seamless followed the WWII, had come to an end. With the fear for a third World War vanished, "there is the very real prospect of a new world order"⁷⁸.

⁷² Carl Philipp Gottfried von Clausewitz (1 June 1780 – 16 November 1831) was a Prussian general and influential military theorist.

⁷³ Otto Eduard Leopold von Bismarck (1 April 1815 - 30 July 1898) was one of the most prominent European aristocrats and statesmen of the nineteenth century. Minister-President of Prussia from 1862 to 1890. From 1867 on Chancellor of the North German Confederation.

⁷⁴ Harold Dwight Lasswell (13 February 1902 - 18 December 1978) was a leading American political scientist and communications theorist.

⁷⁵ The Korean War, Vietnam War and the Russian-Afghan War can be seen as spin-offs of the Cold War.

⁷⁶ http://en.wikipedia.org/wiki/Cold_war#_note-0

⁷⁷ Kaiser, Robert G.; "The U.S.S.R. in Decline"; from *Foreign Affairs*, Winter 1988/89

⁷⁸ USA President Bush's speech to Congress, March 6, 1991

As a result, according to many people regular wars in Western Europe between states were considered as very unlikely. Many Dutch politicians do not fear a hostile attack by any neighbouring countries. The Netherlands are surrounded by Germany, Belgium and the North Sea. Since WWII these countries do not pose any threat. Although the English intended to invade the Netherlands during the Third English-Dutch War (1762) they did not succeed and so, since the Vikings no one has invaded from the North Sea.

Nevertheless, is this prospect of ever lasting peace correct? What about events far beyond the Dutch borders? What about any threats beyond Europe? Or elsewhere in the world? In fact the situation in the world has become more unstable since 1989. Before its decline, the USSR controlled and supported many countries all over the world. But the USSR, and with it its control over these countries, no longer exists. So, these countries went there own way with an instable world as a result. Gray states that today we may see the United States of America as a sheriff, with Great Britain as its deputy⁷⁹, taking care of our well-being. However, European countries like France and Germany don't put up with the US absolute powers. For one, they criticized the US invasion of Iraq. Also Russia and China, although not by a long chalk as powerful as the USA, do criticize the USA. America's status of superpower may not last forever. Other superpowers may arise, for example China, India and/or Russia. They may want to challenge USA's leadership.

Other events might also endanger peace in Europe;

- North-Korea & Iran. North-Korea is one of the last communist states and claims possessing nuclear weapons. Iran is said to have intentions of acquiring nuclear weapons.
- The situation with Israel and the Palestinians in the Middle East. In fact, it is not only the Palestinians wanting to destroy the Sate of Israel; almost every Muslim state hopes to see Israel vanish.
- Global warming is regarded as a fact and this will have effect on the sea level and the vegetation. This might result in mass migration of people. It's uncertain whether these people will be welcomed by other nations.
- With the rise of China and India, not only as military superpowers, but also as economic superpowers, the demand for oil and other raw materials is rising. This while these materials are getting scarce. As a result the prices of raw materials will rise, which will hamper economic growth or even cause an economic recession world-wide. Countries that lack the financial means to provide themselves with raw materials may use military ways to enforce delivery of these materials.
- Muslim terrorists blame the western world of their poverty and undermining the Muslim values and way of life. The natural resources are said to be bled out by America and its heathen allies, while the Moslem population is left poor. Whether or not America and its allies are to blame, is not relevant. Fact is that only a small group of people profits from the oil income. Once the oil resources have been dried out, the prospects of any income have completely gone. This might lead to an increase of anti-western feelings and therefore terrorist activities.

⁷⁹ Gray, Collin S.; *Another Bloody Century*, p175; London; 2005.

Above scenarios are highly speculative and many more can be imagined as Gray describes⁸⁰. A similar warning about the India and China's rise to superpower status and a possible economic-political war comes from Professor Renfrew Christie⁸¹. It is, however, not the objective of this study to predict the next war. The scenarios above only show that wars will likely happen in the future.

3.1 Revolution in Military Affairs

So, we may consider ourselves 'lucky' that wars are no things of the past; the Dutch armed forces are not superfluous. But it is hard to predict in what kind of war Dutch armed forces will get involved. Ideologies like Communism or Nazism are no factor of interstate wars anymore⁸². Today, the war against terrorism, asymmetric warfare and Net Centric Warfare is on every one's lips. Both Gulf Wars are said to have revolutionised warfare (also known as RMA; Revolution of Military Affairs). According to the RMA theorists, the evolution of weapons technology, information technology, military organisation and military doctrine did revolutionise warfare. Army, Air Force and Navy are not operating independently anymore, but are cooperating very closely, connected by a communication network with a central command; Network Centric Warfare or NCW. NCW includes Command, Control, Communications, Computers, Intelligence, Surveillance & Reconnaissance, or better; C⁴ISR. It's total situational awareness on the battlefield, enabling Army, Air Force and Navy operating in close harmony (Joint ops). This C⁴ISR would have revolutionised warfare.

Revolution implies an interruption in developments; a change in direction. But even in the times of Napoleon warfare was difficult without a having a network of communications; "*The important secret of warfare is to make oneself master of communications,*"- Napoleon. During World War I a breakthrough through enemy lines was brought to a halt, because the ground forces had no orders what to do next and had to wait. Communications with headquarters, several miles behind the front, was slow and time consuming. This gave the enemy time to regroup and counter-attack, re-conquering lost territory, thus creating a status quo⁸³. During the American Civil War balloons were used for spotting enemy moves. During WWI this was the initial task of the aeroplane. The success of the Blitzkrieg did not come only from the Luftwaffe's close air support; a well managed communication network might have contributed even more to this success. Just before the WWII, Great-Britain set up a network of radar antennas and a matching organisation that directed the Spitfires and Hurricanes to the approaching German fighters and bombers. With this system the British command gained situational awareness and British fighters did not need to patrol the sky, saving much operational time and thus increasing the time they could engage the Germans. Later during the war, the British and Germans set up a network between a radar operator on the ground and night fighters in the air. The operator would direct the night fighter to the proximity of an enemy bomber. The (small range) radar in the fighter enabled the pilot to locate the bomber and shoot it down. This system proved to be very successful; Bomber Command suffered great losses by the German night fighters.

⁸⁰ Gray, p179

⁸¹ Christie, R.; "A weak Europe is not good for the World"; *Jane's Defense Weekly*; 5 July 2006. Professor Christie is General Secretary of the Royal Society of South Africa and Dean of Research in the University of the Western Cape.

⁸² Gray; p70.

⁸³ House, Jonathan M., *Combined Arms Warfare in the Twentieth Century*, p36; Kansas; 2001.



Figure 7: A captured Messerschmidt Me Bf 110 Night fighter

So, networks, reconnaissance and situational awareness are nothing new. The developments in Information and Communication Technology (ICT) sped up the developments in military affairs, but it can hardly be seen as a revolution.

Network Centric Warfare may not be as new as sometimes preached, it is very important nevertheless. It's what every commander in history had ever wanted; a total situational awareness so its forces could co-operate as closely as possible. Air Power plays an important role in this kind of warfare; it is able to deliver massive firepower over a long distance in a short notice of time; at the right place at the right time. This firepower may consist of bombs, rockets or grenades, but it can also be delivered by ground forces that are transported by air. NCW is today's US military doctrine. Actually NCW meets the network theory of Thomas P. Hughes; "a system is constituted of related parts or components. These components are connected by a network or structure"⁸⁴. As already described, networks within the military are not new, but today these networks have become much larger. Air force, army and navy are connected, so they can share their data, creating a total situational awareness of the environment. The US DoD wanted to have a "Global Information Grid" to be the technical framework supporting NCW. The Global Information Grid (GIG) is defined as "the globally interconnected, end-to-end set of information capabilities, associated processes, and personnel for collecting, processing, storing, disseminating, and managing information on demand to warfighters, policymakers, and support personnel. The GIG includes all owned and leased communications and computing systems and services, software (including applications), system data, security services, and other associated services necessary to achieve information superiority for the United States military"⁸⁵. Communication is provided by computer networks like the SIPRNET (Secret Internet Protocol Router Network)⁸⁶, line of sight networks like Tactical Common Data Link (TCDL)⁸⁷ and satellite networks like MILSTAR⁸⁸. Although the GIG is not completely finished, during the second Gulf War the American forces benefited from the first GIG achievements. In this environment present and future combat aircraft, manned or unmanned have to be able to operate.

Above examples are all American as their doctrine and technology are much more advanced than European or Russian. This is one of the reasons why the RNLA

⁸⁴ Hughes, Thomas P.; *Networks of Power; Electrification in Western Society, 1880 – 1930*; The John Hopkins University Press, Baltimore 1983.

⁸⁵ www.en.wikipedia.org/wiki/Global_Information_Grid

⁸⁶ www.fas.org/irp/program/disseminate/siprnet.htm

⁸⁷ www.fas.org/irp/program/disseminate/tcdl.htm

⁸⁸ www.af.mil/factsheets/factsheet.asp?id=118

Dodging UCAVs censured

prefers an American built combat aircraft⁸⁹. However, the USA is not the only country working on network warfare. The British forces use the term Network Enabled Capability (NEC), while the Dutch Army and Air Force did develop the TITAAN, Theatre Independent Army and Air force Network system⁹⁰. All these systems try to improve the military effect by a better use of communication systems and therefore better communication between the three military branches and units. The three military institutions, army, navy and air force, are force to cooperation. And maybe here lies the real revolution of military affairs, not a technical one or a strategic one, but a mental revolution....

Having the Army, Air Force and Navy cooperating very closely together in a network of communications, any country can create a formidable military force. There are however some disadvantages. Network Centric Warfare leans heavily on electromagnetic data transport. And here lies the Achilles heel of NCW. By using equipment that can jam the electromagnetic communications enemy forces can engage this sophisticated army. Communication will collapse and therefore NCW. To conquer this threat, the communication system can use frequency hopping, which makes jamming the communication very difficult. Jamming enemy systems has been common practises during warfare since WWII.

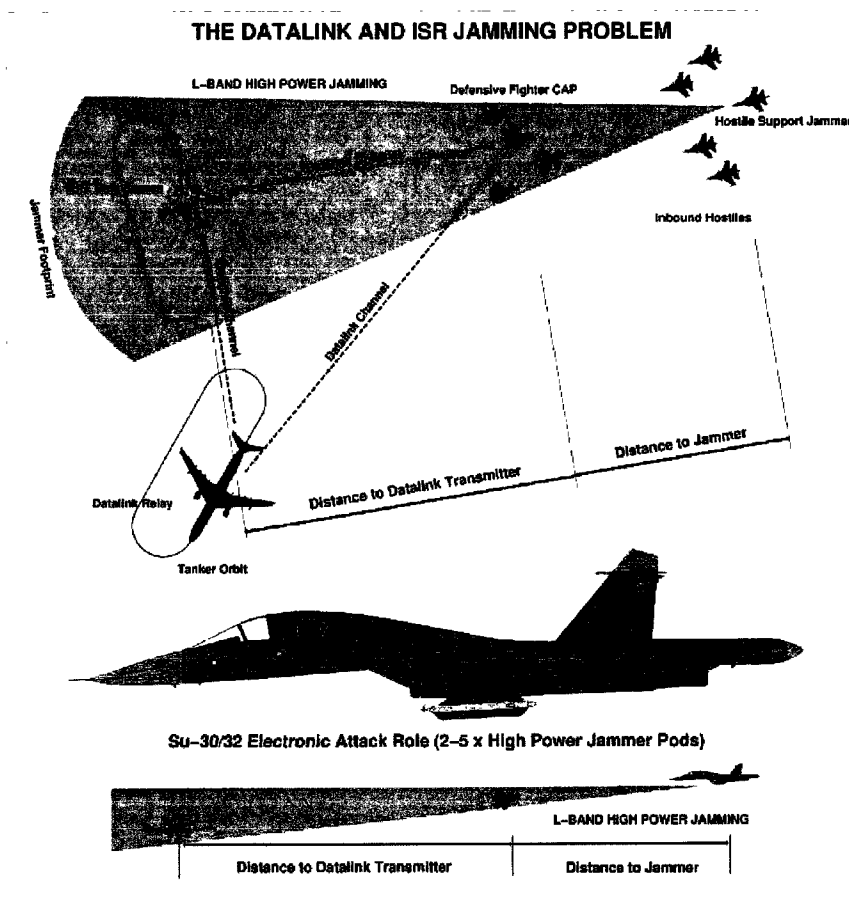


Figure 8: The datalink & ISR jamming problem
Source: www.ausairpower.net/TE-NCW-JanFeb-05.html

⁸⁹ During the Shepard Air Power Conference 2005 RNLAf Lt-Gen. Staring stated that European air forces should not buy European aircraft anymore, if they want to co-operate in the short and medium term. American aircraft like the F-35 Joint strike Fighter offers the best opportunities for operational integration, cost-cutting and inter-operability. Lok, J.J.; Onze Luchtmacht april/mei 2005

⁹⁰ See also "Netwerkend opreden, Defensie stapt in de toekomst met Network Enabled Capabilities"; Dutch Ministry of Defence, May 2006.

Another disadvantage of NCW is the limited bandwidth available for data transfer, while the bandwidth needed per person is growing rapidly⁹¹. According to Cogan and De Lucio the communication tools needed to wage NCW were yet to be invented.

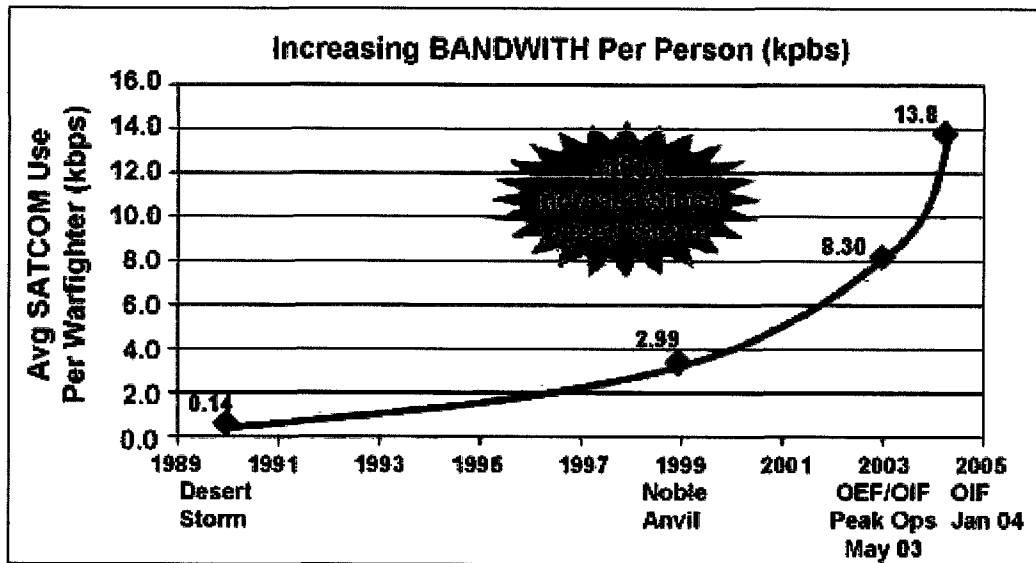


Figure 9: Bandwidth growth

Source: Kevin J. Cogan & Ray De Lucio; *Network Centric Warfare Case Study*, p37.

The Gulf Wars, Desert Storm and Operation Iraqi Freedom, can be regarded as regular wars between states, although a coalition of countries was fighting against one 'Iraq'. The USA and its allies were extremely successful, because of, amongst other things, a completely failing Iraqi leadership⁹². Although the concept of NCW did help, especially during the second Gulf War, the coalition would have won anyway. How the concept of NCW will hold against an enemy as strong as the US forces with comparable technologies, is still to be seen. Maybe it will be a big clash of armies and technologies. If these technologies are as good as they are said to be, very rapidly all equipment should be destroyed. Only the soldiers will be left with their (machine)guns in their trenches. So, in the end all technology might just result in another trench warfare, resulting in another status quo, for every main battle tank or armoured vehicle that will show up, will be destroyed immediately by hand-carried anti-armour weaponry. But instead of a great clash, both opponents may find their equipment too expensive to be risked for destruction, as was a fact during WWI with the dreadnoughts. Because of the fear of getting their precious battleships destroyed, the German Imperial Navy and the British Navy played only a marginal role during WWI⁹³.

As said earlier in this chapter scarce natural resources might be a reason for war. Some countries might decide to defend their economical interests in the regions the natural resources are extracted. This can be achieved by money (bribing) or, if this does not work anymore, by armed forces. Mostly these regions are situated in other parts of the World (Africa, Middle-East); in case of military intervention expeditionary forces are needed. Expeditionary wars were common practise during wars in the 20th Century. During almost all major conflicts the USA shipped its forces to Europe or the Orient. The last examples are the Gulf Wars and Afghanistan. During these conflicts

⁹¹ Kevin J. Cogan & Ray De Lucio; *Network Centric Warfare Case Study; Volume II: A View of Command, Control, Communications and Computer Architectures at the Dawn of Network Centric Warfare*; United States Army War College; August 2006.

⁹² Hirst, p85

⁹³ Kaldor, M. *The Baroque Arsenal*, p38.

other countries, like the Netherlands, shipped their armies and air forces as well. During these conflicts one side of the opposing forces was defending its territory. During economic-political conflicts expeditionary forces may face each other. Although not fought at each order borders, these conflicts can be regarded as conventional warfare.

3.2 Asymmetric warfare

With both Gulf Wars and the Balkan conflict, the West has shown to possess of superior materiel and, maybe, personnel. Any country that is invaded by these forces should not make the same mistakes as the Iraqi Ba'ath regime did. As soon as the Iraqi forces showed themselves in the open, they were destroyed. Instead, an invaded country should engage Western forces with asymmetric tactics; for example operating from populated areas. However successful, in Iraq and Afghanistan the US forces made one big mistake twice. They defeated the Taliban and the Iraqi military forces in direct battles. But winning battles is not the same as winning wars. War is about peace; an instrument of policy⁹⁴. During the Vietnam War the US forces won every battle against the Vietcong or North Vietnamese army, but they lost the war in the end. Winning all the battles was irrelevant⁹⁵. The USA brought down the Taliban regime in Afghanistan, but neglected to stabilise the Afghan society right from the decline of the Taliban. They did not take away the breeding ground for conflict. This gave the Taliban remnants the opportunity to recover, while in the meantime large Afghan regions were left in disorder. Although the Taliban could be seen as a kind of regular army in 2001, they are using guerrilla tactics now. In Iraq the US forces defeated the Iraqi army quite easily. But their number of soldiers was too little to get control over the Iraqi society. As a result the US and NATO forces are facing terrorists, operating in inhabitant areas. With this strategy these terrorist accept a high casualty rate under their own population, or at least, they accept the chance of a high casualty rate. Western societies will not accept a high casualty rate under civilians and might ask for a withdrawal of their armed forces.

Being faced with these dilemmas, (Western) regular armed forces have to change their tactics. Main Battle Tanks are rather useless in inhabited areas like cities, while infantry men are vulnerable for snipers. These circumstances call for pre-cautious acting, with a pinpoint bombing. Modern technology makes it possible to drop a bomb very accurate, but it also allows the warhead to be much smaller. In stead of a 500lb or 2000lb bomb, only as much as 50lb of explosives (small diameter bombs) can be sufficient to destroy the target or enemy. Even kinetic bombs, with out any explosives can be efficient when dropped at exactly the right place. Cold War era combat aircraft may not be the most suitable aircraft for counter-insurgency operations. In fact, they are over-qualified. As a result the US DoD is looking for alternative aircraft types that are more suitable or less expensive to fulfil these Counter Insurgency (COIN) tasks⁹⁶. The C-130 gunships are a well-known example. During the Vietnam War small aircraft like the Pilatus Porter or the CASA C-212 were used. In the future COIN aircraft may look like the Stavatti Machete.

⁹⁴ Gray, p189.

⁹⁵ A North Vietnamese colonel in an answer to a US Army colonel, who argued North Vietnam had never beaten the US Army on the battlefield. Summers Jr., H.G.; *On Strategy: A Critical Analysis of the Vietnam War*; Novato, CA: Presidio Press; 1982.

⁹⁶ Fabey, M; "Counter-Insurgency Urgency?"; *Aviation Week & Space Technology*; August 21/28, 2006.

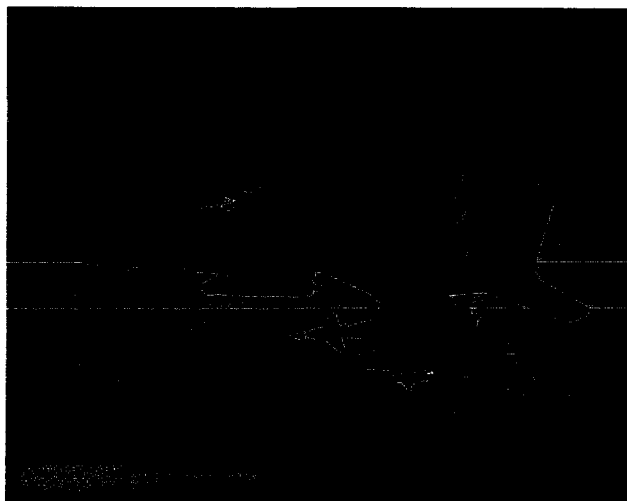


Figure 10: The propeller-driven Stavatti Machete

The technology that can be used for warfare is limited, however. According to Gray in warfare a 'dialogue' exists; what technology permits, what politicians require and what society allows⁹⁷. Israel attacked Hezbollah August 2006 using high-tech weaponry. They hoped to achieve a quick victory by precision bombing, like the Kosovo war in 1999. But they failed, although being better equipped, better trained and outnumbering Hezbollah. Had the Israelis used full scale war tactics, they would have annihilated Hezbollah, together with many civilians. People all over the World watching the images of many dead civilians on their televisions, would call for measures against Israel⁹⁸. Having only hostile neighboring countries, Israel could not afford such a worldwide reaction. Hezbollah won the conflict by not losing, although they may have suffered many losses. Why the Israelis failed is still under investigation, but it will be a lesson for the military all over the world.

3.3 Dutch Wars

The Netherlands can be regarded as being a medium-sized industrial nation and therefore may be expected to be a coalition partner for large scale combat missions or lead peacekeeping missions⁹⁹. Whether this expectation will be fulfilled will depend on the compilation of the Dutch Parliament and as a result the Dutch Government. War is political behaviour and in addition it is social and cultural behaviour. Furthermore, it is an expression of a society's level of economic and technological development¹⁰⁰. The Dutch society is not known as a belligerent nation. It did not experience war for ages, except for a short period during World War II. But this is no guarantee for the future. The present fast changing world made the Commander of the Dutch Armed Forces to issue a pamphlet to start "a professional discussion about the future of the Dutch armed forces from a military-operational perspective"¹⁰¹. Today the Dutch society is an open society and strongly interdependent, not only with its neighbouring countries but with the whole World. The Dutch society is vulnerable and sensitive to events abroad, against which it needs protection¹⁰². Today the Dutch armed forces are a professional defence force; it is well equipped and well trained. It is therefore, capable of participating in many peace keeping,

⁹⁷ Gray, p120

⁹⁸ www.en.wikipedia.org/wiki/2006_Israel-Lebanon_conflict

⁹⁹ Clingendael, Center for Strategic Studies; *Airpower: luxury or necessity?*, p16; CCSS Essay 1, The Hague, CCSS, February 2006

¹⁰⁰ Gray, p64

¹⁰¹ *Militaire Strategische Verkenning 2006 (Military Strategic Reconnoitring 2006)*; Commander Dutch Armed Forces; 2006

¹⁰² Ibid, p5

peace enforcing or even combat missions. Lacking a clear present enemy at the borders, the Dutch Armed Forces will be turned more and more into an expeditionary force. The last decennia the Dutch Armed Forces played a role in the Balkan conflict and in Iraq. The last ten years the Dutch armed forces were engaged in missions with an increasing violent character. Today they fight the Taliban in Uruzgan Afghanistan, although this mission is intended to be a mission for rebuilding Uruzgan.

3.4 Sub Conclusion

Although we can not rule out a large enemy attack from the East, Western military planners will shift their attention to smaller scale expeditionary operations. For these missions are accomplished today, while a large attack is not to be expected in the foreseeable future.

Modern wars will be fought in a network environment, so all own forces can cooperate. Until today wars have been fought at a relatively small scale. Also the 2003 Gulf War (Operation Iraqi Freedom) was fought with a minimum of men and equipment, made possible by NCW. However, winning battles is not sufficient to win wars; an occupying force is needed to get control of the country. Such an occupation force requires much more personnel.

Seeing the results of recent wars, mostly fought by the Americans, enemy forces will practise asymmetric warfare more and more, as almost no armed force is a match to the American and Allied forces on a regular battlefield. To beat these forces requires a different, counterinsurgent, strategy. But what ever strategy or technology is used, it is very difficult for any regular army to defeat irregular forces, as the situation in Iraq, Lebanon and Afghanistan show.

Most present combat aircraft were developed for large scale wars against technological equivalent (air) forces. They are less suitable, or maybe just too sophisticated for counter insurgency operations. This fact may lead to the development of a lighter, less sophisticated, type of combat aircraft. In chapter 7 we will have a closer look into the development of fighter aircraft

Till the Second World War the Royal Netherlands Air Force's mission was to defend the national aerospace. During the Cold War the (Northern) European Aerospace was the stage to operate. Today, the RNLAF must be able to operate worldwide. The next chapter will illustrate how the development took place.

4 Royal Netherlands Air Force

4.1 Pre Second World War

Since the 18th century, the Netherlands relied on their neutrality preventing them from being involved in war(s). Being small and surrounded by large countries like France, Great Britain and largely depending on international trade, the Netherlands benefited from (international) peace. The religious-humanistic and bourgeois society had no room for any heroism¹⁰³. By choosing neither side, they hoped to stay out of war. Till World War I this strategy was successful. At the start of WWII, Adolph Hitler had other ideas about the Netherlands' neutrality.

With the rise of Adolph Hitler and Nazi Germany, the Dutch government did not rely solely on the strategy of neutrality. But the Dutch armed forces had suffered from budget cuts in the twenties and early thirties, like most European armed forces. And so the armed forces were strengthened. The Dutch air force, established in 1913, was using early 1920 aircraft at the late 1930's. In fact the Dutch air force was a subdivision of the Dutch army, the "Luchtvaart Afdeling" (LVA); or Air Division, in 1939 transformed to "Wapen der Militaire Luchtvaart", or Military Air Division. In 1936 new aircraft were ordered from the Fokker aircraft company, which resulted in the Fokker D-XXI and the more modern G-I. Aircraft from the USA were also ordered in 1939, but they were either not available in time or were no match for the German aircraft. Even aircraft from Germany were considered (the Heinkel He-112 proved to be very capable). The LVA's strategy was quite simple, pursuit aircraft for defending the Dutch airspace from intruders, reconnaissance aircraft/light bombers for reconnoitring or supporting ground forces and some bombers.

Fokker introduced an air cruiser; the Fokker TV. It was a twin-engined aircraft with a retractable gear and armed with one 20mm cannon in the nose and four 7.9mm machineguns. It should cruise the air and shoot down intruding bombers. Today, this may sound as an unsound idea, but viewed in the light of the British and American 1930's air power doctrine, not that dim-witted. Intruding bomber aircraft would have no fighter escort, so they could be engaged by similarly aircraft and the 20mm gun could cause havoc amongst the bombers. The Germans however had a different air power doctrine and also the LVA didn't think too much of the idea. The LVA wanted the TV as a bomber aircraft; 16 were ordered 9 were in service when war broke out. Lacking self-sealing fuel tanks they proved to be deadly aircraft, for their crew...

Being heavily outnumbered against the German Luftwaffe the Dutch air force proved to be no match. By the time Rotterdam was bombed at 14 May, the Dutch air force practically had ceased to exist....

4.2 Post Second World War, entering the Cold War

WWII had shown that (small) individual countries were incapable of defending them against (larger) hostile countries. When WWII was ended, a new enemy showed up at the eastern horizon. After the Nazi's defeat and the hostilities had ceased, the

¹⁰³ *Airpower: luxury or necessity?*; Clingendael, Centre for Strategic Studies; Essay 1, The Hague, CCSS, February 2006; www.ccss.nl/publications/2006/20060200_ccss_inkluisief_1_en.pdf

Soviet Union had no intentions to decrease their military forces. Also the ideology of the Soviet Communist Party did not guarantee the national sovereignty or independence of democratic states. The events in Eastern Europe in 1947 and 1948 increased the fears for a possible Soviet attack on the countries of Western Europe furthermore. These countries, together with the United States and Canada formed the North Atlantic Treaty Organisation in 1949. With this treaty it was stated that if one of them would be attacked by a hostile nation, all members will join in to defend this country.

The great Soviet armed forces in Eastern Europe meant that NATO members had to build up strong military forces as well. In return the Soviet Union said it had to strengthen its forces to be able to defend the Warsaw Pact against an invasion by NATO forces. The arms race had begun.

After the Second World War the Dutch air force had to be rebuilt. Similar to Great Britain's RAF the air force was to be an independent force. In 1953 it was declared 'Royal', so from then on it was called "Koninklijke Luchtmacht", or Royal Netherlands Air Force (RNLAf). Being a NATO member meant also that the RNLAf's strategy had to fit in the NATO strategy or NATO's air power doctrine.

Right from 1949 NATO's strategy to defend the North Atlantic Area made clear that nuclear weapons would be delivered promptly¹⁰⁴. In 1950 NATO's strategy was more distinct: "to destroy by a strategic offensive in Western Eurasia the will and capabilities of the USSR and her satellites to wage war". Four phases were defined;

Phase 1: D-Day to the stabilization of initial Soviet offensive, to include the initiation of the Allied air offensive.

Phase 2: Stabilization of initial Soviet offensive to allied initiation of major offensive operations.

Phase 3: Allied initiation of major offensive operations until Soviet capitulation is obtained.

Phase 4: Final Achievement of Allied War Objectives¹⁰⁵.

For all members of NATO, including the USA, the costs for maintaining a military force capable of withstanding and withdrawing the Warsaw forces became too expensive. In 1954 nuclear weaponry was included into NATO's strategy. In case of a surprise Soviet attack, immediately NATO would employ nuclear weaponry, tactically and strategically¹⁰⁶. Nuclear weapons were introduced in Western (Europe) silently, also in the Netherlands. The Dutch prime minister thought that these weapons were cheaper than soldiers¹⁰⁷. In the following years the main point of NATO's defence was mutual retaliation by nuclear weapons, with the conventional forces as "trip wire". Nonetheless, NATO should also be able to fight limited conventional wars. Mutual retaliation had its disadvantages; it would end up in a nuclear war very quickly. By 1967 a new strategy was presented which provided more flexibility in defence; a "Flexible Response" instead of "Massive Retaliation". The level of military force would depend on the level of violence employed by the aggressor. The main point of defence lay initially on the conventional armed forces, but if needed, nuclear weapons would be used. The ultimate response would be nuclear retaliation¹⁰⁸. This strategy was official until the Cold War had ended.

¹⁰⁴ NATO STRATEGY DOCUMENTS 1949-1969, p12; Edited by Dr. Gregory W. Pedlow, Chief, Historical Office Supreme Headquarters Allied Powers Europe; 1997; <http://www.nato.int/docu/stratdoc/eng/intro.pdf>

¹⁰⁵ *ibid* p14

¹⁰⁶ *ibid*, p18

¹⁰⁷ J.M. Bik "Een halve eeuw krimpen"; 1999; www.nrc.nl/WV2/Lab/Profiel/Krijgsmacht/historie.html

¹⁰⁸ NATO STRATEGY DOCUMENTS, p25.

The guided surface-to-air missiles, which were on an alert status 24hrs per day, 7 days per week (24/7), were the RNLAF's first line of defence against an (surprise) attack by bomber aircraft. These missiles were stationed in West-Germany. Enemy aircraft that succeeded avoiding interception or entered via the North Sea, had to be intercepted by the RNLAF's interceptor aircraft. Other tasks for the RNLAF were reconnaissance and (offensive) fighter-bomber attacks against enemy troops & equipment.

The USA wanted to build up a large military force in Europe, to face the Soviet threat. They therefore supplied Western European countries with cheap military equipment according to the Mutual Defence Assistance Program (MDAP). In this scope the Netherlands received the North American F-86K Sabre "*Kaasjager*" (night fighter), Republic F-84F *Thunderstreak* (ground attack) and RF-84F (reconnaissance). Together with the Gloster *Meteors*, the Dutch air force had a remarkable strength of over 400 combat aircraft during the 1950s. During the 1960s this number decreased to about 250 aircraft. The RNLAF entered the supersonic age with the Lockheed F-104G *Starfighter*. The F-104G(erman) was chosen, because it had all-weather capabilities and (limited) (nuclear?) ground-attack capabilities. In the early 1970's the sub-sonic F-84F *Thunderstreak* was replaced by the supersonic Northrop N(etherlands)F5 *Freedom Fighter*. From 1979 the F104G *Starfighter* was replaced by the General Dynamics F-16 *Fighting Falcon*. The F-16 is a multi-role aircraft; it can be used as an air-superiority fighter, but it also has ground attack capabilities. Even during flight the mission can be altered from an air-to surface role to an offensive counter air operation. This concept is called swing-role. As the NF-5 reached the end of its operational lifespan and the RNLAF already operated with F-16, which could carry three times the load of an NF-5, the F-16 was the obvious choice to substitute the NF-5 in the late 1980s. The F-16 became the main stay of the RNLAF since then.

4.3 Post Cold War

At the time the Soviet Union disintegrated, the Dutch armed forces were at the height of their power. 128,000 men personnel served the armed forces, which was equipped with state of the art armoured vehicles (incl. nearly 800 Leopard II Main Battle Tanks) and combat aircraft (F-16). During the 1990's the armed forces suffered from budget cuts. The political parties wanted to cash the so-called peace dividend. The expenditure for defence could be reduced and the money, that became available, could be spent for other (peaceful) purposes. The compulsory armed forces were replaced by a professional army. Lack of a very strong opponent meant that much equipment had become superfluous. For the RNLAF this meant a reduction of 30% of their fleet of operational F-16s and a similar reduction of personnel¹⁰⁹.

Lacking a clear and present enemy gave raise to questions about what the new strategy for NATO and also the Netherlands' armed forces should be. To the Dutch politicians the Dutch armed forces should transform into a peacekeeping force with, if necessary, peace-enforcing capabilities. Regional instability could end-up in international instability, resulting in war. This policy was practised in the Balkans, where several civil wars were fought during the 1990's. Being a small country, the Dutch could not afford an army which could impose Dutch governmental will to another country or individual hostile parties by military force. In concert with international diplomacy, lightly armed forces should be able to avoid hostile parties

¹⁰⁹ Van Loo, P.E.; *Crossing the Border, De Koninklijke Luchtmacht na de val van de Berlijnse Muur*, p47; Den Haag 2003.

fighting each other. Although the Serbs were equipped with tanks, the Dutch forces had to do without. The 25mm canons were dismantled from the YPR armoured vehicles as they might look too aggressive to the Serbs. Unfortunately, the Dutch politicians and armed forces learned a hard lesson at Srebrenica in former Yugoslavia. Once faced with the Serbian tanks at the Srebrenica safe-haven, the Dutch forces were no match. Although the RNLAf had F-16s available to provide close air support, they were not allowed to do so by the international higher command. Once the enclave was captured by the Serbs two Dutch F-16s were allowed to attack. The Dutch relied on international agreements, by which close air support would be guaranteed when the Dutch forces were in danger. But they were let down and the Serbs took over control of the refugees.

Srebrenica had a deep impact on the Dutch armed forces and politicians. Agreements with other countries on close air support did not guarantee this support would be given, when asked for. Srebrenica also showed that light armed forces would always be at a disadvantage against hostile parties. As a result Leopard II main battle tanks were sent to Bosnia-Herzegovina to guard the Dayton agreements are lived up to. Today, the Dutch ground forces are heavily armed against the Taliban in Uruzgan, Afghanistan, while the RNLAf provides close air support by Apache helicopters and F-16s.

4.4 The 21st Century

The international order had changed after the decline of the Soviet Empire. As a result the domain of operations for the Royal Netherlands Air Force did change as well. To be able to cope with this changed situation, the RNLAf issued a new doctrine for air power¹¹⁰. Facing only the Warsaw Pact as an enemy, from 1989 it soon became apparent that the whole world would be the field of activity for the RNLAf. In their first Air Power Doctrine (1996) the RNLAf grounded their doctrine on the role of the aerial firepower. In the 2002 Air Power Doctrine, air power is much more than 'firepower' only. It is "the ability to deliver manpower and if needed firepower over long distances by air, without being hindered by mountains or water, accomplishing politically and military goals". It involves combat aircraft and transport aircraft; fixed wing as well as rotary wing aircraft. In the chapter two we only dealt with bombers and fighter aircraft, being the key players. Within the RNLAf Air Power doctrine also the Dutch army can be involved in air power; they provide the ground forces that are capable of being transported over great distances, delivering the needed firepower where needed.

In his pamphlet "Militair Strategische Verkenning 2006" the Commander of the Dutch Armed Forces expects no aerial battles on a large scale in the near future. A decrease of the classical threat and the ability to eliminate the enemy air forces on ground at an early stage by NCW and precision weaponry are the underlying factors of these expectations¹¹¹.

Avoiding collateral damage as much as possible has become more and more important during the last decades. This resulted in aircraft systems capable of precision bombing. By modifying the F-16 during a 'Mid-Life Update program, the F-16 could be equipped with laser guided bombs. By doing so the RNLAf was able to join the US Air Force over Kosovo and Afghanistan. The main operations for the

¹¹⁰ Koninklijke Luchtmacht *Air Power Doctrine*; www.luchtmacht.nl/images/4_20360.pdf

¹¹¹ *Militaire Strategische Verkenning 2006* (Military Strategic Reconnoitring 2006), p16; Commander Dutch Armed Forces; 2006

RNLAF changed from air defence and offensive fighter-bomber-attack missions over the Balkan to close air support for (own) military forces on the ground in Afghanistan. The RNLAF's Air Power Doctrine expects that in future conflicts small mobile targets will have to be eliminated. Targets like these require higher demands in capabilities of sensors and weaponry¹¹². Ammunition like bombs and rockets must all be guided in the future¹¹³.

The F-16 is due for replacement between 2010 and 2020. According to the RNLAF the Lockheed-Martin Joint Strike Fighter (JSF) F-35 *Lightning* is the best aircraft for the best price. The decision whether to buy this aircraft will be somewhere in 2008, depending progress of the JSF program and the politicians decision making process. A total of 85 JSFs are to be obtained. This is another decrease of 20% in numbers of combat aircraft compared to the 105 F-16s that will be operational at that time. The number of RNLAF combat aircraft dropped considerably over the last few years, as can be seen in the picture below¹¹⁴.

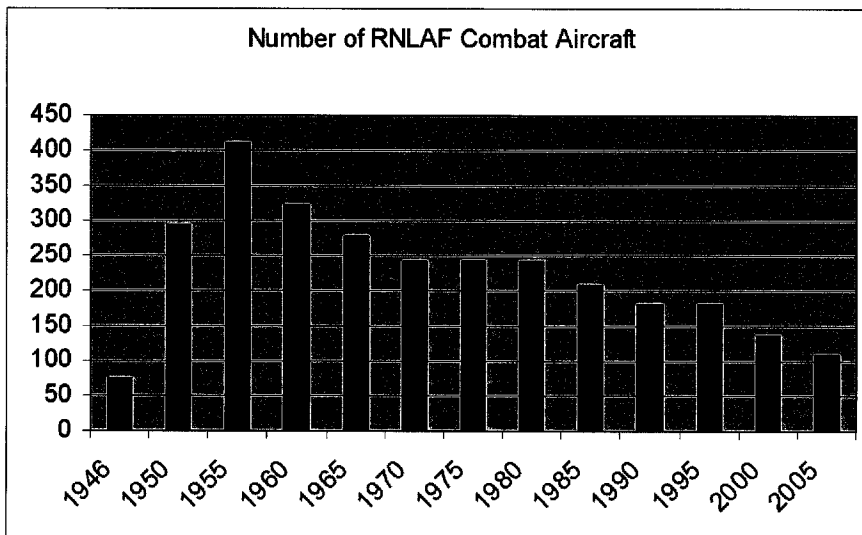


Figure 11: Changing numbers RNLAF combat aircraft

This decline has several causes. The immediate threat of the Dutch territory has gone, so less aircraft are needed for protection, swing-role like the F-16 can perform more tasks, which reduces the number of needed aircraft (or aircraft types) and, of course, budget cuts have had their impacts on the size of the RNLAF's fighter fleet.

Being a small air force, the multi-role capability (capable of several different missions) or swing-role capability (capable of changing the purpose of its mission during the mission¹¹⁵) is a very important concept for the RNLAF. This means it can operate with only one type of fighter aircraft, but is still able to perform every essential mission. At the next page the result of swing/multi-role aircraft for the RNLAF is made clear.

¹¹² RNLAF *Air Power Doctrine*, p101.

¹¹³ *Militaire Strategische Verkenning 2006* (Military Strategic Reconnoitring 2006), p24

¹¹⁴ The losses during peacetime before 1985 were not taken in account in this chart because of missing data. It therefore gives only a global picture.

¹¹⁵ Whether this is possible depends on the weapons carried. An F-16 on a bomber mission, also armed with air-to-air missiles can switch to an counter-air mission. However, an F-16 armed with only air-to-air missiles for an counter-air mission, cannot switch to a bomber mission.

4.5 Sub Conclusion

The swing-role concept is a very important issue for the RNLAf. The F-16 was a swing-role combat aircraft, as is its successor the JSF. To prolong the swing-role doctrine, the successor of the JSF should be, of course, a swing/multi-role aircraft. And according to many, this successor will be unmanned. So, in the next chapter we will have a look into the UCAV developments.

Dodging UCAVs censured

















	1920-1930	1930-1940	1940-1945	1945-1960	1960-1980	1980-2020	2020-2050?	2050-
Fighters	 Fokker DVII (20 ea)	 Fokker D-XVII (11ea)	 Supermarine Spitfire (322sq RAF)	 Supermarine Spitfire (35 ea)	 Gloster Meteor (Mk IV: 60 ea, Mk VIII: 160 ea)	 Hawker Hunter Mk VI: 93 ea)	 Lockheed F-104G Starfighter (138 ea, all versions)	 Lockheed Martin F-35 Lightning II (85 ea?)
Gound attack	 Fokker C-V (49 ea)	 Fokker C-X (20 ea)		 Republic F-84F Thunderstreak (167ea, incl. RF-84F Thunderflash)	 Northrop NF-5A/B (105 ea)	 General Dynamics / Lockheed Martin F-16A/B (213 ea; maximum, decreased to 108ea)		
Bombers		 Fokker T-V (16 ea)	 North American B-25 Mitchell (139 ea)					 ???

Figure 12: Combat aircraft RNLAF

5 UCAV; Past, present and Future Developments

"Everyone agrees that UCAVs are the answer," a speaker commented at a conference on unmanned combat air vehicles. "We just have to figure out what the question is."¹¹⁶

5.1 Why UCAVs?

Many experts in today's aircraft magazines entitle the F-35 the last manned fighter aircraft. The next generation fighter aircraft will be unmanned, so is their believe. Is this development of UCAVs inspired because 'we' need it, or is it just because we can do it? The same question could be asked for the electric bulb. Society never asked for the electric bulb (W. Edwards Deming). Many people, however, can not live without, or better, we don't want to live without it anymore. What society wanted was light in the dark. Being much cleaner and safer, the electric bulb replaced the gaslight. The Nazis lacked a strategic bomber. They were unable to build one during the war and would have lacked sufficient crewmembers as almost all were needed to defend das Reich during the last satge of the Second World War. They therefore came up with the V1, as a cheap substitute for a strategic bomber, which needed no aircrew. So one could say the electric light bulb and V1 were developed out of the disadvantages, although being of different nature, of the preceding technologies.

If disadvantages of one technology can start the development of other, what are the disadvantages of present manned combat aircraft?

- For one, it is manned. So therefore limited with the physical and psychological limitations of man.
- A manned aircraft needs to accommodate the crew.
- Pilots need to be trained regularly. This can be achieved, partly by flight simulator, partly by practical flying in an aircraft. This means the aircraft needs to be inspected, needing manpower, materiel and financial resources.
- Practical flying means noise nuisance in the direct area of the airbase.
- Practical flying means wear and tear and therefore more technical breakdowns.
- Modern combat aircraft became more and more expensive over time. Only a few countries can nowadays afford an independent developing aircraft industry. The Panavia Tornado and the Eurofighter are developed and built by a three nations (Great Britain, Germany & Italy) consortium. Even for the US Joint Strike Fighter, countries outside the US are involved in the development (costs).
- Becoming more complex, they became more sensitive to technical breakdowns.

The RNLAf, also interested in U(C)AV's, is doing several investigations on this matter, in co-operation with TNO. In TNO report FEL-04-A109 the advantages of unmanned aircraft vs. manned aircraft are described¹¹⁷;

- Unmanned aircraft are capable of 3D missions; Dull, Dangerous & Dirty.

¹¹⁶ From: "Revolution or curiosity? UCAVs wait for a mission statement", by Bill Sweetman, *IDR Aerospace and Technology Editor*, Jane Defense Weekly; 11 November 2005

¹¹⁷ Bos, A.H.W. & Visser, B.J., *Mix van Wapensystemen ter Vervanging van de F16*, TNO-rapport FEL-04-A109, Den Haag 2004

Dodging UCAVs censured

- Unmanned aircraft are not limited by the physical and psychological limitations of a pilot. A pilot is only capable of a certain number of sorties. To fly more sorties with one aircraft, a number of pilots must be available per aircraft.
- Miniaturisation. The physical dimensions of the crew don't need be taken into account with unmanned aircraft. The aircraft might become therefore much smaller.
- Load factor. A pilot can take as much as 8G¹¹⁸, before getting unconscious. The unmanned aircraft can be designed as strong as possible or thought needed.
- With remote controlled UCAVs, the controller can be trained by simulation. No practical flying is needed. The UCAV can be stored in crates and will see daylight only when put into operation. This means no inspections on a regular basis, saving manpower, material and therefore money.
- No regular practical flying, reducing noise nuisances and wear and tear.

Another, once thought, advantage of unmanned aircraft was that the purchase costs would be lower than for a manned fighter. But this seems no longer to be the case¹¹⁹. The Nazi V1 was a cheap substitute for a strategic bomber. The future UCAV must be 100% autonomic and "is growing fat on requirements"¹²⁰.

In the same TNO report some disadvantages are mentioned; the unmanned factor. No crew means the aircraft has to be controlled either autonomic or remote. To control the UCAV remotely, many data links from UCAV to the ground controller are needed. The Situational Awareness of the ground controller is less than when a pilot is flying the aircraft. The Rules of Engagement may therefore become stricter. The data links are the Achilles heel of the system. Being vulnerable to jamming, the data might get lost and therefore control of the aircraft. The "toxic electromagnetic environment" is the reason the US military don't send the F-22 Raptor fighter aircraft to Iraq or Afghanistan. They fear the intense jamming of firing mechanism of improvised explosive devices (IEDs) on the ground, which distorts radio traffic and UAV operations. This jamming might degrade F-22 electronic devices¹²¹. Another "bottleneck" for operating with multiple UCAVs simultaneously is the data transfer, or better the limited bandwidth. The Pentagon's "Unmanned Aircraft Systems Roadmap: 2005-2030," released in August 2005, expects "self healing" solutions for this problem by on-board processing power¹²². But limited bandwidth is a major issue in NCW, for which experts don't see any solutions yet (see also chapter 3).

The needed artificial intelligence for a 100% autonomic UCAV to match the performance of current aircraft is not available yet. It might be possible to develop UCAVs that autonomously control the sky. It will be able to identify friend from foe. This IFF technology has been in use for many years now. As this is controlled by a computer, it can only make comparisons; 'one' or 'zero', or 'friend' or 'foe'. In practise every friend will be spared will every not identified aircraft will be shot down. This happened to a British Tornado during the second Gulf War; its IFF module was not operative. The result was it was shot down by a Patriot missile, killing both crew members¹²³.

¹¹⁸ This number differs per individual pilot, duration of G load and taken protective measures (G-suit etc.)

¹¹⁹ Butler, A & Fulghum, D.A.; "Boom or Bust"; *Aviation Week & Space Technology*; July 24, 2006.

¹²⁰ Sweetman, B. *Jane's International Defense Review*, 2003.

¹²¹ Fulghum, David A; "Electronic Stew"; *Aviation Week & Space Technology*; 29 January 2007.

¹²² Tirpak John A., "Will We Have an Unmanned Armada?"; *Air Force Magazine*, vol. 88 November 2005

¹²³ "Patriot missile, Tornado friendly fire investigation completed"; Headquarters United States Central Command; May 12, 2004; www.globalsecurity.org/space/library/news/2004/space-040514-centcom03a.htm

Another mission the UCAV can be programmed is to attack stationary targets. It will depart, destroy the target and return autonomously. It will operate more or less like the Cruise Missile, but instead of being destroyed as well, it can be re-used.

Maybe the most interesting mission for an UCAV is to cruise over an area in which friendly forces are patrolling. This UCAV will be equipped with bombs and can be refuelled in the air. When in need, the ground forces may instruct the UCAV to drop a bomb at a certain target; either by laser guidance by ground forces or GPS.

These autonomous missions implicate that 'the man on the ground' is responsible for the result and, hence, the collateral damage. He might miss the actual situational awareness, which may result in unacceptable collateral damage. This is way some people have some doubt about the legal consequences^{124, 125}.

Nevertheless these disadvantages, most military aircraft manufacturers are (or were) developing UCAVs; either due to Government request or by own initiative. Anyway, mainly because of their advantages, UCAVs have been developed since the beginning of the air war.

5.2 A Pilotless History

The loss of pilots has been a concern for military commanders right from the start of military aviation. Shot down aircraft can be replaced by mass production, but it takes much longer getting an experienced pilot operational. During both WWI and WWII some experiments were done with unmanned aircraft, but lack of success stopped further developments¹²⁶.



Figure 13: The Kettering Bug

One of the first UCAVs that was more or less successful was the US Kettering Bug, an unpowered biplane. It was developed by Charles Kettering, weighing just 270 kg, including a 135-kg bomb as payload and powered by a 40-h.p. engine. Once wind speed, wind direction, and target distance had been determined, the number of revolutions the engine needed to take the missile to its target was calculated. A cam

¹²⁴ Klein, John J., LCDR USN; "The Problematic Nexus: Where Unmanned Combat Air Vehicles and the Law of Armed Conflict Meet"; *Air & Space Power Chronicles*; 22 July 2003.

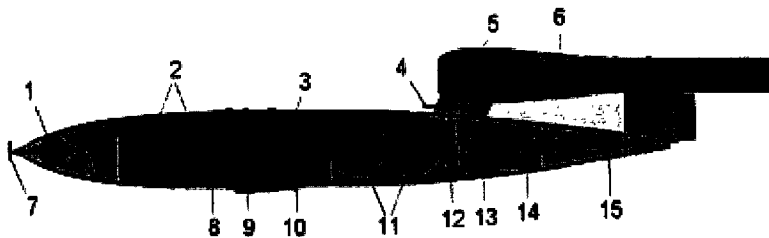
¹²⁵ Lazarski, Anthony J., LtCol. USAF; "Legal Implications of the Uninhabited Combat Aerial Vehicle"; *Aerospace Power Journal*; 3 June 2002.

¹²⁶ Lewis, W.K. UCAV – The Next Generation Air-Superiority Fighter?

was then set to drop automatically into position when the right number of engine revolutions had occurred. The end of WWI deprived the Kettering Bug its opportunity to prove itself in combat.

Vergeltungswaffe 2

As pilots (and aircraft) became scarce for the Germans at the end of the Second World War, they came up with unmanned aircraft (Vergeltungswaffe 1, or V1) and the first long-range rocket (Vergeltungswaffe 2, or V2).¹²⁷ Although in fact a flying bomb and rather crude in design, the V1 could be seen as the first successful Unmanned Combat Aerial Vehicle. Technological development of the UCAV was stopped after WWII and the focus came on the development of the long-range rockets. Together with the development of the nuclear bomb the Intercontinental Ballistic Missiles (ICBMs) became the nightmare for many people in the West and behind the Iron Curtain.



1. Magnetkompass
2. Aufschlagzünder
3. Rohrholm
4. Staurohrdüse
5. Mischdüsen
6. Brennkammer
7. Anemometer-Zählpropeller
8. Sprengladung
9. Starthaken
10. Treibstofftank
11. Druckluftflaschen
12. Luft-Drosselklappe
13. Batterie
14. Hauptkreisel
15. Pneumatische Servomotoren

<i>Länge:</i>	7,90 m
<i>Spannweite:</i>	5,30 m
<i>Nutzlast:</i>	850 kg
<i>Vmax:</i>	500-800 km/h
<i>Flughöhe:</i>	0,5-3 km
<i>Reichweite:</i>	370 km

Figure 14: V1; Source: www.luftarchiv.de

Cruise Missile

¹²⁷ Ellis

In the 1980's the Cruise missile was introduced. Equipped with a nuclear or conventional warhead, it could deliver its load very accurate. Flying at low altitude, guided by a terrain following radar, it could reach its target without being detected by enemy radar. This made a first strike possible for NATO (or USA?) against the Warsaw pact countries. In a full-scale nuclear war, a very big advantage....

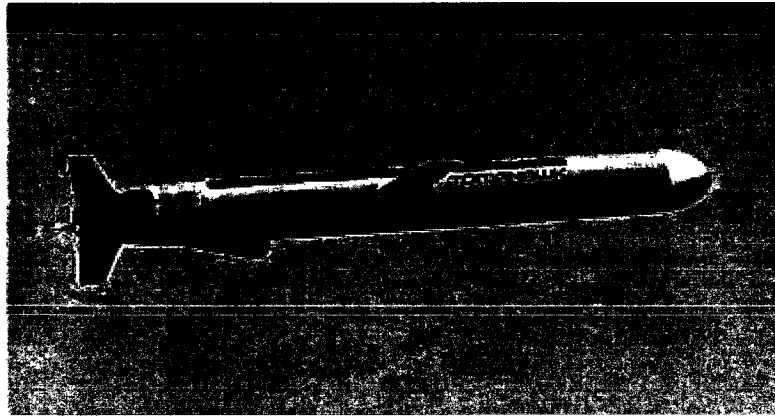


Figure 15: Submarine-launched Tomahawk cruise missile

Although years later and much more advanced, the Cruise missile had one big resemblance with the V1; both were in fact aircraft and both were to be lost on their mission. The V1 was rather cheap (€200,- each), but the Cruise missile costs about €1,000,000- a piece. Equipped with a nuclear warhead a cruise missile would cause destruction worth thousands times its costs. So seen from an economical point of view, using a €1,000,000 missile was a sensible thing to do. However, with the end of the Cold War, nuclear warheads did become less practical. In the wars the USA and NATO fought since 1990, only conventional warheads were used, also on Cruise missiles. The damaged they caused was substantial less than would have been with nuclear warheads.

Dropping bombs from aircraft also became increasingly accurate with the years, first with laser guided bombs and now by satellite navigation. Together with stealth aircraft like the F-117 Nighthawk and the B2 Spirit bombers, the payloads could be dropped on target without the aircraft being detected. This meant that the same affect could be achieved in a much cheaper way. USAF Colonel Robert E. Chapman II made the same equation¹²⁸.

	5.2.1.1 Tomahawk	CALCM	JDAM
Warhead	1,000 lb	2,000 lb	1,000/2,000 lb
Unit Cost	\$600,000	\$1,160,000	\$21,000

Table 1: CALCM: B-52s launched conventional air launched cruise missiles

JDAM: Joint Direct Attack Munitions guided by the Global Positioning System (GPS)

The Cruise Missile had one other great advantage; the ability to appear over the target undetected. In 1988 the USAF revealed their then greatest secrets; the Lockheed F-117 Nighthawk and the Northrop-Grumman B2 Spirit bomber. These manned aircraft could enter a hostile airspace undetected. Their shape and construction materials were such that hardly any radar signals were reflected back to

¹²⁸ Chapman II, Robert E.; "Unmanned Combat Aerial Vehicles, Dawn of a New Age"; *Aerospace Power Journal* 2002

the radar. So, these aircraft too could reach the target undetected. Although being manned, these aircraft formed an inspiration for the shape of future UCAVs.

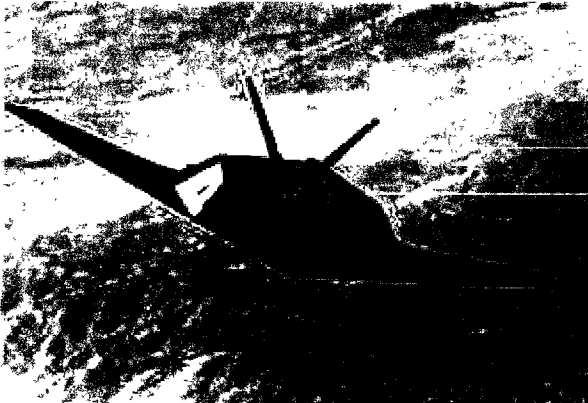


Figure 16: Lockheed F117 Nighthawk

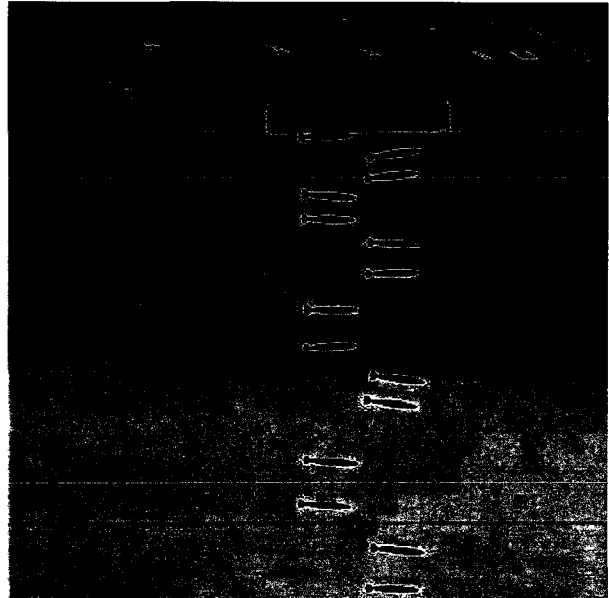


Figure 17: Northrop-Grumman B2 Spirit

5.3 UCAVs Today

Similar to WWI reconnaissance aircraft which were fitted with guns and bombs commencing the development of fighter aircraft, the armament of a UAV started the development of the combat UAV; the UCAV. The first modern UCAV was in fact a UAV (the General Atomics RQ-1 Predator) with one or two Hellfire missiles attached to it. Capable of surveying for a long time and waiting for it's pray; the Predator could attack without a warning. Used in 'the war against terrorism it had some successes'¹²⁹;

- On February 7, 2002, an armed Predator attacked a convoy of sport utility vehicles in Afghanistan. A suspected al Qaeda leader was killed.
- On March 4, 2002, a CIA-operated Predator fired a Hellfire missile into a reinforced al Qaeda machine gun bunker that had pinned down an Army Ranger team whose CH-47 Chinook had crashed on the top of Takur Ghar Mountain in Afghanistan. Earlier attempts by F-15 and F-16 aircraft were unable to destroy the bunker. This was the first use of an UCAV in a close air support role.
- November 2002, a Predator armed with a Hellfire missile was used to kill a senior al Qaeda leader, Abu Ali al-Harithi, when he was driving a car in the Yemeni desert.
- On May 13, 2005, Haitham al-Yemeni, an al Qaeda explosives expert from Yemen, was killed in a village in northwest Pakistan near the Afghanistan border by a Predator aircraft firing a Hellfire missile.
- On December 3, 2005, a US Predator UAV reportedly killed Al Qaeda #3 Chief Abu Hamza Rabia in his sleep in Haisori, Pakistan. Four others were also killed.
- On January 13, 2006, several US Predators carried out an air strike on Damadola village in Pakistan where al Qaeda's second-in-command Ayman

¹²⁹ http://en.wikipedia.org/wiki/RQ-1_Predator

Dodging UCAVs censured

al-Zawahiri was reportedly located. CIA Predator Drones fired 10 missiles killing 18 civilians, including five women and five children.

- On October 30, 2006, the Bajaur airstrike was conducted, targeting an supposed militant training camp and targeting al Qaeda's second-in-command, Ayman al-Zawahiri. Although Zawahiri does not appear to have been caught in the strike, casualty figures range from 80 to 85 people killed.

Most of above missions were operated by the CIA, as they were aimed at al Qaeda terrorists.

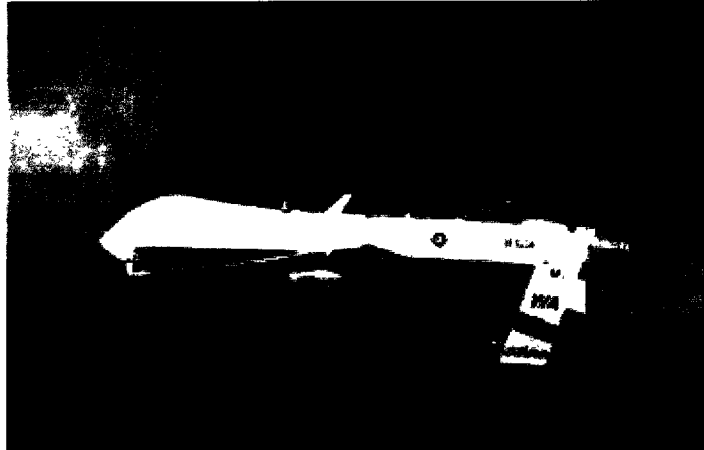
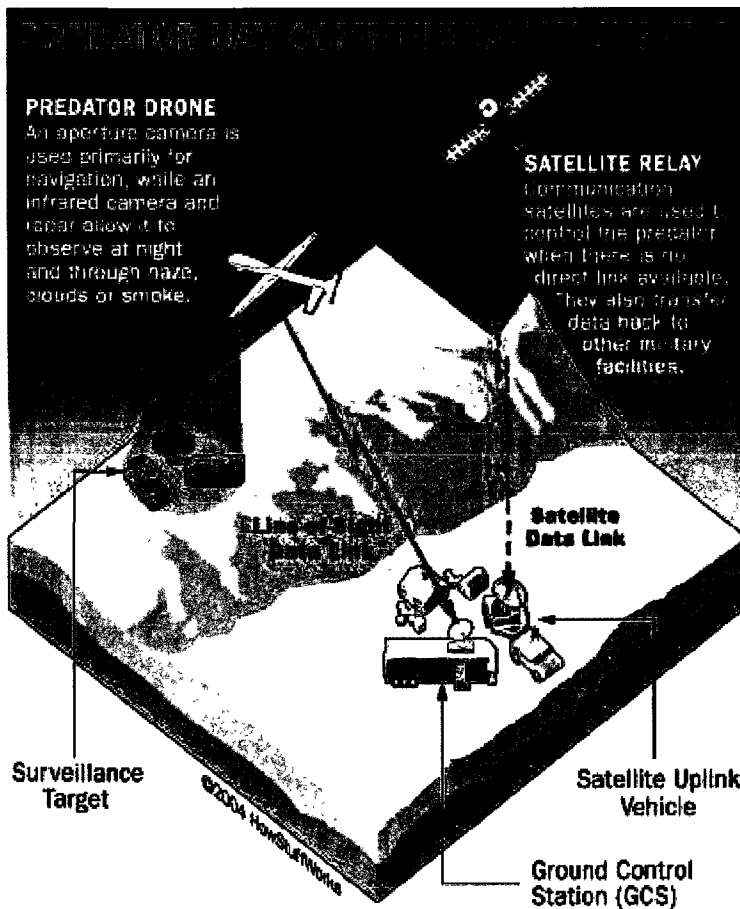


Figure 18: General Atomics RQ-1 Predator armed with a Hellfire missile



Although the Predator can operate autonomously for simple (reconnaissance) missions, it is usually operated by a crew of three; one pilot and two sensor operators. It has an endurance up to 30hrs, but only a range of 400nm. This limitation is due to its line-of-sight data link.

Figure 19: Predator communication system

For navigation the Predator uses an integrated inertial navigation system/global positioning system (INS/GPS). Although the GPS alone would make it possible for the Predator to arrive at its destiny, the combination with INS improves its immunity to jamming and spoofing. This system could make the pilot absolute. But the pilot was not needed only for controlling the aircraft; he also had to aim his weapons, (machine)guns, rockets and/or bombs at the enemy. Today all air-to-air anti aircraft missiles are either guided by infrared sensors or guided by radar. The old-fashioned bombs caused either much collateral damage or many were needed to destroy a target. During the Vietnam War the first laser guided bombs were used successfully. A laser beam is aimed at the target, while the bomb's seeker looks for the reflected laser "sparkle" and will steer itself to this spot. Into the 1980s guided bombs were directed by a separate designator, either carried by ground forces, operated by the forward air controller, or carried by another aircraft in the strike group. Today most combat aircraft are fitted with targeting pods to self-designate the laser-guided bombs. Laser guided technology does have some major disadvantages. Laser designation is very sensitive and vulnerable to weather conditions. Cloud cover, rain, and smoke can make reliable designation impossible. During as the 1991 Gulf War, laser designation sometimes reflected off the sand, causing weapons to home on false targets. Furthermore, the 'aiming aircraft' is dangerously exposed to ground fire or enemy air support, because it has to stay in the target's vicinity. To overcome these disadvantages, the GPS-guided bomb was developed. "Dumb" 1,000 or 2,000 pound bombs can be modified rather inexpensive (\$ 18,000.-¹³⁰), creating the Joint Direct Attack Munitions, or JDAM. These JDAMs are in many cases more precise than a laser-guided bomb. "The pilot simply programs in the GPS coordinates of a target, sometimes broadcast to air crews from ground forces by radio, and the bomb glides its way to the target, day or night, in clear skies and stormy weather"¹³¹.

The ability to deliver a JDAM bomb as accurate as a Cruise Missile, as unseen as a Cruise Missile by stealth technology, navigated by INS/GPS, together with ever developing computer technology opened the door for the UCAV. Several firms in several countries are developing UCAVs. Boeing worked on the X-45 for the USA and the X-46 for the US Navy. Northrop Grumman had its X-47 under development. Both aircraft showed great similarity with the B-2 Spirit.

¹³⁰ http://nl.wikipedia.org/wiki/Joint_Direct_Attack_Munition

¹³¹ Lowe, C.; "Smarter Bombs"; *The Daily Standard*; September 2003;
www.weeklystandard.com/Content/Public/Articles/000/000/002/089ntkyp.asp

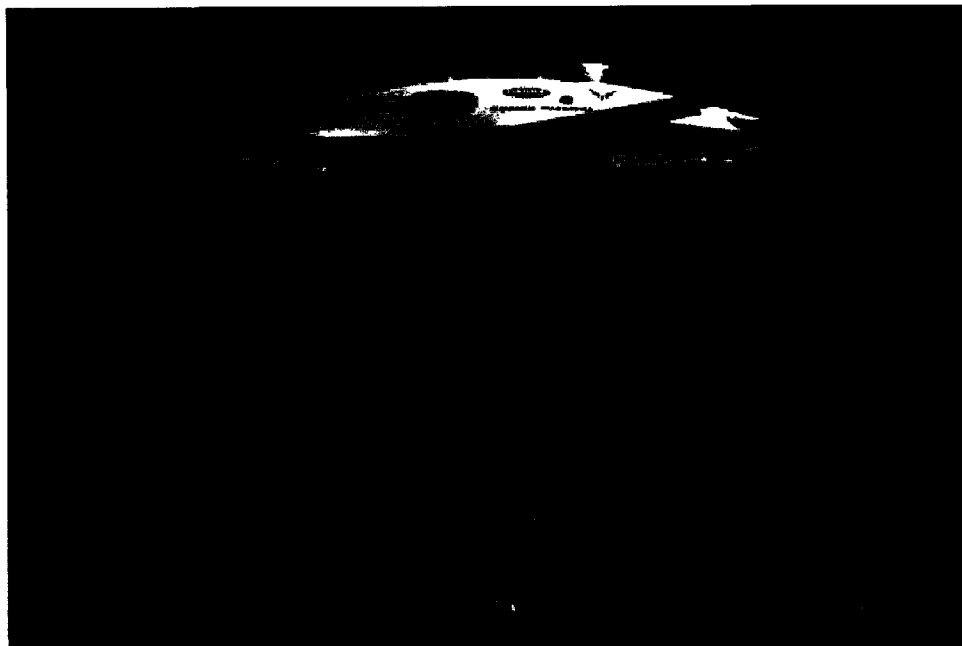


Figure 20: The X-45A drops an inert, precision weapon and flies into aviation history
(Source: Boeing)

Initially, the UCAV was seen as a relatively low-cost weapon against high-value, well defended targets deep behind enemy lines¹³². The Predator with one or two Hellfire missiles can be seen as an example in such. But the intentions of developing a UCAV is not just getting rid of the pilot, it has to do "something unique"¹³³ "Persistence" should be this unique capability. The UCAV's biggest advantage is lacking a pilot; its endurance is not constrained by the crew's physical and mental limitations. In theory, with aerial refuelling, it can stay in the air infinite.

Initially the UCAV was thought for suppression enemy air defences (SEAD)¹³⁴ in 2003 however, the US Department of Defense was "not really sure what they're best used for"¹³⁵. Electronic Attack (EA) could be another option the UCAV could be used for. Fixed-target strike or bombing on GPS co-ordinates might be another option.

The US Defense Advanced Research Projects Agency (DARPA) was managing the UCAV program for the USAF and US Navy, with Boeing's X-45A UCAV for the USAF and Northrop-Grumman's X-47A for the US Navy. Initial both programs ran independently, but were united in the Joint Unmanned Combat Air Systems (J-UCAS) program. This program was a joint effort to develop and demonstrate unmanned combat capabilities for high-threat; Suppression of Enemy of Air Defence (SEAD), Information Operations/ Electronic Attack, Persistent Intelligence, Surveillance, Reconnaissance (ISR), and "persistent ground attack missions within the emerging global command and control architecture for the war fighting community"¹³⁶. The program was focused on demonstrating capabilities that support both USAF and US Navy and enable an operational system development decision by the end of the decade¹³⁷. The J-UCAS program was a fusion of the DARPA/USAF

¹³² Cook, N.; "Armed & Dangerous"; *Jane's Defense Weekly*, 2003

¹³³ Sweetman, B.; "UCAVs Grow Fat on Requirements"; *Jane's Defense Weekly*, 2003).

¹³⁴ Chapman II

¹³⁵ Sweetman.

¹³⁶ www.js.pentagon.mil/descriptivesum/Y2007/Navv/0604402N.pdf#search=%22%20%22global%20command%20and%20control%20architecture%20for%20the%20war

¹³⁷ <http://www.globalsecurity.org/military/library/budget/fy2006/usaf-peds/0604400F.pdf>

Dodging UCAVs censured

Unmanned Combat Air Vehicle (UCAV) and the DARPA/USN Naval Unmanned Combat Air Vehicle (UCAV-N) programs. In early January 2006 the J-UCAS program was cancelled due to budget cuts and changes in priority. The US DoD would begin work on a next-generation long-range strike aircraft that year. This aircraft should be capable of very long endurance while carrying a "significant load of bombs"¹³⁸. The J-UCAS program was developing a similar aircraft, however with a much smaller payload. This new \$2bn program will start in 2008 and the first unmanned bombers should enter service in 2018¹³⁹. The X-45 and X-47 may not be cancelled by Boeing respectively Grumman, but these developments are only meant to benefit the new program. However, since the J-UCAS program was cancelled, things got quiet on both X-planes....

In Europe Dassault collaborates with EADS, Saab and other for a European UCAV, the nEUROn. The demonstrator is expected to fly in 2011, while the production aircraft will enter service in the time frame of 2020/2030¹⁴⁰. The aircraft is said to have "unmanned autonomous air-to-ground attack capabilities with precision-guided munitions, relying on an advanced stealth airframe design that reduces radar and infrared cross-sections to penetrate undetected at a speed of about Mach 0.8"¹⁴¹. Other mission capabilities, such as reconnaissance, might be validated at a later stage.

Other European UCAV projects are the British Taranis and the German-Spanish Barracuda. Both are seen as test beds for future developments. Unfortunately, the Barracuda crashed September 2006. A new test vehicle is already at the planning stage. In contrast with the Barracuda it will be designed for the reconnaissance role. The new aircraft will have a tapered wing, conventional tail unit, two engines at the rear and a forward fuselage with large fairing for a satellite communications antenna.

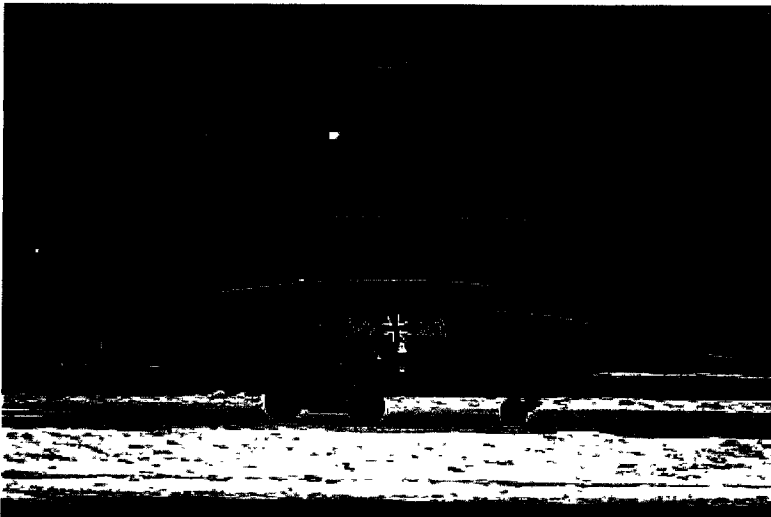


Figure 21: The Barracuda

While the UCAV programs in the USA seem to be on a low profile, Europe is making up their arrears. But as things are now, only test beds or demonstrators will be flying around in the near future.

¹³⁸ www.military.com/features/0,15240,85361,00.html?Etopstories.RSS

¹³⁹ Trimble, S; USAF to spend \$2bn on next unmanned bomber"; *Flight International*, issue 07feb2006, page 4

¹⁴⁰ www.dassault-aviation.com/defense/gb/neuron/n_programme.cfm

¹⁴¹ www.defenseindustrydaily.com/2006/05/neuron-ucav-project-rolling-down-the-runway/index.php

5.4 Future developments

The US Air Force established its first UCAV attack squadron equipped with the Predator B (or MQ-9A Reaper) while the RAF may have its UCAV squadron with armed Predator As. But these are in fact reconnaissance aircraft equipped with additional armament, just as at the beginning of WWI. The US Navy recently restarted the UCAS project for unmanned carrier operations; Northrop Grumman is currently manufacturing its UCAS-D vehicle. It is smaller than the X-45C design and only intended for live safe and reliable carrier demonstrations. However, "some Navy officers still remain sceptical about operating unmanned aircraft in the challenging carrier environment"¹⁴².

Great-Britain, Germany and France will continue with their demonstrators. The USA has reconsidered the UCAV by cancelling the J-UCAS program. The US Air Force and US Navy had not defined their requirements clearly enough to justify the J-UCAS program¹⁴³. The US Navy has scaled back its requirements to "persistent Intelligence, Surveillance and Reconnaissance (ISR) with some strike capabilities". For the USAF the UCAV may be the Next Generation Long Range Strike, but this depends whether this future bomber will be manned or unmanned and whether or not it will be supersonic. The British might go for a platform with long endurance equipped with a multiple bomb load¹⁴⁴. The French Air Force wants the UCAV to perform missions like suppression of enemy air defence, combat air patrol and close air support. The UCAV does not need to be a multi-role aircraft like the French Rafale¹⁴⁵.

The 2002 RNLAf Air Power Doctrine states that UCAVs must be able to attack enemy targets and return to base autonomously¹⁴⁶. But as the exact capabilities of the UCAV still had to be determined, the RNLAf did not expect that the UCAV would be employed in "complex scenarios" before 2030. Today, 2007, it is still not clear what the final capabilities of the UCAV will be. While the French are still looking at multiple missions for the UCAV, the US and British seem to concentrate on long range or long endurance missions. This last vision might result in air forces that consist of a mix of manned and unmanned aircraft. It will therefore take some time, before the RNLAf will consider whether the UCAV can "partly" fulfil the need for "offensive" firepower in the future. These 2002 statements reveal the RNLAf's opinion that the UCAV will never be a complete substitute for the manned aircraft. It looks like a visionary analysis!

In the table on the next page the latest, most significant, development on UCAVs are shown.

¹⁴² Butler, A; "Let the Race Begin"; *Aviation Week & Space Technology*, Vol 166, no. 13; 2 April 2007.


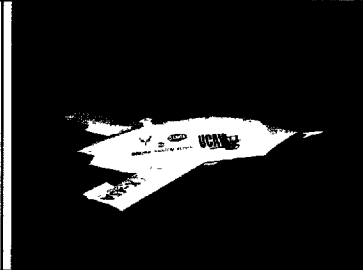

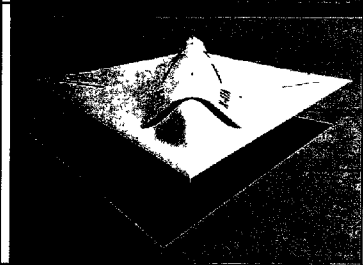

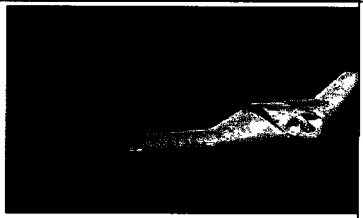
¹⁴³ Sweetman, B.; "UCAVs offer fast track to stealth, long-range and carrier operations"; *Jane's International Defence Review*, January 2007.

¹⁴⁴ Sweetman.

¹⁴⁵ Sweetman.

¹⁴⁶ RNLAf's *Air Power Doctrine*, p105.

Dodging UCAVs censured

UCAV		Status
<p>General Atomics Predator</p>		<p>Armed reconnaissance aircraft, operational in a.o. Afghanistan.</p>
<p>Boeing X-45A</p>		<p>Demonstrator aircraft, 64 test flights were performed successfully, including dropping guided bombs. Two were built; both are currently displayed in museums.</p>
<p>Boeing X-45C</p>		<p>The intended successor of the smaller X-45A. This aircraft was never realized because of cancellation of the Joint Unmanned Combat Aerial System (J-UCAS) in January 2006.</p>
<p>Northrop-Grumman X-47A</p>		<p>Demonstrator aircraft for the US Navy. Flight tests have been stopped in favour of the X-47B.</p>
<p>Northrop-Grumman X-47B</p>		<p>The development of this successor of the X-45A has been stopped due to the cancellation of the J-UCAS program. Once the requirements for the N(avy)-UCAS program have been defined, "Northrop Grumman will refine the design of the X-47B as necessary"¹⁴⁷.</p>
<p>Lockheed Martin Polecat</p>		<p>High altitude (18,000+ meters) unmanned demonstrator aircraft. Lockheed Martin is aiming at two possible mission areas; the possible UASF Long Range Strike (LRS) system and next-generation intelligence, surveillance & reconnaissance aircraft¹⁴⁸. First flights in 2005, crashed December 2006.</p>

¹⁴⁷ Navy League of the United States; April 2006, http://www.navyleague.org/sea_power/apr06-08.php

¹⁴⁸ Butler, A; "Not to be left behind", *Aviation Week & Space Technology*, July 24, 2006

Dodging UCAVs censured

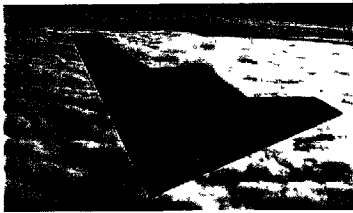
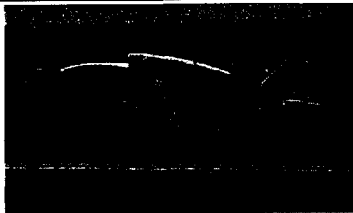

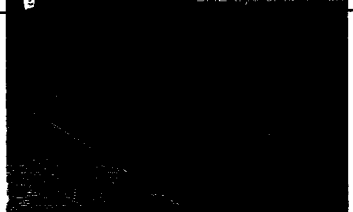
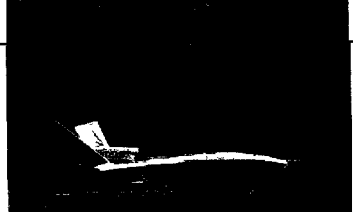

UCAV		Status
Saab / Dassault nEUROn		Swedish/French demonstrator unmanned aircraft. Final assembly will be carried out in 2009. Dassault does not foresee the first flight before 2011 ¹⁴⁹ .
EADS Barracuda		German/Spanish demonstrator aircraft, crashed September 2006. A new test vehicle is already at the planning stage. In contrast with the Barracuda, it will be designed for the reconnaissance role ¹⁵⁰ .
BAE Systems Corax		British demonstrator aircraft, first flights in 2004. In 2006 superseded by the Taranis project (see below).
BAE Systems Taranis		Technology demonstrator; ground trials will start in early 2009. Flight tests will be conducted in 2010. During these trials, weapons deployment will be simulated ¹⁵¹ .
Alenia Sky-X		An Italian unmanned demonstrator aircraft. First flight June 2005.
IAI Eitan		The Israeli Eitan has an operational endurance of 50 hours, propeller driven, with a wing-span of 26 metres and is said to be capable of carrying a maximum payload of 1,800 kg ¹⁵² .

Table 2: Overview latest UCAV developments

¹⁴⁹ Swarz, K; "BAE to build Taranis", *Flug Revue* February 2007; <http://www.flug-revue.rotor.com/FRheft/FRHeft07/FRH0702/FR0702f.htm>

¹⁵⁰ Swarz.

¹⁵¹ Swarz.

¹⁵² "Israel to Unveil its Biggest Unmanned Combat Aerial Vehicle"; *Jane's*; 07 March 2006; http://www.janes.com/press/articles/pc060307_1.shtml

5.5 Sub Conclusion

The question for which the UCAV may be the answer might be found. Regarding the above views, the main role for the UCAV will be persistence; long range (or endurance) missions. Whether the UCAV might still be the answer to the RNLAf depends on the role the RNLAf has in mind for the UCAV.

Electromagnetic interference and limited bandwidth are two major disadvantages that have to be overcome before UCAVs can be operated remotely at a large scale. An alternative may be autonomous operation by artificial intelligence. However, this technology hasn't matured yet. For both kinds of operation solutions are nowhere near yet.

During the late 1990s and early 2000, the development of the UCAV had quite a momentum with the X-45 and X-47 in the J-UCAS program. However, since this program was cancelled in January 2006, UCAV development seems to have lost its momentum. Although Northrop Grumman is manufacturing a new UCAS-D vehicles, it is only intended a demonstrator for carrier operations. UCAV development may find a new future in Europe; however, the Europeans have not reached the X-45A milestones by far.

The Dutch Air Power Doctrine states that UCAVs must be able to attack enemy targets and return to base autonomously. But the RNLAf does not expect that the UCAV will be employed in "complex scenarios" before 2030. Nor does the RNLAf think the UCAV will be a complete substitute for the manned aircraft. As things are now, they may just be right.

The RNLAf's Air Power Doctrine was issued in 2002 and therefore might have become at age at some points. The US Department of Defence is working on the next update to its road map for unmanned systems. It expected to be released in summer 2007. Maybe this will give new insights on the use of UCAVs for the RNLAf as well. However, as the next chapter will show, the RNLAf is not the only actor in the process of replacing a military aircraft. The Netherlands (Air Force) are (is) just (a) some small player(s) in an ever changing world, politically and military.

6 Dutch Defence Material Process

Final Observation: politics is always a stronger decision criterion than technology or air warfare strategy. (Dr. Carlo Kopp)

6.1 Acquisitioning New Combat Aircraft

Buying new combat aircraft for the RNLAF has been a controversial process since the acquisition of the Lockheed F-104G *Starfighter*. In the early 1960s the *Starfighter* was regarded as very expensive. Many doubted whether it was wise to buy such an expensive aircraft. Initially Lockheed had sold only 296 *Starfighters* to the US Air Force, who for their part was not content with this aircraft. If Lockheed could sell this aircraft to some European air forces, they would be able to make a success of this aircraft after all. Selling the *Starfighter* to the European market was regarded by many as the deal of the century. One of the *Starfighter's* rivals for the European orders was the French Dassault *Mirage III*, a very capable aircraft and popular with many air forces. If Germany, the Netherlands and Belgium (an order for over 1100 aircraft) would choose the *Mirage III*, the *Starfighter* would become a financial failure. Especially for the German market, the *Starfighter* design was changed by adding ground-attack capabilities. This new version became the F-104G(erman) *Starfighter*. Years later it became true that Lockheed had bribed some influential people in the Netherlands and Germany to force the acquisition of the *Starfighter*. Had Lockheed not done this, both countries might have purchased the *Mirage III* instead. However, this we will never know. 15 years later the discussions started again when was sought for a replacement for the *Starfighter*.

Competitors for the Dutch *Starfighters* were the Swedish SAAB *Viggen*, the US Northrop YF-17 *Cobra* and, once again a Dassault aircraft, the *Mirage F1*. Later the US General Dynamics YF-16 was added to the list. Due to the Swedish strict neutrality it was believed they would not deliver spare parts when the Netherlands (or NATO) was at war. So, the SAAB was removed from the list. Although the *Mirage F1* was a very capable aircraft, the RNLAF preferred an American aircraft. The RNLAF had operated with American aircraft since the end of WWII; when a change was made to a French product it was feared that this would have a deep impact in the operational management¹⁵³. As the RNLAF operated the Northrop NF-5 at that time, initially the Northrop YF-17 *Cobra* was preferred. However, in the end the YF-16 proofed to be the best aircraft. Behind the scenes Dutch and American politicians had played an important role in the decision which aircraft to choose. The Americans wanted the Dutch to choose an American aircraft. If the Dutch did so, other countries would follow soon, so was the general believe. The deal with the Dutch was that important, that an argument with the Dutch government about the KLM flying too frequently on the USA than allowed would have to wait¹⁵⁴. With the acquisition of the General Dynamics F-16 by the United States, Belgium, Denmark, Norway and the Netherlands, people talked about the "Big Deal" or "The sale of the century". The Dutch budget for replacing the F-104G amounted to fl 2,300,000,000.- for 102 aircraft. When the deal was finally made, still many feared the F-16 would become much more expensive than anticipated¹⁵⁵. Even television documentaries were made

¹⁵³ Joeri Boom; "Luchtgevecht"; *De Groene Amsterdammer*, 23 March 2002

¹⁵⁴ Ko Colijn and Freke Vuijst; "De Holland-Amerika-Ijijn"; *Vrij Nederland*; 13 mei 2006

¹⁵⁵ "Ontwikkeling van de F-16 onder scherp toezicht" Article in the *Emmer Courant*, unfortunately I can't date this article as I do only have copies of the text.

about the F-16 deal¹⁵⁶. During the 1980s additional F-16s were bought to replace the ageing NF-5s, totalling the number of purchased F-16 on 213 aircraft.

With the acquirement of a main weapon system for the Dutch armed forces much money is involved. Acquiring the Royal Netherlands Army's main battle tanks or armoured vehicles does not seem to raise that many questions, while replacing RNLAf's aircraft however can count on much debate between the political parties in the Parliament. What's the reason for this difference? Maybe the theory of Social Construction of Technology can offer an answer.

6.2 Social Construction of Technology (SCOT)

According to the theory of Social Construction of Technology (SCOT) technology development is a sociological process rather than the result of engineering efforts. The combined actions of multiple social groups are determined for the outcome of the development process. The specific technology has a different meaning for every separate social group. The perception of a social group about success or failure of a technology depends highly on the meaning this group has about this technology. A technological artefact is therefore no longer an object with only one form and one function. It has turned into an object with many faces, or the *Pluralism of Artifacts*. Every social group has its interests in the artefact and problems with the artefact.

Three social groups can be identified that have a relationship with the fighter aircraft; the RNLAf as a user, the military aircraft industry as manufacturer and the political parties who decide about the deployment of the aircraft. Each of these three social groups has its own interests and/or problems with the fighter aircraft.

To the RNLAf the fighter aircraft is an instrument to perform its assignments; defending national (and that of NATO members) air space, participate in peacekeeping (and enforcing) missions, etc.. For many air forces the fighter aircraft is the mainstay of these air forces, their *raison d'être*. And as a result of the fighter aircraft, within air forces a certain culture has developed and a status is derived from the type of fighter aircraft.

Manufacturing fighter aircraft means employment and therefore making money to the military aircraft industry. For some military aircraft manufacturers (if not all) the fighter aircraft is their *raison d'être* as well.

The relationship between the political parties and the fighter aircraft is somewhat more complex. Some, mostly leftwing, political parties regard the fighter aircraft as an aggressive, killing machine which should not have been bought and therefore a waste of money. Other parties consider them as necessary for national defence and a tool for international politics. The ability to deploy fighter aircraft represents international power.

For the fighter aircraft the situation may be as illustrated in the next picture.

¹⁵⁶ "Big Deal", a 1979 Granada Television documentary.

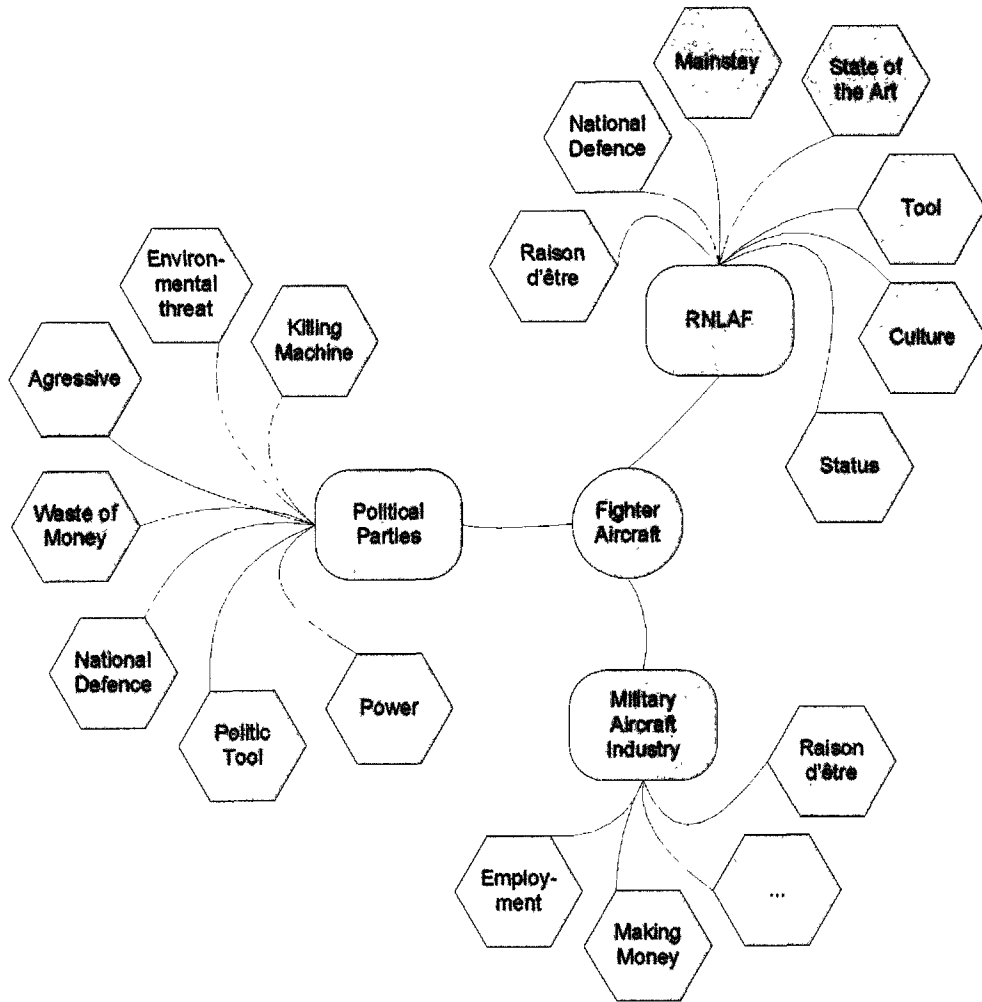


Figure 22: Interests, social groups and one artefact

6.3 Actor Network

In the case of replacing an old aircraft by a new one, a problem - solution relation can be set up. The problem is the old aircraft; it is getting out-of-date and/or it may not be economical to keep them operational. The theatre the aircraft has to operate in or above might have changed. For instance, during ISAF the Dutch F-16 provide CAS to the ground forces, fighting for air superiority over Afghanistan is not an issue. The Rules of Engagement are subject to change; fratricide and collateral damage have to be avoided as much as possible. Killing friendly forces or even civilians is unacceptable. The aircraft must offer means to fulfil these demands. The solutions are buying another type of aircraft or modifying the old one. In case of modification the aircraft should not reach the end of it's technical (and economical) lifetime, like RNLAF's present F-16s. But for the RNLAF more problems exist; which type of aircraft to choose? What is the level of threat? Which technology developments are creating these threats? What's the level of ambition?

Dodging UCAVs censured

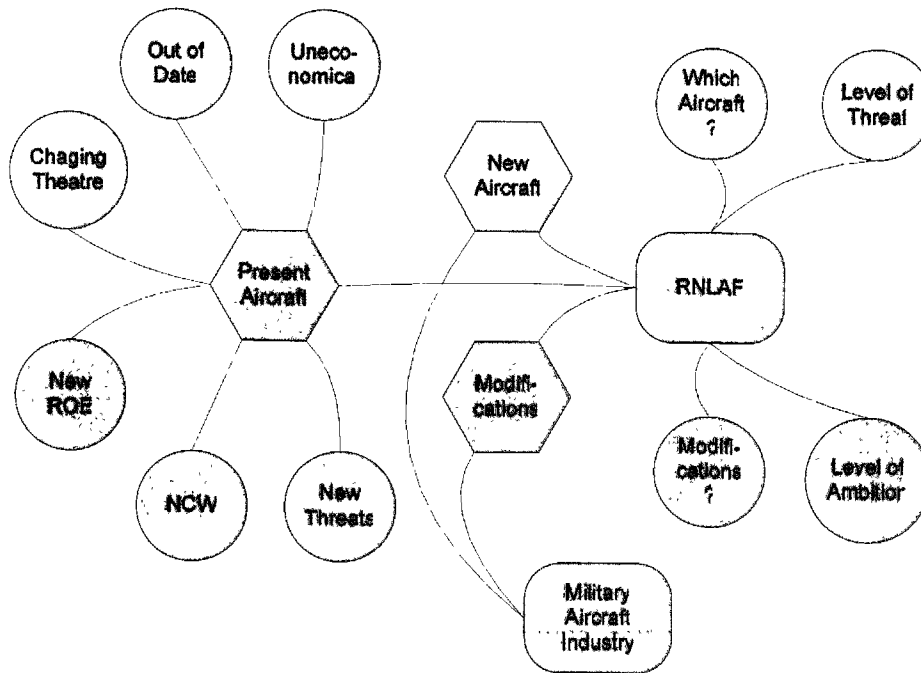


Figure 23: Problem – Solution relationship

The level of ambition is determined by the Government. This government has the supreme authority about what to do with the armed forces, the defence budget and where to employ the armed forces. The Government's level of ambition depends on the composition of the cabinet. Which political parties form the government? What is their level of ambition?

In their article about the development of the British TSR-2 Law & Callon described global and local networks that arose¹⁵⁷. For the replacement of a fighter aircraft we can do the same. In stead of two, three networks can be drawn up; a national one, a global one and an economical one. As the RNLAf is intending to replace its F-16s by, most likely, the Lockheed Martin JSF, this process will act as an example.

As defined earlier, the RNLAf is the user of the fighter aircraft. The politicians however, decide where and when these aircraft will be deployed. Although being a user, the RNLAf is not the customer to the military aircraft industry. The Dutch society is the costumer for the RNLAf's services; the protection of their homes by interception of any intruder¹⁵⁸. The Dutch Government is formed by political parties that represent the Dutch society. The Dutch pay taxes, by which fighter aircraft can be bought. So, in fact, the Dutch society is the costumer of fighter aircraft, represented by the Dutch Government and the Parliament. To illustrate all the actors in this play, a national network can be drawn up, see the next figure.

¹⁵⁷ Law, John & Callon, Michel; "Engineering and Sociology in a Military Aircraft Project: A Network Analysis of Technological Change"; *Social Problems*, Vol. 35, No. 3 Special Issue: The Sociology of Science and Technology, p284-297; University of California Press.

¹⁵⁸ The Dutch armed forces are also employed to protect and stimulate international stability. With regard to story in newspapers, magazine and the Internet, one may wonder whether this task is agreed upon by the Dutch society....

Dodging UCAVs censured

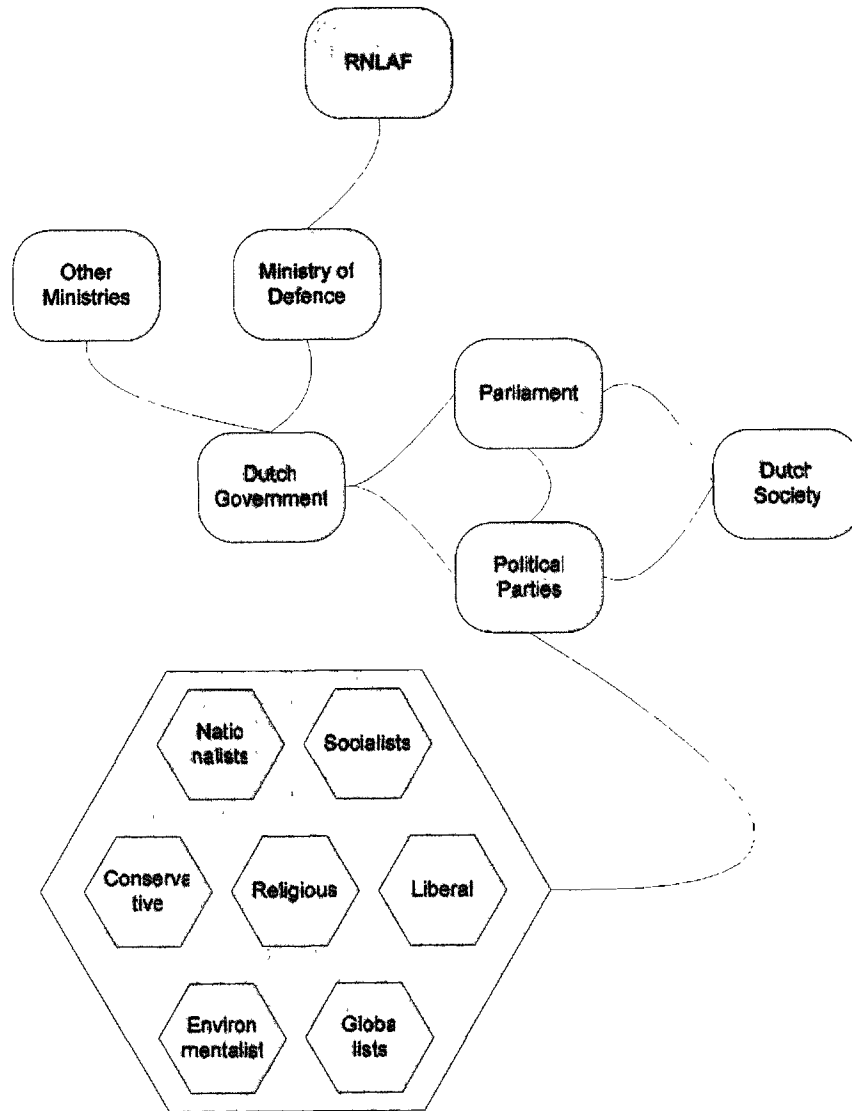


Figure 24: The National Network

The political parties represent several movements; from conservative to liberal, from socialism to religious, etc. In stead of these movements the separate political parties could have been shown. But most parties represent several ideologies and show similarity with other parties at some points and differ at other.

After November 22nd 2006 elections, the following political parties came out as the most significant parties;

- CDA, Christian Democrats.
- PvdA, Labour Party
- SP, Socialist Party
- VVD, Liberals
- PVV, Nationalists
- GL, Environmentalists

Next chart shows a summary of the points of view of these political parties about the Armed Forces, the European Union, NATO, and the Dutch Air Force.

Dodging UCAVs censured

Party	Armed Forces	Europe	NATO	Air Force
CDA	Pro	Pro	Pro	Pro
PvdA	Pro	Pro	Pro	Pro
SP	40% Budget cuts; wants to turn it into a police force	Against	Sees it changing into a USA lead aggressive mondial operating organization	Wants a military and foreign policy that needs no "bombers"
VVD	Pro	Pro	Pro	Pro
PvV	"Increased efficiency"	Only economical co-operation	Wants the Armed Forces only to participate in NATO missions	Pro
Groenlinks	Wants a united European army so money can be saved	Pro	Wants to have it changed into regional peacekeeping organizations	Pro

Table 3: Points of view Dutch political parties

The 'old' political parties, CDA, PvdA & VVD, don't differ much on above items. Groenlinks, a rather pacifistic party, wants a decrease in the defence budget, but recognizes the need for armed forces for peacekeeping missions. The PvV can be regarded as a nationalistic orientated party and is rather new at the political scene. Their international points of view are not clear yet. Although a socialist party, the SP too can be regarded as nationalistic. It is against the EU and in a fact also against NATO. According to the SP NATO has become an aggressive organisation that should be changed into a safety organisation. Dutch soldiers should only participate in peacekeeping missions under strict conditions and no peace-enforcing missions. Above points of view can be found in the parties' Internet websites.

The Dutch political parties also think the European Union should play a more important role in peacekeeping missions. A European army should replace the numerous national armies. This European army would be more efficient than all these European national armies and it would save a lot of money. But the EU seems to be powerless, frustrated by internal squabble. Furthermore, by participating in (large) missions (peacekeeping or combat) individual countries can perpetrate international policy. They can distinguish themselves from other, passive countries, as shown by Italy, who hopes to return to the World's greatest powers by participating in the UN peacekeeping mission in Lebanon¹⁵⁹

¹⁵⁹ "Prodi trots op 'delicate missie' "(Prodi proud on delicate mission); *NRC Handelsblad*; 30 August 2006.

Similar to the national network a global network can be drawn up, see the next figure.

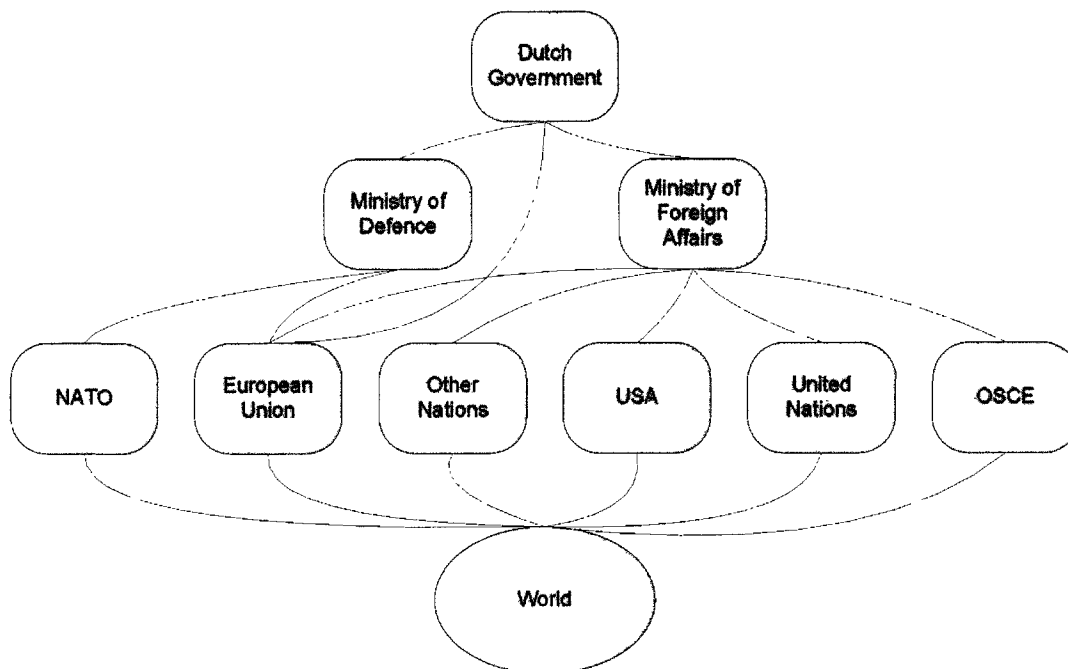


Figure 25: The Global Network

The scheme above is just a summary of the most important players. NATO, the European Union and the UN can be seen as today's most important international organisations. NATO, once established to defend the 'free Western World from the Warsaw Pact, is orientating increasingly on worldwide missions like ISAF in Afghanistan. However, if this ISAF mission fails, this might be the beginning of the end of NATO. The European Union has grown to 27 countries over the last few years. This increase in members did not increase EU's power, as it seems. The differences of opinion in the EU have grown as well, which hampers decision making. The United Nations, and in particular the Security Council, is in charge of international safety and stability. In this 15-members council, the five permanent members, China, Great-Brittan, France, Russia and the USA, have the right of veto to prevent the adoption of a proposal. As a result, one of these five nations can halt the decision making process, regardless of the opinions of a majority of nations. This may cripple any possible UN armed or diplomatic response to a crisis. Although Russia did use the most vetoes, the USA had a 69% share of all vetoes since 1984¹⁶⁰. Being the last superpower, the USA play a major role on the world stage and, therefore, show up separately in the above figure. The USA is so powerful compared to other nations and organisations; it does not need to wait for an agreement on certain issues to act. Although many times a quiet player, the Organisation for Security and Co-operation in Europe (OSCE) plays an important role. The OSCE works with "preventive diplomacy" and does not have a military force to its disposal, nor will it ask NATO or any other organisation to interfere with military means¹⁶¹.

The Netherlands are member of NATO, the EU, the UN and the OSCE. The Dutch Government advocates a strong and reliable United Nations; it wants however a

¹⁶⁰ http://en.wikipedia.org/wiki/United_Nations_Security_Council

¹⁶¹ www.osce.org

reformation of the Security Council and an improvement of the UN management. NATO and the trans-Atlantic relationship with the USA (and Canada) stay essential for Dutch national safety as international safety¹⁶².

In the near future the European Union might become an important factor for the Dutch Armed Forces. Most EU members feel the need for a better collaboration between the individual European Armed Forces. This wish for collaboration was stated in the European Constitution that had to be rectified by all members in 2005. The Constitution states, amongst other things, that EU members are obliged to improve their military capabilities¹⁶³. As the EU wants to have a European defence force, with the Constitution, EU member states are committed to contribute to a European defence organisation. A close cooperation between EU member states is therefore essential. To improve this cooperation, an EU Defence Agency is established¹⁶⁴. The tasks of this agency are, amongst others;

- helping the member states in determining their military capacities and their ability obey to these rules,
- Supporting, coordination and scheduling research on military technology so that future operational requirements will be met.

The EU Minister of Foreign Affairs can propose to take part in a mission, but this proposal has to be approved unanimously by the member states.

The Dutch and French population rejected the EU Constitution in 2005. This fact delayed the rectification of the Constitution and till today it is unclear when this Constitution comes into operation.

Most international relations will go through the Ministry of Foreign Affairs; where as the Ministry of Defence will be involved in most military relations. The international employment of Dutch armed forces does need a co-operation between the Ministry of Defence and the Ministry of Foreign Affairs. The employment has to be agreed upon in the Cabinet; an agreement of the Parliament is not required.

The relations with the European Union are more diverse. The head of states meet in the European Council, while the individual ministers have contact through the Council of the European Union.

Finally an economical network can be made. In this scheme the national industries have connections with the national governments, hoping they might pull some strings.

¹⁶² Press Release Dutch Ministry of Foreign Affairs; 19 September 2006;
www.minbuza.nl/nl/actueel/persberichten.2006/09/Persbericht-Prinsjesdag-2006.html

¹⁶³ www.grondweteuropa.nl; article I-41

¹⁶⁴ www.eda.eu.int

Dodging UCAVs censured

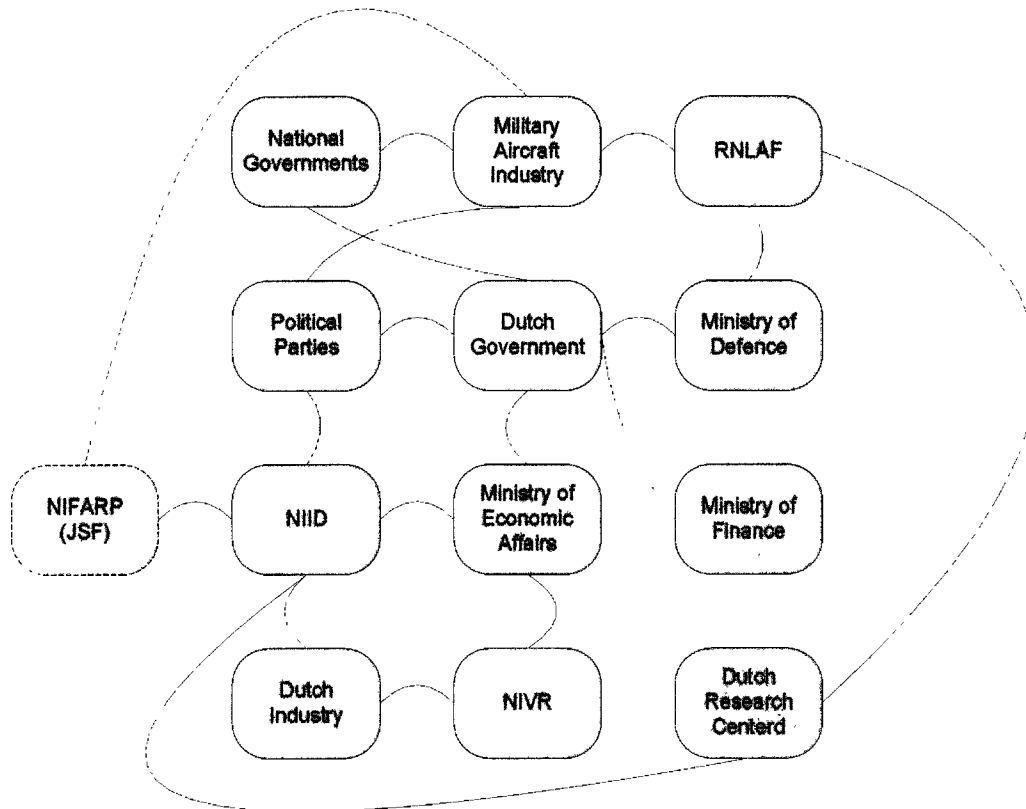


Figure 26: An Economical Network

In the picture above only the official lines are drawn. From the articles in newspapers and newsmagazines it can be concluded some unofficial communication lines are operative as well¹⁶⁵. The fact that Dutch industry could also profit from defence projects, made them unite into the Stichting Nederlandse Industriële Inschakeling Defensieopdrachten, NIID (or; Foundation Dutch Industrial Enlisting Defence Orders). With the NIID, 179 companies are hoping to profit as much as possible from orders for the Dutch armed forces. For the intended successor of the ageing F-16, the JSF, all aircraft related industries are united in the NIFARP (Netherlands Industrial Fighter Aircraft Replacement Platform). The general belief is that the Joint Strike Fighter could become a very lucrative program for the Dutch industry. The NIID will do its best to convince the government to continue with SDD program. They will do so by lobbying at the Ministries of Defence and Economical affairs and at some, pro-fighter, political parties¹⁶⁶. The NIID expects that the purchase of the JSF will be the final result joining SDD program (“when you spend 920 million euros in the development of an aircraft, you will not look for another aircraft in the end”)¹⁶⁷. The Ministry of Economical Affairs will want to increase employment by either orders for the Dutch industry or technological development. To promote the Dutch aircraft industry the Nederlands Instituut voor Vliegtuigontwikkeling en Ruimtevaart, NIVR, (or Dutch Institute for Aircraft development and Space) was established by five Ministries (Economic Affairs, Transport & Public Works, Defence, Treasury and Education & Science) in 1947. All relation go through the Ministry of Economical Affairs.

¹⁶⁵ Ko Colijn and Freke Vuijst; “De Holland-Amerika-lijn”; *Vrij Nederland*; 13 mei 2006

¹⁶⁶ www.ochtenden.nl/aflleveringen/10558946/

¹⁶⁷ ir. J.H. (Hans) Dibbetz as quoted in the article “Luchtgevecht” by Joeri Boom in the magazine *De Groene Amsterdammer*, 23 March 2002.

Dodging UCAVs censured

To be able to predict the requirements needed in the threat environment in which future fighters like the F-35 have to operate, research centres like the NLR (Nationaal Lucht- & Ruimtevaartlaboratorium, or National Aerospace Laboratory) and TNO (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, or Dutch Organisation for Applied Science Research) assist the RNLAF with these matters. New technological developments are a cause of the increased threat levels, but technological developments may also offer the solution. For the JSF program the NLR and TNO have assisted the RNLAF. The USAF presented the RNLAF the Systems Threat Assessment Requirement (STAR) document, in which the future levels of threat are drawn. Together with a similar document of the Dutch Military Intelligence Department (MIVD), the NLR and TNO were able to draw up requirements for the JSF design¹⁶⁸. TNO and NLR are both member of the NIID.

And finally, although not an active member in this process, the Ministry of Financial Affairs will watch the costs of the project.

The network above is the 'official' network; unofficially there are other networks as was illustrated by the radio program "De Ochtenden"¹⁶⁹. The military industry will do its best to convince political parties that the Netherlands should purchase their aircraft. While some parties are to be said pro-American (VVD), others are said to be pro-European (PvdA). Foreign governments will try to promote their national industries.

For the replacement of the F-16 the complete scheme may look as is shown in the next picture;

¹⁶⁸ Major A. Steur, Projectteam Replacement F-16, Defence Materiel Organisation.

¹⁶⁹ www.ochtenden.nl/afleveringen/10558946/

Dodging UCAVs censured

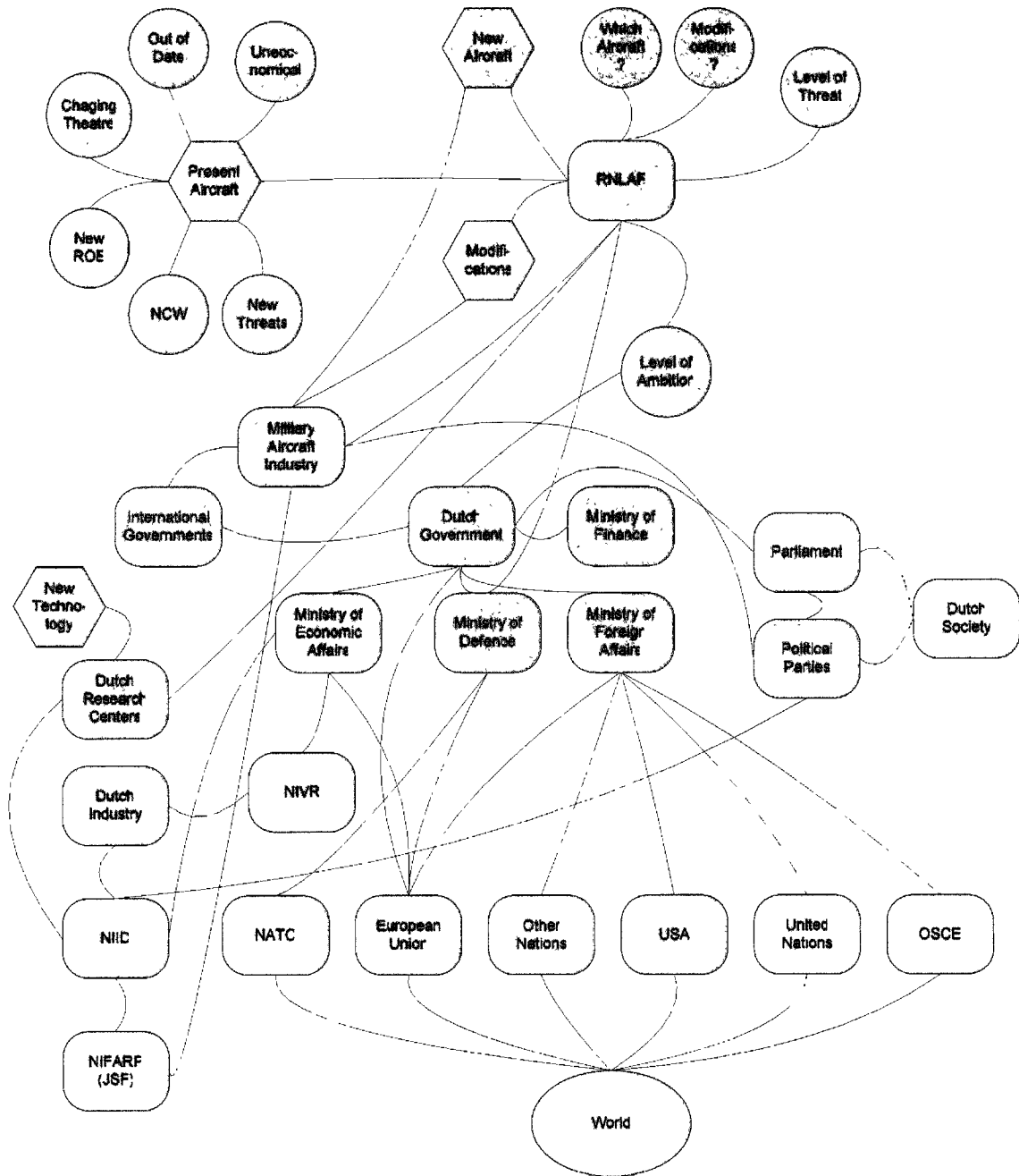


Figure 27: Chaos?

6.4 Phases

As the previous paragraphs show, the RNLAF, the government, several Ministries, Parliament, political parties, the media, national research centres & industries and international organisations play a role in the decision making process. This makes purchasing military material a complex process. To cope with this complexity the Dutch Ministry of Defence initiated the Defence Material Process (DMP) for projects beyond € 5 Million in the 1980's. The DMP process is being evaluated every few years, the last time in 2002, as described by a letter to the Dutch parliament in 2002¹⁷⁰. The DMP for large non mandated projects is divided into five phases. In the

¹⁷⁰ van Hoof; Defence Secretary of State; Letter to Parliament M2002002420; The Hague; 2002

DMP-A document for example the need for combat aircraft may be defined. In the next phase, phase B, a pre-selection the choice is made which aircraft are qualified for the operational requirements. Several alternative aircraft are described and a shortlist is made. During this phase the Ministry of Economic Affairs and the NIID consult on the feasibility calling in the Dutch industry. In phase C the alternatives are compared to each other and a choice is made. This choice can mean buying a product 'of the shelf' or participating in the development of a new design. In phase D the final choice is made for product and manufacturer. For project beyond 250M€ an evaluation has to be done; phase E. At the end of each phase parliament is informed about the outcome and the intentions for the next phase. Parliament can ask questions by letter or may ask for a general meeting to discuss the outcome and intentions

Phase A describes the theorem for need and is initiated by the Commander of the Armed Forces. This first stage is of great influence of the whole process. The final DMP-A document describes the desirable capacity in material first. Next a more concrete need for material is filled in. Also all alternatives are mentioned. With this data it must be made clear to the Dutch Parliament why the choice was made for that kind of equipment. The DMP-A document should describe, amongst other, the following points of attention;

- A clear definition of the need for these material according plan-documents, policy goals, plan alternatives, preferred plan proposal and under lying operational concepts.
- Demands of quality and quantity to the new material.
- Consequences for personnel, material, organisation, logistics, infrastructure and operation.
- Possibilities of co-operation with army, navy or international defence departments.
- Relevant legislation and regulations.

The whole process is a kind of teamwork between the Air Force¹⁷¹ and the Ministry of Defence, to convince the Parliament to agree. The case of the F-16 replacement can be used as an example of the DMP. On 9th April 1999 the Dutch State Secretary of the Ministry of Defence informed the Parliament with a letter to this Parliament of the need for replacement of the F-16. Besides the reason for replacement (reaching the end of its life span), the operational need was described, as were alternative solutions and the possible involvement of the Dutch industry. As a 'trial' the amount of money involved was estimated at fl 10,000,000,000.- (1998 price level).

During the MPD-B/C stage, several combat aircraft were compared with these requirements. The list of aircraft existed of the Eurofighter *Typhoon*, Dassault's *Rafale*, Saab's *JAS-39 Gripen*, Boeing's *F-18E Super Hornet*, Lockheed-Martin's *Advanced F-16* and the possibility of prolonging the service life of the current F-16s. A request for information containing about 700 questions was sent to the manufacturers. In February 2002 Parliament was informed about the outcome of the study (Multi Criteria Analyse, MCA)¹⁷²; the American JSF met the RNLAf's requirements best. Mid 2002 a memorandum of understanding was signed by the Dutch government with the US government to participate in the JSF System Development & Demonstration phase. This enabled the RNLAf to participate in the JSF development process. Since then DMP process transitioned from stage B/C to

¹⁷¹ Today it is the Defence Materiel Organisation; this will be described farther down this chapter.

¹⁷² Letter to Parliament M2002000176, 11 February 2002

D; the acquirement stage. This stage will last till 2013. The signing of the SDD MoU (Memorandum of Understanding) does not imply the RNLAf will indeed buy this aircraft. Presently one prototype of the JSF is flying and a second one will follow shortly but it still has to prove itself. The RNLAf intends to buy one JSF in 2011 and one in 2012 for the Operational Test and Evaluation¹⁷³. The first six operational JSFs should enter the RNLAf in 2014; as the JSFs have to be ordered four years in advance, the decision whether or not to continue with the JSF has to be made in 2010. In the beginning of 2010 a supplementary 'D-letter' should be sent to the Parliament for the decision of the first batch¹⁷⁴. Yet, as illustrated previously, having spent 800 millions euros into the JSF SDD program, the chances the F-35 will not be the chosen one are very slim. Participating in this SDD program is a controversial issue. The uncertainty about the yield of the 800 million euros the Government spent to join the SDD program, makes the political left wing parties sceptical about this program. Besides, the JSF is still in the middle of its developmental Test and Evaluation stage. The final 'fly-away' costs have not yet been determined. The price tag for one F-35 could end-up well above the present estimated 45 million dollars, as they fear. As a lot of money is involved, they want the Government to cancel the participation and buy aircraft 'off the shelf'.

And then there was still the unmanned combat aircraft. The cabinet could have decided to purchase only half the number of F-35s initially. If in the meantime suitable unmanned combat aircraft become available, the Dutch government could have prefer purchasing them in stead of the remaining F-35s¹⁷⁵. This scenario is not valid anylonger¹⁷⁶.

Despite the Defence Material Process, the replacement of the F-16 is still a process with many backstage scenes. For instance, a bad handling of the JSF issue meant the decline of the successor of the leader of the Partij van de Arbeid (PvdA, or labour party) in 2002¹⁷⁷.

It is remarkable to see that the acquisition of the JSF is under the same discussions as the F-16 in 1975. These discussions take place in the Parliament and media (newspapers, newsmagazines, television and radio). During a broadcast of VPRO's *de Ochtenden* of 21 February 2003 some critics raised questions about the Dutch commercial success of the JSF program, the role of the RNLAf and whether the JSF would be out-of-date because of the development of the UCAV¹⁷⁸.

6.5 Ministry of Defence

So far three actor networks have been shown and the Defence Materiel Process has been explained. Nothing has been said about the main actors of this play; the Ministry of Defence and the RNLAf. Although both were mentioned separately in above networks, in fact, they are one and the same; the RNLAf is part of the Ministry of Defence.

Until now we have been speaking about the RNLAf. But the RNLAf as such does not exist anymore. The Dutch Armed Forces were reorganised after the 2002 budget

¹⁷³ These are actual standard operational aircraft, meant for the F-35 OT&E (Operational Test & Evaluation) phase (Maj. A. Steur).

¹⁷⁴ Major Trouerbach, Staff Member Project Bureau Replacement F-16; Powerpoint presentation F-35 Joint Strike Fighter; January 2007. Note: All plandates are subject to change.

¹⁷⁵ Defence's Secretary of State, Mr. Van der Knaap, at a NIID conference October 2005.

¹⁷⁶ Major A. Steur.

¹⁷⁷ Eric Vrijssen; "Gevecht om een Vliegtuig"; *Elsevier*, 12sep2002.

¹⁷⁸ www.ochtenden.nl/afleveringen/9964335/

cuts. Materiel was disposed of and jobs were cut. The Materiel departments of Navy, Army and Air Force were joined, forming the Defence Materiel Organisation. The separate services were joined under one commander. For the RNLAf this meant the name was changed into Command Air Forces (Commando Luchtstrijdkrachten, CLSK). The new organisation chart is shown below.

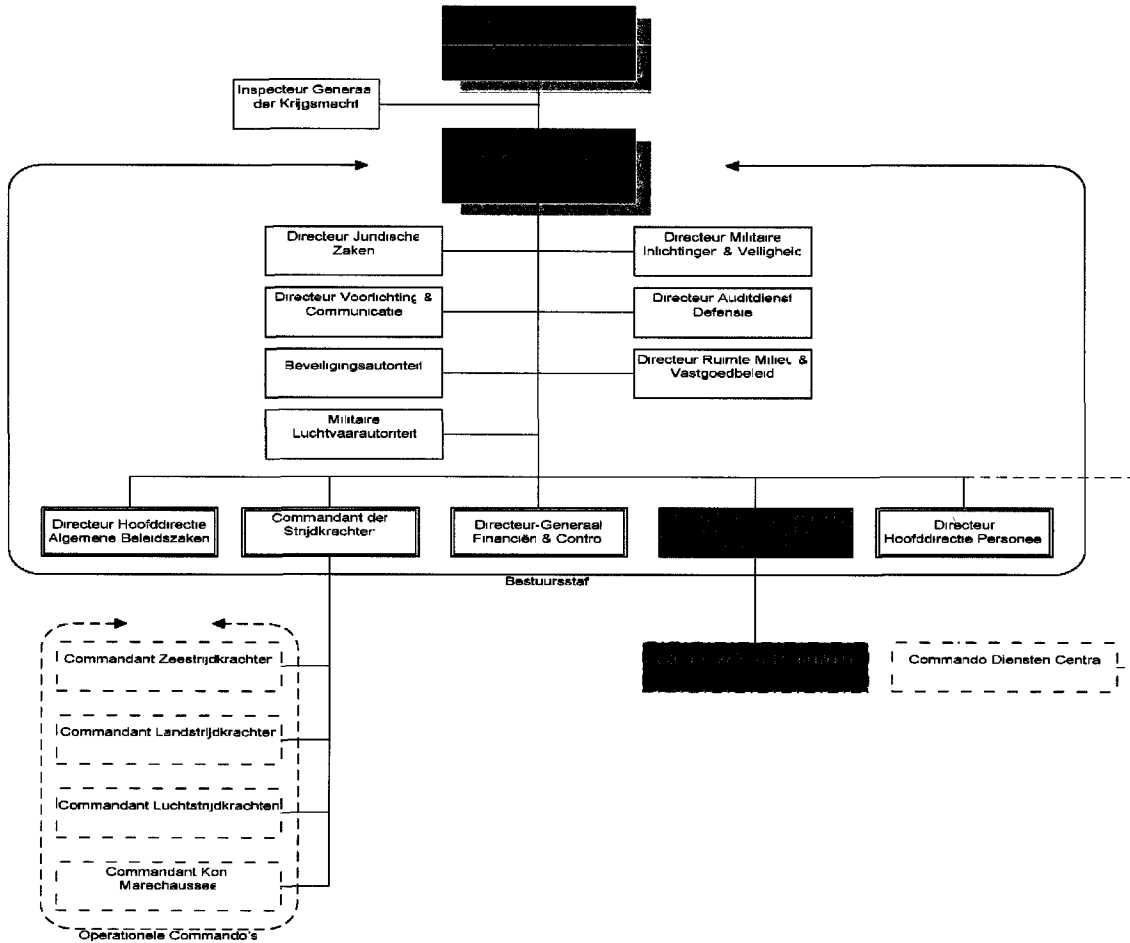


Figure 28: Dutch Ministry of Defence

Within this organisation three departments play a role in the Defence materiel decision process; Directorate of General Policy Issues, Commander Armed Forces and the Defence Materiel Organisation.

The Directorate of General Policy Issues gives recommendations about national and international policies and social factors which could be of influence for the Defence policy. Although not directly involved in the decision process, it can present conditions that can influence this process. In their View of Policy 2008 this directorate gives a guideline to the Defence Materiel Organisation to perform a study in enlarging the innovative capabilities of the defence organisation¹⁷⁹.

The Commander of the Armed Forces commands all Armed Forces, Air Force, Army, Navy and the Military Police; the Operational Commands. The Commander of the Armed Forces has three directorates (not shown in the picture above); one of them is the Directorate Operational Policy, Requirements & Planning¹⁸⁰. This directorate coordinates these issues with the Operational Commands and advises the

¹⁷⁹ *Beleidsvisie 2008, Nieuw Evenwicht, Nieuwe Ontwikkelingen*, p14; Hoofddirectie Algemene Beleidszaken; August 2006.

¹⁸⁰ In Dutch: Directie Operationeel Beleid, Behoeftstellingen en Plannen (DOBBP)

Dodging UCAVs censured

Commander. It is here where the DMP A document, or the specification of their needs, is initiated. Army , Air Force and Navy are represented within DOBPP.

The Defence Materiel Organisation takes care of the Defence materiel during the whole life span; from acquisition, depot level maintenance till disposal of the materiel. The DMO consists of five departments, or directorates; Policy, Planning & Control, Personnel & Organisation and Projects & Acquisition. The first and the last directorate, Policy and Projects & Acquisition, play a role in the materiel decision process.

The Directorate Policy consists of another five divisions; Research & Development, Materiel Co-ordination & Control, National Armaments Director's Office and the Materiel Attaché Washington. In the materiel process Research & Development and the division Co-ordination & Control play a role. Research & Development is not actually involved in the process, but provides knowledge about technological developments. This division has close contacts with Dutch research centres. The division Co-ordination & Control is engaged within the DMP, it recognizes political-governmental risks in the materiel-logistic process and it advises the minister about these issues.

The Directorate Projects & Acquisition is, as already suggested by its name, involved in acquisition of (new) material and projects. One of these projects is the replacement of the F-16.

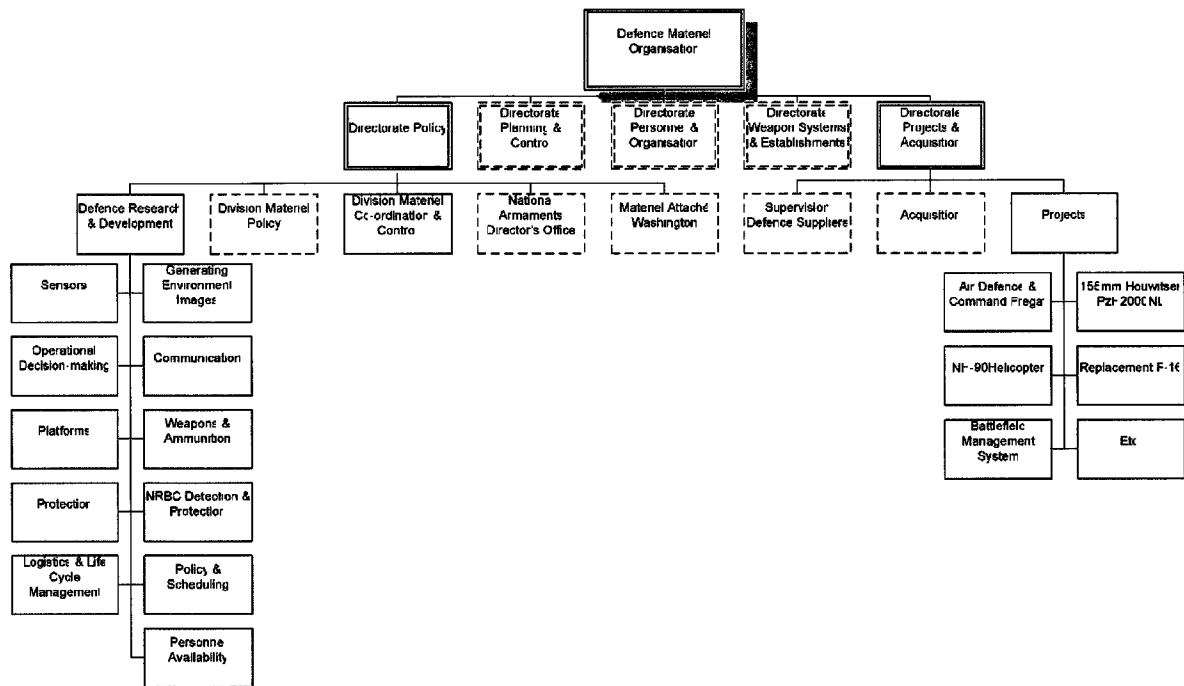


Figure 29: Defence Materiel Organisation

The project team Replacement F-16 analyses the RNLAf's need for a new aircraft and evaluates the candidates. Before the forming of the DMO, this project team was part of the RNLAf. Despite the move to the DMO, this project team is composed mainly of (former) RNLAf officers. Two CLSK officers (F-16 pilots) are posted to this project team.

6.6 Deciding Actors

So far we've gone through all the actors that are involved in buying new fighter aircraft. This study, however, is about whether unmanned fighter aircraft would ever replace the manned aircraft. For this issue the number of actors can be reduced significantly. Military aircraft manufacturers and foreign governments are interested in selling aircraft, whether manned or not is not an issue. The Dutch industry is only interested in participating in these projects, once more, manned or not is not an issue. To all international organisations it's not an issue either. The actors that do play a role in the unmanned issue are the DOBBP, CLSK, DMO, the Dutch Government, the political parties and the research centres.

To start with the last, unmanned combat aircraft might mean additional research and therefore additional revenue. However, until now the TNO reports advice against the acquisition of UCAVs. According to TNO report TNO-DV1 2005 A104¹⁸¹, UCAVs can only exist complementary with the manned aircraft. One of the major disadvantages of remote controlled aircraft is the limited bandwidth; during Iraqi Freedom a maximum of four Predator aircraft could be operated at the same time. Autonomous operations, a solution for the limited bandwidth, are said to be not feasible by a long chalk. With their reports the research centres could influence the decision process. When these Research Centres issue reports independently, then they can be seen as an actor. When, on the other hand they are fed by another actor to proclaim this actor's opinion, they are merely a tool.

The view of the Dutch Ministry of Defence should be the same as that of the Government. However, the RNLAf plays an important role in this matter. DOBBP may initiate the need for a new aircraft; (pilot) officers play an important role in defining the need for a new aircraft. In the domain of operations, tactics and strategies (fighter) pilots have their way. They are the ones that fight enemy aircraft or drop a bomb for CAS, so they should tell what is needed. The issue manned or unmanned should be still open. Although the DMO project team analyses the defined need, the fact that this project team is composed of (former) RNLAf officers, their sentiments will not differ much. So the manned aircraft will be preferred and when there are no forces against this preference the next combat aircraft will be a manned one. Stories about UCAVs taking over the role of the manned fighter have become more and more numerous over the last few years. Maybe to tone down these stories, the RNLAf states that it will take at least another 30 years before the UCAV will become feasible^{182, 183, 184, 185}. This statement is founded on reports like the TNO report mentioned above and other international reports.

In the future the affection of fighter aircraft like the F-16 and JSF may decrease as the number of these aircraft within the RNLAf decreases. Furthermore, the importance of transport aircraft like the (K)DC-10 and the Hercules and transport helicopters like Chinook and Cougar increases fast, while the Apache attack helicopter represents a feared rival to the fighter aircraft in some scenario's. Pilots flying these aircraft will fill more and more management positions in the future. As a result the sentiments for manned aircraft within the RNLAf might get weakened to a

¹⁸¹ Bos, A.H.W., Visser, B.J. & Stiefelhagen, M.; *UCAV's: het einde van het bemande gevechtsvliegtuig?* (UCAVs: the end of manned combat aircraft?); TNO report TNO-DV1 2004 A104; TNO 2006.

¹⁸² www.mindef.nl/dossier_vervanging_f16/veel_gestelde_vragen/vervanging/index.aspx; question no. 9.

¹⁸³ Letter to Parliament 11 February 2002.

¹⁸⁴ RNLAf's *Air Power Doctrine*, p105; 2002

¹⁸⁵ www.luchtmacht.nl/vluchtdoortijd/tijdvakken/toekomst/watgebeurdeermeer/onbemandetoestellen.html

Dodging UCAVs censured

level that UCAVs may be considered as an option in the long term. This development will not endanger the acquisition of the manned JSF. For the short term, however, the position of the manned aircraft may be endangered by a very influential group of actors; the politicians.

To a political party the UCAV might be an interesting alternative for the manned fighter. When shot down, there is no loss of RNLAf lives. And according to some stories the UCAV is much cheaper, although this might turn out to be not true¹⁸⁶. Nevertheless, the political parties might turn out to be a powerful pro-UCAV actor. To get a clear view about the point of view of the six largest parties, following questions were sent to these party's spokes(wo)men by e-mail;

- What is your (or your party's) point of view on combat aircraft? Hoe kijkt u (of uw partij) aan tegen het gevechtsvliegtuig? Denk daarbij aan het voorbeeld van de auto. U mag meerdere kwalificaties geven.
- Do you think it is necessary for the RNLAf (and as a result the Netherlands) to possess combat aircraft?
- Should these aircraft be 'state of the art'?
- Should these aircraft be manned or, at the contrary, be unmanned?
- Why manned or particularly unmanned?

Unfortunately only three out of six answered these questions. Following answers were given;

Mr. Boekesteijn (VVD): Close air support is of great value during peacekeeping missions. The Netherlands should therefore possess of 'state of the art' fighter aircraft. Unmanned aircraft will be the future, the JSF will become unmanned as well¹⁸⁷.

Mr. Brinkman (PVV): Fighter aircraft should be fast and smart. Like the car 'Smart', fast and practical. Based on a sound study the RNLAf should specify their needs. Unmanned aircraft are to be preferred during dangerous missions.

According to Groenlinks the combat aircraft is an inevitable evil. For peacekeeping missions the Netherlands should have some combat aircraft to protect its own forces. They should be safe to operate, but do not need to be state of the art. Although Groenlinks is aware of the advantages of UCAVs, it has no clear total view of all advantages and disadvantages.

From these three answers no clear statement can be drawn up. To get an idea of the points of view of those parties, which did not answer the questions; their individual websites on the Internet were visited to look for possible answers on the UCAV issue. Democrats '66 (D66) stated in their election program 2002 – 2006 that "for the replacement of the F-16 more attention should be paid to the possibilities of unmanned aircraft"¹⁸⁸. This party was decimated during the November 22nd 2006 elections and does play only a marginal role since then. Unfortunately on the websites of CDA and PvdA, no statement about UCAVs could be found. The SP states that no premature decisions about the JSF should be made, because by the time the F-16 is out-of-date, "technological and military developments may justify a

¹⁸⁶ See chapter 5; UCAV; Past, present and Future Developments

¹⁸⁷ Lockheed Martin has proposed an unmanned version of the JSF; www.washingtonpost.com/wp-dyn/content/article/2006/08/15/AR2006081501288.html. However, one of the advantages of the UCAV should be the lower costs. It is hardly imaginable that an unmanned JSF would cost significantly less than a manned version.

¹⁸⁸ <http://archieff.d66.nl/veilige%20wereld>

completely different acquisition"¹⁸⁹. But then again, the SP doesn't want bombers at all. So, none of these websites do shed a light into this matter.

6.7 Sub Conclusions

Many actors are involved in the acquisition of new fighter aircraft, but only a few are involved in the decision process of whether it will be manned or unmanned. These actors are DOBBP, CLSK & DMO (for the Dutch Ministry of Defence), the Dutch research centres and the Dutch politicians. The reports by the research centres may influence the decision process; either pro or contra unmanned crafts. As long as the need for new combat aircraft is defined by (fighter) pilots, manned aircraft will be preferred. Although there has been some talk about unmanned combat aircraft, the view of the Dutch politicians is not uniform; some favour unmanned aircraft, while others have no plain point of view yet. However, the lifespan of the F-16 will be 40 years; as long as the RNLAF is the single organisation initiating the need for a combat aircraft and it can convince the Government to purchase the JSF, the manned near future for the RNLAF is guaranteed.

Hence, according to the theory of Social Construction of Technology (SCOT) technology development is a sociological process rather than the result of engineering efforts. To most artefacts this may be true. However, in the case of the next generation manned or unmanned aircraft the outcome may be highly influenced by engineering efforts, as the next chapter will describe.

¹⁸⁹ www.sp.nl/standpunten/cd_223/standpunt_over_isf.html

7 Developing Combat Aircraft

According to Mary Kaldor developing modern weapons systems has become the creation of a baroque arsenal¹⁹⁰. Aircraft, main battle tanks, battleships, they all have become excessively complex. This developing of armament takes its toll of the national economies. Kaldor can be seen a pacifist, so in that respect, her views and the objectives of this study may be diametrically opposed. However, she has some interesting points of view. Weapons systems have indeed become very, very expensive during the last decades. The military industry is in a crisis and many can't guarantee stable employment¹⁹¹. To survive times of (relative) peace, many weapon manufacturers merged. Kaldor wrote her book 25 years ago, 9 years before the collapse of the USSR. Since then, the world has changed. What about the military industry since then? Let us have a look in the history of developing of some well known combat aircraft and what is left of the industry. By doing so, we might be able to predict the prospects for combat aircraft.

7.1 Combat Aircraft

One of the best known WWII fighters was the Supermarine Spitfire. Development of the Spitfire started January 1935. By March of 1936 the prototype flew for the first time on 5 March 1936. This prototype cost £20,765¹⁹². The British Air Ministry issued a contract for 310 *Spitfires* on 3 June 1936 and the first were delivered by August 1938. The cost for a *Spitfire* was about £15,000.-¹⁹³. During its successful career the original design underwent many changes; around 40 different variants were built. The last of the more than 20,000 *Spitfires* was built in 1947.

Jet aircraft took over the duty of defending the skies from the piston engine powered aircraft. The first generation jet fighters had straight wing, just like their predecessors. As a paradox, the first operational jet fighter, the Me-262 *Schwalbe*, had swept wings, although initially designed to have straight wings. Increased engine diameter caused weight & balance problems, which had to be solved by sweeping the wings backwards 23 degrees. This configuration increased its aerodynamic performances. Because of these better aerodynamic figures, the next generation jet fighters had all swept wings. Development of one of these second generation jet aircraft, the Hawker *Hunter* started in 1948, with the prototype's first flight in June 1951. The first production *Hunters* were operational in 1953, although these were more or less used for development and evaluation purposes. In 1955 these F1 *Hunters* were replaced by the F4 variant. At the end of the 1950s combat aircraft, capable of flying beyond the speed of sound, came available. This made the *Hunter* obsolete as an air superiority fighter. It could however, prolong its career as an air-to-ground attack aircraft. A total of 1927 *Hunters* were built.

With the third generation the supersonic era started. The war in Korea stood at the birth of the successor of the *Hunters*. The American pilots in Korea wanted "speed and altitude". With this in mind, Lockheed's chief designer, Kelly Johnson, returned home in 1951, to build the first Mach 2 jet fighter. The Lockheed XF-104 flew for the first time in February 1954. It was fast, but had poor dogfight capabilities. The idea was to penetrate enemy airspace at high speed, benefiting from stealth-like features

¹⁹⁰ Kaldor, M.; *The Baroque Arsenal*; New York; 1981.

¹⁹¹ *Ibid*, p192

¹⁹² www.k5054.com

¹⁹³ http://en.wikipedia.org/wiki/Supermarine_Spitfire

as a very small radar cross section and small visual appearance seen head on. The USAF did not like the F-104 too much, because of its limited range and loading capabilities and lacking all-weather capabilities. The USA bought only 296 *Starfighters* of the 2439 built. The rest went abroad. The USAF's dislike about this aircraft meant the last one was withdrawn from service in 1967. The RNLAf flew with the F-104G *Starfighter* (fly away cost \$1.5M¹⁹⁴) till 1984, while the Italian air force had them in service till 2002.

In 1961 Secretary of Defense, Robert McNamara, initiated the Total Procurement Package philosophy, in which an aircraft was committed to go to production even before the first prototype had flown and without any competitive fly off against rival designs. This led to controversial aircraft as the Lockheed C-5A Galaxy and General Dynamics F-111. Both encountered expensive and time-consuming developmental problems and extensive cost overruns. The General Dynamics F-111 was a multipurpose tactical fighter bomber, capable of supersonic speeds. It was meant to be a supersonic strike aircraft for the USAF and an interceptor for the US Navy, although both did not want the aircraft¹⁹⁵. Development started in 1961, the first prototype flew in December 1964 and the operational ones, the F-111A, were delivered to the USAF October 1967. The version for the US Navy, the F-111B was cancelled. The US Navy had Grumman perform a study of the interceptor capabilities of the F-111. According to this study, the F-111 "could not cope" in a dogfight¹⁹⁶. The US F-111As were withdrawn from duty in 1996, while Australia is keeping them still operational. A total of 563 were built. The costs per aircraft were 75 million dollar (\$FY98).

Another consequence of McNamara was that the McDonnell F-4 *Phantom*, a US Navy long range interceptor, should also be used by the USAF. The *Phantom* had to protect the US fleet, by intercepting enemy aircraft long before they could reach the fleet. It was equipped with long distance air-to-air rockets and had no gun. The USAF used it over Vietnam, where it had to fight North Vietnamese MiGs. These were small, agile aircraft which often had to be fought in dogfights. At close range the US air-to-air missiles proved to be unreliable and ineffective. These dissatisfactions led to the development of the US Navy Grumman F-14 *Tomcat* and the USAF McDonnell F-15 *Eagle*. These were very capable aircraft, but were large and also very expensive (\$38 million and \$43 million).

In the late 1960s a group of USAF jet pilots objected about the fact fighter aircraft becoming ever larger and expensive. They wanted relatively simple aircraft, designed for mainly one task. Although the F-15 was designed as an interceptor, to the opinion of some of the so-called *Fighter Mafia*¹⁹⁷, it was still too large and too expensive. They wanted a successor of aircraft like the North American P-51D *Mustang* or the F-86 *Sabre*, small, relatively cheap and agile dogfighters¹⁹⁸. Vietnam proved that the ability to fight at close range was still valid. This started the Lightweight Fighter program in 1972. This led to the General Dynamics F-16, which first flew in 1974 and became operational in 1979. It beat the Northrop YF-17 in the Light Weight fighter program competition. The latter, in turn, became the F-18 *Hornet*. The F-18 superseded the F-4 *Phantom* in the US Navy. A further development of the *Hornet*

¹⁹⁴ <http://en.wikipedia.org/wiki/F-104>

¹⁹⁵ www.fas.org/man/dod-101/sys/ac/f-111.htm

¹⁹⁶ Grumman developed and manufactured many carrier based fighter aircraft for the US Navy. The successor of the cancelled F-111 was the Grumman(!) F-14 Tomcat (unit cost 38 million USD).

¹⁹⁷ An informal and influential group of US pilots, nicknamed the "Fighter Mafia".

¹⁹⁸ The F-104 Starfighter, although small, was not really a dogfighter.

was the *Super Hornet*, a multi-mission strike aircraft. While the *Hornet* costs \$39.5 million, the *Super Hornet* costs \$60 million. The FY98 price for an F-16 was \$25 million. Compared to the *Hornet* it may look cheap, but in 1975 the cost of an F-16 was around \$6 million. But that was because it was originally thought as a simple daylight dogfighter, armed with one single six-barrel 20-mm cannon and two Sidewinder missiles. In the years to come, the aircraft was transformed into a multi-role all-weather combat aircraft. This fact did, of course, increase the purchase price. However, for air forces equipped with a limited number of aircraft, it's an advantage when more can be done with only one type of aircraft. The multi-role capabilities made the RNLAf decide to replace the (single role) NF-5 attack aircraft with the F-16. Having only one aircraft type would reduce operational costs. Aircraft like the F-15, F-16 and F-18, equipped with numerous computers, fly-by-wire, and many other features formed the fourth generation jet fighters.

The F-16 was supposed to have an operational life of 20 years. It therefore would have to be replaced between 2000 and 2010. But being short of a successor, the RNLAf had to upgrade their F-16s by a midlife update, which not only prolonged its operational life, but also modernised the craft. Developing new fighter aircraft has become difficult as the successor of the McDonnell-Douglas, now Boeing, F-15, the Lockheed Martin F-22 *Raptor* shows. This 'next-generation' air superiority fighter, "designed to penetrate enemy airspace and achieve a first-look, first-kill capability against multiple targets" has a "low-observable, highly manoeuvrable airframe; advanced integrated avionics; and aerodynamic performance allowing supersonic cruise without afterburner"¹⁹⁹. The years before the Russians had deployed their equivalent to F-15, F16 and F18 fighters, in the appearance of the Sukhoi Su-27 *Flanker* and the Mikoyan-Gurevich MiG 29 *Fulcrum* and had very rapidly closed the technological gap. This fact started the Advance Tactical Fighter program in 1986. Two teams of aircraft manufacturers, Northrop/McDonnell-Douglas and Lockheed/Boeing/General Dynamics, competed for the contract. Both teams had their prototypes, the YF-23 and YF-22, flying in 1990. The latter won the \$ 86.6 billion contract for 648 aircraft in 1991. In 1993 this number was decreased to 442 aircraft, while in 1997 this number was decreased once more to 339. The number of aircraft to be delivered is now at 178 aircraft with a total budget of \$69 billion. These figures are still subject to change. Budget cuts and increasing development costs caused these reductions. But also lacking an opponent during a time of war had impact on the decision on how many F-22s would suffice. The F-15 *Eagle* is of no match for the F-22, but on the other hand, hardly any present aircraft is a match for the F-15. Therefore, the F-15 may stay in service along with the F-22, until they have reached a service life of 40 years. One F-22 is said to cost \$130 million. However, on a \$69 billion budget for 178 aircraft, one F-22 *Raptor* will have cost the US taxpayer \$380 million...²⁰⁰.

For a replacement of the F-16 the US Air Force's Multi-Role Fighter (MRF) program was started in 1991. The outcome had to be a relatively low-cost (\$35 to 50 million) single-seat / single-engine aircraft, with a similar size of the F-16. The MRF might also have to replace USAF A-10s strike aircraft, the US Navy F-18s and other aircraft. The end of the Cold War made the F-16 service life situation considerably less critical. The number of USAF fighter wings was reduced, which meant that less aircraft had to be replaced. Furthermore, F-16 aircraft would fly less, which meant

¹⁹⁹ www.globalsecurity.org/military/systems/aircraft/f-22.htm

²⁰⁰ <http://www.globalsecurity.org/military/systems/aircraft/f-22-cost.htm>

that the F-16 could remain in service for a longer period than initially was thought²⁰¹. Because of exceeding the F-22 budget the MRF program was suspended in August 1992 and in 1993 it was cancelled.

Another program that ran more or less parallel with the MRF program was the Advanced-Attack / Advanced/Fighter-Attack (A-X / A/F-X) program. This aircraft would replace the US Navy A-6 and the Air Force F-111, F-15E *Strike Eagle*, and Lockheed-Martin F-117. The program would require \$20 billion for research and development, while it would take up to 20 years before significant operational capability would be achieved. One aircraft was believed to cost \$100 million. Misunderstanding about the already available bomber capacity and misunderstanding about the number and nature of deep strike targets made the program being cancelled in 1993.

Originating from both programs above, came the Joint Advanced Strike Technology (JAST) program, which was to develop aircraft, weapon and sensor technology that would support the future development of tactical aircraft. The final goal was to replace several aging U.S. and UK aircraft. Out of this program came the Joint Strike Fighter (JSF) program. This aircraft had to replace the 'jump jets', the *Harrier* of the US Navy, UK Navy and the Royal Air Force (RAF), as well conventional aircraft like the F-16, F-18 and the A-10. It had to be a multi-role strike-fighter (capable of close air support and tactical bombing as well as of air-to-air combat) and had to be using stealth technology. The fight for this program was between the Boeing Company with their X-32 and the Lockheed-Martin (main contractor) / Northrop-Grumman / British Aerospace (BAe) Systems with their X-35. In 2001 the X-35 was the chosen one. Three variants are planned: the Conventional Takeoff and Landing (CTOL) F-35A for the USAF, the Short Take-Off Vertical Landing (STOVL) F-35B for the U.S. Marine Corps (USMC), the RAF and the British Royal Navy (RN); and the carrier-based (CV) F-35C for the U.S. Navy. Cost per version (2002 figures²⁰²):

- **F-35A:** \$45,000,000,-
- **F-35B:** \$60,000,000,-²⁰³
- **F-35C:** \$55,000,000,-

²⁰¹ www.globalsecurity.org/military/systems/aircraft/mrf.htm

²⁰² www.answers.com/topic/f-35-joint-strike-fighter

²⁰³ According to some sources, the price may be well beyond \$100M

Developing one aircraft for USAF, US Navy and Marine Corps, an estimated 80% commonality would be achieved. This would result in lower procurement and service costs. In fact, this was just the idea that McNamara had in mind in the early 1960s and what went wrong so expensively....

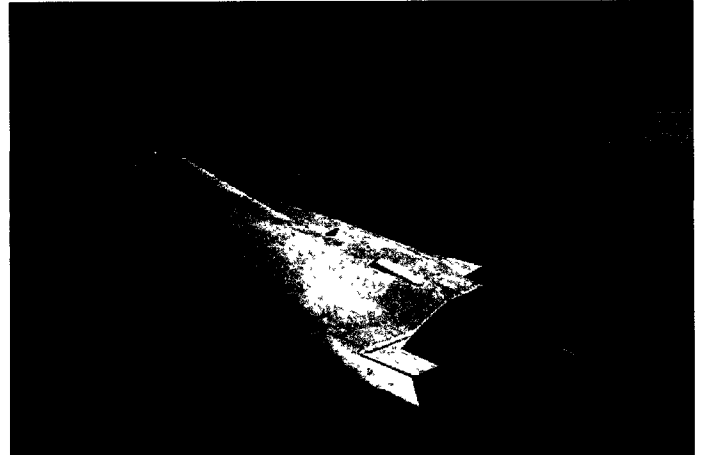


Figure 30: The Boeing X-32; not a winner.

The newest European fighter aircraft are the French Dassault *Rafale* and the British-German-Spanish-Italian Eurofighter *Typhoon*. Initially the French joined the Eurofighter concept, but pulled back in 1985 and started the development of their *Rafale*. The first ideas of a new European fighter came up in the mid 1970s. In 1985 the European Aircraft Program demonstrator (EAP) was rolled out and flew for the first time in 1986. From this demonstrator the Eurofighter *EF2000*, now *Typhoon*, was developed, which flew for the first time in 1994. February 2003 the first operational *Typhoons* saw daylight. Initially the four countries planned to buy 765 aircraft. This was before the decline of the Warsaw Pact. To date the number of aircraft to build is 620. One *Typhoon* would cost about €62 million²⁰⁴, a price comparable with its rival, the French *Rafale*²⁰⁵.

From 1960 till 2000, the fly away costs for a fighter aircraft have gone from \$1.5 (F-104) to \$45 (F-35A) or, in other figures, a duplication of 30 times. If we correct these figures with the US inflation from 1960 till 2005²⁰⁶, the increase of cost would be 4.6 times. Of course, an F-104 can't be compared with an F-35A. The latter is much more sophisticated, being a multi-role fighter with lots of sensors for Network Centric Warfare and capable of precision bombing. But purchasing an F-35 will weigh much more on the defence budget. Both the F-22 and the F-35 possess stealth features, in shape and technique, which make them low observable by radar. Together with improved situational awareness and network-enabled operations, it makes the F-22 and F-35 the fifth generation jet fighters. The Eurofighter *Typhoon* and Dassault's *Rafale* are missing these last feature(s). This makes them the fourth-and-a-half generation.

In the next figure the prices of the combat aircraft above are compared. The prices are corrected to 2005 USD, in which the euro is put on a par with the USD. The F-22 is left out of this comparison, because of its extreme costs and the fact that it's doubtful any other nation will ever purchase this aircraft. Another remark is about the costs per aircraft; they differ from source to source. But anyhow, the picture below gives a nice representation on the development of the costs per fighter from 1960 till now.

²⁰⁴ www.flug-revue.rotor.com/FRheft/FRH0309/FR0309d.htm

²⁰⁵ <http://en.wikipedia.org/wiki/Rafale>

²⁰⁶ http://inflationdata.com/inflation/Inflation_Rate/HistoricalInflation.aspx?dsInflation_currentPage=1

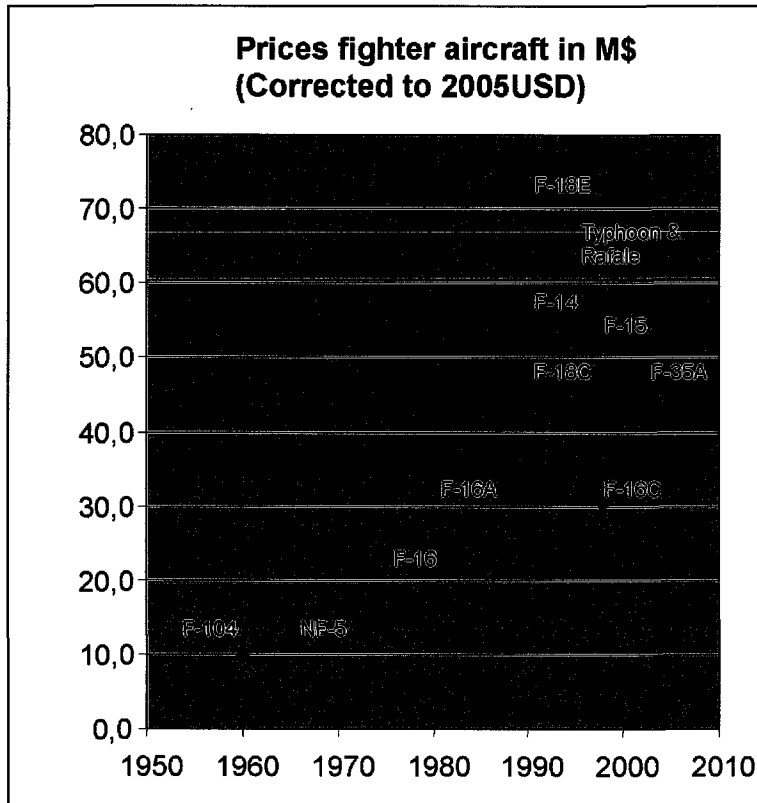


Figure 31: Fighter aircraft prices

Can these increases be justified? The development of next generations US fighters was initiated by new Russian aircraft. What opponent will the \$380 million F-22 face in case of an armed conflict? The most modern Russian aircraft is the Sukhoi Su-35. Britain's Defence Evaluation and Research Agency (DERA) performed a test (simulation based on the available data) comparing the Typhoon with some other modern fighters in how well they performed against the Sukhoi Su-35, with following results:²⁰⁷

Aircraft	Odds vs. Su-35
Lockheed Martin/Boeing F-22 <i>Raptor</i>	10.1:1
Eurofighter <i>Typhoon</i>	4.5:1
Sukhoi Su-35 <i>Flanker</i>	1.0:1
Dassault <i>Rafale C</i>	1.0:1
McDonnell Douglas F-15C <i>Eagle</i>	0.8:1
Boeing F/A-18+	0.4:1
McDonnell Douglas F/A-18C	0.3:1
General Dynamics F-16C	0.3:1

Table 4: Comparing fighter aircraft

These results mean that it takes ten Su-35 before one F-22 is being shot down. The costs for an Su-35 are not known, but the Su-30 (an earlier version) costs about \$38 million. The Su-35 will be more expensive, so according this comparison the idea of

²⁰⁷ http://en.wikipedia.org/wiki/4th_generation_jet_fighter

building such a costly air-superiority fighter is a sensible thing. Thus the 178 F-22s can match 1700 Su-35; the Russian air force possesses 100 Su-35. The DERA comparison was created in the mid 1990s and was a highly theoretical study. Today some more accurate comparisons exist between the F-22 and the F-15, F-16 & F-18 aircraft. During the 2007 Red Flag exercise the F-22 scored an impressive 241 to 2 kill ratio²⁰⁸. But even then the military must be willing to put this expensive weaponry into combat. The big battleships hardly came into action during the First World War, because neither side dared to take the risk of losing one²⁰⁹. Once NATO (or the USA) faces an opponent capable of intercepting NATO's expensive aircraft, will the USA dare to deploy one (or more) of its twenty-one \$2.1 billion B2 bombers? Mutual Assured Destruction may not be necessary anymore to prevent war between superpowers; waging war might simply have become too expensive....

7.2 Fighter Aircraft Manufacturers

At the end of WWII the US had thirteen military aircraft manufacturers. In 2005 only three companies were still involved in manufacturing military aircraft. Boeing lost the JSF competition with its X-32, while Northrop-Grumman did not succeed in winning the Advanced Tactical Fighter deal with its YF-23A. The YF-22A and the YF-23A were each other's match. At that time Lockheed-Martin had only the F-16 in its portfolio. Once this program would be closed and if they lost the ATF competition, Lockheed-Martin would produce no fighter anymore. Boeing and Northrop-Grumman had the F-15 and F-18 programs running that would last longer. This fact could have been of some influence on the final decision to choose for the Lockheed-Martin aircraft²¹⁰. However, by now also the F-15 and F-18 programs draw to an end, leaving Lockheed-Martin the only company working on the fifth-generation fighters; the F-22 and F-35 JSF..

Another remarkable fact is that for developing two JSF prototypes, including avionics, software and hardware, Boeing and Lockheed-Martin were awarded \$750 million each. It prevented Boeing or Lockheed-Martin from getting bankrupt trying to win this competition²¹¹. The period needed for developing a new fighter aircraft has doubled or tripled over the last 30 years. No independent manufacturer can bear these costs themselves. The next table shows an overview of the years of development of some combat aircraft. Note: the development and evaluation period of the F-35 has not ended yet.

²⁰⁸ In fact it was 241 to 0, as those two downed aircraft weren't F-22s but F-15Cs. John A. Tirpak; "The Raptor in the Real World"; *Air Force Magazine* on line; February 2007; <http://www.afa.org/magazine/feb2007/0207raptor.asp>

²⁰⁹ Kaldor, p38

²¹⁰ Kopp, C; *The Advanced Tactical Fighter*; www.sci.fi/~fta/atf-2

²¹¹ www.answers.com/topic/boeing-x-32

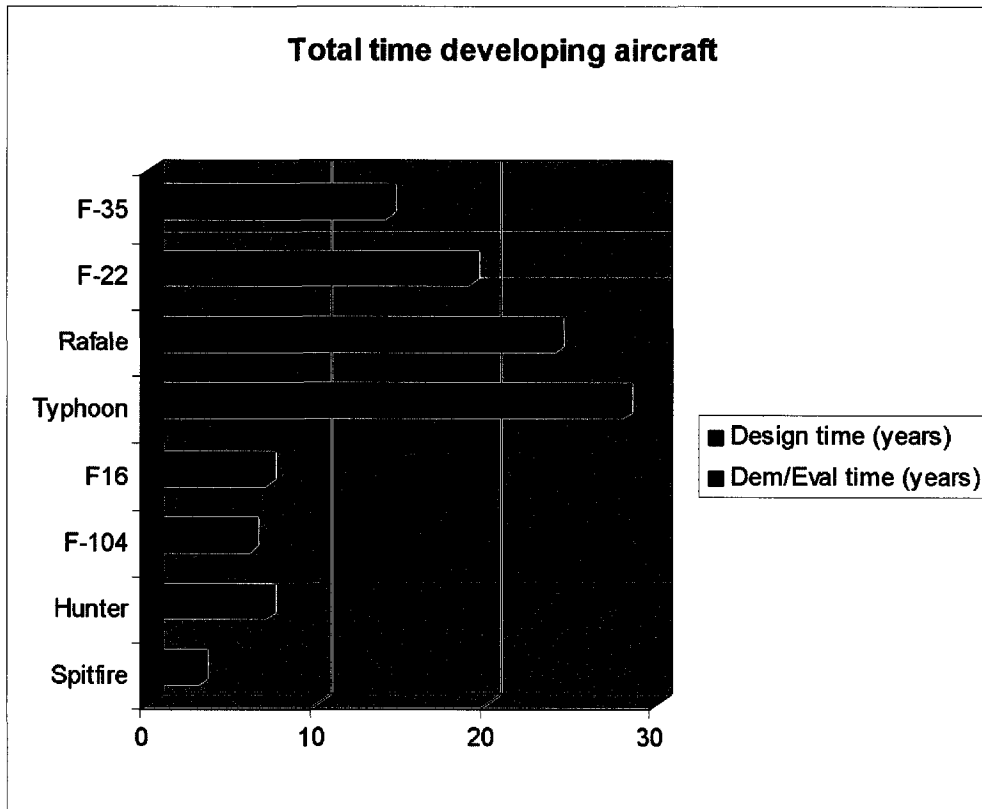


Figure 32: Development time aircraft

Kaldor called the development of modern armament baroque; it is capable far beyond the needs. In a way that may be true. The USA however won the Cold War's arms race over the Soviet Union, by creating ever more capable fighters and other equipment. The final blow came when President Reagan announced the Space Defence Initiative (SDI). This Mother of all baroque arsenals contributed to the break up of the Soviet regime. It could simply not bear the financial strain any longer.

By developing more and more sophisticated and therefore more and more expensive weapon systems, the military industry in a way may be killing themselves. The number of F-22s to produce dropped from 750 to 180. The F-35 may fear the same fate, although this aircraft may be sold to foreign countries. It may well be, once the initial orders have been produced, the production lines have to be shut. Lockheed Martin is facing a gap between the end of the production of the F-22 and the ramp-up of the F-35. They got two options to solve this problem. The first is to sell the F-22 to Japan, "the only country that could afford the F-22". However, besides being extremely expensive, US Congress is blocking the export of USAF technology. The second option is to build the last 60 F-22s over a three year period, an issue Congress has to decide about²¹².

At the time Mary Kaldor finished her *Baroque Arsenal* there were eight companies left that manufactured military aircraft. As already said above, now only three are left, of which only one is producing fifth generation fighters. Because combat aircraft are becoming more and more expensive, it is economically sound to keep the fighter of the previous generation(s) in service as long as possible. 40 years for a fourth, or even third, generation fighter is no exception. The F-22 and F-35 may be kept in

²¹² Doyle, J.M. et al; "Production Band-Aid"; *Aviation Week & Space Technology*, July 31 2006.

service even longer. At some point there will be a gap when the one generation has reached the end of its development and designing the next generation fighter. By the time designing the next generation, all the experience and tacit knowledge may well have been gone...

Finally, complex systems, as modern multi-role combat aircraft are, break down more often than simple ones. It is just a multiplication of one of Murphy's Laws; "Anything that can possibly go wrong, does". And; "If multiple things can go wrong, they probably will at the same time". And without any doubt; the same systems will brake down at multiple aircraft at the same time, exhausting stock in no time. Anyway, maintaining these complex machines takes high-skilled and well-educated engineers. And these engineers are hard to come by. No wonder many focus on unmanned systems now. Among other advantages, which will be discussed in the next chapter, they only need to be deployed when necessary. So, there'll be no wear and tear after a period of operating time. The discrepancies will be limited, reducing the need for high-skilled personnel.

On the next page the decline of military aircraft manufacturers is shown.

7.3 Sub Conclusions

Modern combat aircraft have become very sophisticated and, as a result, very expensive. Another consequence is that less aircraft are needed to achieve the same. Together with the increase aircraft costs, less aircraft were acquired. And these aircraft had to stay in service much longer than initially anticipated. When the enemy has a very sophisticated air force as well, might justify the purchase of the expensive machines. But no other aircraft comes near the F-22 and so the numbers that were ordered dropped from 750 to 182 aircraft. Lacking natural enemies might prove to be a nail to the coffin of combat aircraft as we know today.

Kaldor's final conclusion is that all modern armaments have to be abolished if human civilisation is to survive, however utopian it may sound...²¹³. As a paradox, the military industry might just achieve this! Or be it for the baroque arsenal at least....

²¹³ Kaldor, p230

Dodging UCAVs censured

1945	Transformations	1980	Transformations	2005	Military aircraft activities		
					Fighter	Helicopter	Transport
Bell	Moved to helicopter manufacturing.						
Boeing		Boeing	Merged with McDonnell-Douglas in 1997, creating the Boeing Company.	Boeing	F-15, F-18	AH-64 Apache, RAH-66 Comanche, CH-47F	C-17
Convair	Purchased by General Dynamics 1954. Sold to McDonnell-Douglas in 1994; shut down in 1996.	General Dynamics	The F-16 division was sold to Lockheed-Martin in 1993.				
Curtiss-Wright	Sold to North American in 1948.						
Douglas	Merged with McDonnell forming McDonnell-Douglas in 1967.	McDonnell-Douglas	Merged with Boeing in 1997, creating the Boeing Company.				
Grumman		Grumman	Merged with Northrop in 1994 forming Northrop-Grumman.	Northrop-Grumman			
Lockheed		Lockheed	Merges with Martin Marietta forming Lockheed Martin in 1995.	Lockheed-Martin	F-16, F-22, F-35		C-130
Martin	Merged with the American-Marietta Corporation in 1961 forming the Martin Marietta Corporation.						
McDonnell	Merged with Douglas forming McDonnell-Douglas in 1967.						
North American	Merged with Rockwell in 1967.	Rockwell	Rockwell International was sold to Boeing in 1996.				
Northrop		Northrop	Merged with Grumman in 1994 forming Northrop-Grumman.				
Republic Aircraft	Purchased by Fairchild in 1965.	Fairchild-Republic	Bankrupt as Fairchild-Dornier in 2002.				
Vought	Bought by James Ling in 1961, forming the new conglomerate Ling-Temco-Vought (LTV).	LTV	Vought was bought out by Northrop-Grumman in 1994. Currently an aero structures subcontractor.				

8 Conclusions

We tried to answer the question whether a pilot orientated organisation like the RNLAf will ever choose an unmanned aircraft with the theory of SCOT, the Social Construction of Technology. According to SCOT it is not the engineer, but human action that shapes technology. To understand how and why the technology is used, we had a look into the history of what it is used for (air power), by whom (a.o. the RNLAf), which technological developments occurred (UCAVs) and which actor networks are involved.

From the history of air power we can conclude that, although not being able to win the war on their own, aircraft are the key weapon systems over the battlefield. In combination with ground forces and guided by NCW warfare the aircraft has become very efficient. However, there is still a difference between winning battles and winning the war, as Iraq and Afghanistan show.

The RNLAf's mainstay is the F-16 swing-role combat aircraft. The JSF, a multi-mission aircraft, is meant to be the successor of the ageing F-16. The multi-mission/swing-role concept is an important issue for the RNLAf; with only one type of aircraft all missions can be performed.

The first UCAV made their appearances at the battlefield. Although being actual armed reconnaissance aircraft, their success was widely known soon. All major military aircraft manufacturers started development programs for specially designed unmanned combat aircraft. The US DoD may be aiming at UCAVs for long range or endurance bombers, while European manufacturers are aiming at several missions. These UCAVs will become single mission aircraft.

The limited bandwidth for data transfer to remotely control the UCAV may become a real bottleneck for large scale UCAV operations. As completely autonomous operations by artificial intelligence are not possible by far, the bandwidth problem has to be solved, if the UCAV is indeed to replace the manned combat aircraft.

With its swing-role aircraft, the single-role UCAV would only be complementary to the JSF. However, a mixed fleet of JSF and UCAV raises internal logistical problems. Furthermore, according to the RNLAf it will take decades before UCAVs that can be compared with the JSF, will be operational.

Many actors are involved in the acquisition of new fighter aircraft, but only a few are involved in the decision process of whether it will be manned or unmanned. These actors are DOBBP, CLSK & DMO (for the Dutch Ministry of Defence), the Dutch research centres and the Dutch politicians. The reports by the research centres may influence the decision process; either pro or contra unmanned crafts. As long as the need for new combat aircraft is defined by (fighter) pilots, the focus will be on manned aircraft. And as long there are no forces that can or want to change the focal point to unmanned aircraft, manned vehicles will be preferred. Although there has been some talk about unmanned combat aircraft, the view of the Dutch politicians is not uniform; some favour unmanned aircraft, while others have no plain point of view yet. When we leave a government led by the Socialistic Party out of consideration, the RNLAf will most probably acquire the manned JSF as the successor of the F-16. Even if UCAVs will become available, the RNLAf will not acquire an unmanned aircraft type next to the JSF. Being a multi-role aircraft, the JSF is capable of performing every mission the RNLAf wants it to do. Furthermore, an additional type

Dodging UCAVs censured

of aircraft will claim an extra burden of the RNLAF's operational managements which is already suffering of shortage of (technical) manpower.

Modern combat aircraft have become very sophisticated and, as a result, very expensive. Another consequence is that less aircraft are needed to achieve the same. Together with the increase aircraft costs, less aircraft were acquired. And these aircraft have to stay in service much longer than initially anticipated. When the enemy has a very sophisticated air force as well, might justify the purchase of the expensive machines. But no other aircraft comes near aircraft like the F-22 (and so the numbers that were ordered dropped from 750 to 182 aircraft). As a result it will become increasingly difficult justifying the acquisition of these sophisticated aircraft. This decrease in production numbers causes problems for the aircraft manufacturers to maintain production lines for these aircraft. Many of them merged with others and when the production line of the F-15 and F-18 has ceased to exist, only one manufacturer of combat aircraft exists in the USA. And this one, Lockheed Martin, will only be manufacturing the JSF.

By the time the JSF has reached the end of its lifespan (technical, economical or operational), no doubt the World will have changed dramatically. By that time the UCAV may be an alternative for the manned combat aircraft. However, regarding the recent developments in the USA on UCAVs, it is also possible that the UCAV replacing multi-role combat aircraft may have just been a temporary hype. But then again, even combat aircraft may have become obsolete by then, as the Dreadnoughts are today. If the hi-tech sophisticated combat aircraft stays without a peer, developing extremely expensive combat aircraft will become indefensible to the public. The final conclusion may be that lacking natural enemies might prove to be a nail to the coffin of combat aircraft as we know today. And this may just open the door for less sophisticated, single-mission UCAVs.

9 Bibliography

Books

- Chun, Clayton K. S.; *Aerospace Power in the Twenty-First Century, A Basic Primer*, United States Air Force Academy, in cooperation with Air University Press; July 2001
- Cogan, Kevin J. & De Lucio, Ray; *Network Centric Warfare Case Study, Volume II: A View of Command, Control, Communications and Computer Architectures at the Dawn of Network Centric Warfare*; United States Army War College; August 2006.
- Gray, Collin S.; *Another Bloody Century*, London; 2005.
- Conversino, Mark J. Lt Col USAF; "Executing Deliberate Force, 30 August–14 September 1995"; in *Deliberate Force, A Case Study in Effective Air Campaigning*.
- Corum, James S.; *Airpower Thought in Continental Europe between the Wars*; in Meilinger's *The Paths of Heaven, The Evolution of Airpower Theory*.
- Creveld, M van.; *Air Power and Manoeuvre Warfare*; Air University Press; Maxwell Air Force Base, Alabama; 1994.
- Drew, Dennis M.; *Air Theory, Air Force, and Low Intensity Conflict: A Short Journey to Confusion*; in Meilinger's *The Paths of Heaven, The Evolution of Airpower Theory*.
- Faber, Peter R., Lt Col USAF, *Interwar US Army Aviation and the Air Corps Tactical School: Incubators of American Airpower*; in Meilinger's *The Paths of Heaven, The Evolution of Airpower Theory*.
- Fadok, David S, Lt Col. USAF; *John Boyd and John Warden: Airpower's Quest for Strategic Paralysis*; in Meilinger's *The Paths of Heaven, The Evolution of Airpower Theory*
- Hirst, P.; *War & Power in the 21st Century*, Cambridge; 2001
- House, Jonathan M., *Combined Arms Warfare in the Twentieth Century*, Kansas; 2001.
- Hughes, Thomas P.; *Networks of Power, Electrification in Western Society, 1880 – 1930*; The John Hopkins University Press, Baltimore 1983.
- Kaldor, M.; *The Baroque Arsenal*; New York; 1981.
- Kaldor, M.; *New & Old Wars*; Cambridge; 2001.
- Van Loo, P.E.; *Crossing the Border, De Koninklijke Luchtmacht na de val van de Berlijnse Muur*, Den Haag 2003.
- Lewis, W.K. UCAV – The Next Generation Air-Superiority Fighter?; School of Advanced Airpower Studies, Air University, Maxwell Air Force Base Alabama; June 2002.
- McLaughlin, Mark C., Maj USAF; "Assessing the Effectiveness of Deliberate Force: Harnessing the Political-Military Connection"; in *Deliberate Force, A Case Study in Effective Air Campaigning*.
- Meilinger, Phillip S., Col USAF; *The Paths of Heaven, The Evolution of Airpower Theory*; Air University Press; Maxwell Air Force Base; Alabama
- Meilinger, Phillip S., Col. USAF; *Airmen and Air Theory, A Review of the Sources*; Air University Press, Maxwell Air Force Base, Alabama; 2001
- Meilinger, Phillip S; *Airwar, Theory and Practise*; Portland, Oregon USA; 2003
- Mets, David R.; *The Air Campaign, John Warden and the Classical Airpower Theorists*, Revised Edition; Air University Press Maxwell Air Force Base, Alabama; April 1999
- Momyer, William W., General USAF; *Air Power in Three Wars*; Air University Press; Maxwell Air Force Base, Alabama; April 2003
- Mueller, Karl P.; *Strategic Airpower and Nuclear Strategy: New Theory for a Not-Quite-So-New Apocalypse* in Meilinger's *The Paths of Heaven, The Evolution of Airpower Theory*.

DodgingUCAVs censured

- Mueller, Karl; "The Demise of Yugoslavia and the Destruction of Bosnia: Strategic Causes, Effects, and Responses", in *Deliberate Force, A Case Study in Effective Air Campaigning. Final Report of the Air University Balkans Air Campaign Study*, Edited by Col Robert C. Owen, USAF Air University Press Maxwell Air Force Base, Alabama; January 2000
- Murray, W.; *Strategy for Defeat, The Luftwaffe 1933-1945*; Air University, Maxwell Air Force Base, Alabama; January 1983
- Summers Jr., H.G.; *On Strategy: A Critical Analysis of the Vietnam War*; Novato, CA: Presidio Press; 1982.
- Watts, Barry D.; *The Foundations of US Air Doctrine, Friction in War*, Air University Press; Maxwell Air Force Base, Alabama; 1984.
- Williams, George K.; *Biplanes and Bombsights, British Bombing in World War I*; Air University Press; Maxwell Air Force Base, Alabama; May 1999.

Magazine and Newspaper articles

- Bik, J.M.; "Een halve eeuw krimpen"; *NRC Handelsblad*; 1999; www.nrc.nl/W2/Lab/Profiel/Krijgsmacht/historie.html
- Boom, J.; "Luchtgevecht"; *De Groene Amsterdammer*, 23 March 2002
- Butler, A.; "Let the Race Begin"; *Aviation Week & Space Technology*, Vol 166, no. 13; 2 April 2007.
- Butler, A & Fulghum, D.A.; "Boom or Bust"; *Aviation Week & Space Technology*; July 24, 2006.
- Chapman II, Robert E.; "Unmanned Combat Aerial Vehicles, Dawn of a New Age"; *Aerospace Power Journal 2002*, Volume XVI, No. 2.
- Christie, R.; "A weak Europe is not good for the World"; *Jane's Defense Weekly*; 5 July 2006. Professor Christie is General Secretary of the Royal Society of South Africa and Dean of Research in the University of the Western Cape.
- Clingendael, Center for Strategic Studies; *Airpower: luxury or necessity?*, p16; CCSS Essay 1, The Hague, CCSS, February 2006.
- Clingendael, Centre for Strategic Studies; *Airpower: luxury or necessity?*; Essay 1, The Hague, CCSS, February 2006.
- Colijn, K & Vuijst, F.; "De Holland-Amerika-lijn"; *Vrij Nederland*; 13 mei 2006.
- Cook, N.; "Armed & Dangerous"; *Jane's Defense Weekly*; 8 January 2003.
- Doyle, J.M. et al; "Production Band-Aid"; *Aviation Week & Space Technology*; July 31 2006.
- Edgerton, D.; *England and the Aeroplane*, p15; Centre for the History of Science, Technology and Medicine, University of Manchester; 1991.
- Fabey, M; "Counter-Insurgency Urgency?"; *Aviation Week & Space Technology*; August 21/28, 2006.
- Fulghum, David A; "Electronic Stew"; *Aviation Week & Space Technology*; 29 January 2007.
- Hinen, Anthony L., Col USAF; Kosovo: "The Limits of Air Power II"; *Air & Space Power Chronicles*; May 2002; <http://www.airpower.maxwell.af.mil/airchronicles/cc/hinen.html>; (accessed 06may2006)
- Kaiser, Robert G.; "The U.S.S.R. in Decline"; from *Foreign Affairs*, Winter 1988/89
- Kopp, C; *The Advanced Tactical Fighter*, www.sci.fi/~fta/atf-2
- Law, John & Callon, Michel; *Engineering and Sociology in a Military Aircraft Project: A Network Analysis of Technological Change; Social Problems*, Vol. 35, No. 3, Special Issue: The Sociology of Science and Technology, p284-297; June 1988
- Lowe, C.; "Smarter Bombs"; *The Daily Standard*; September 2003;

Dodging UCAVs censured

- Pinch, Trevor J. & Bijker, Wiebe E.; "The Social Construction of Facts and Artefacts: Or How the Sociology of Science and the Sociology of Technology Might Benefit Each Other"; *Social Studies of Science* 14 (1984): 399-441.
- Sweetman, B.; "Revolution or curiosity? UCAVs wait for a mission statement", , *IDR Aerospace and Technology Editor*, Jane Defense Weekly, Vol 38; 11 November 2005
- Sweetman, B.; "UCAVs Grow Fat on Requirements"; *Jane's Defense Weekly*, 2003, Vol. 36; Part 5, pages 44-49.
- Sweetman, B.; "UCAVs offer fast track to stealth, long-range and carrier operations"; *Jane's International Defence Review*; January 2007.
- Swarz, K; "BAE to build Taranis"; *Flug Revue* February 2007; <http://www.flug-revue.rotor.com/FRheft/FRHeft07/FRH0702/FR0702f.htm>
- Tirpak, John A., "Will We Have an Unmanned Armada?"; *Air Force Magazine*, vol. 88 November 2005
- Tirpak, John A.; "The Raptor in the Real World"; *Air Force Magazine* on line; February 2007; <http://www.afa.org/magazine/feb2007/0207raptor.asp>
- Vrijssen, E; "Gevecht om een Vliegtuig"; *Elsevier*, 12sep2002.
- Trimble, S; USAF to spend \$2bn on next unmanned bomber"; *Flight International*, issue 07feb2006, page 4, Vol. 169.
- "Ontwikkeling van de F-16 onder scherp toezicht"; *De Emmer Courant*; undated.
- "Prodi trots op 'delicate missie' "(Prodi proud on delicate mission); *NRC Handelsblad*; 30 August 2006.
- "Israel to Unveil its Biggest Unmanned Combat Aerial Vehicle"; *Jane's* ; 07 March 2006; http://www.janes.com/press/articles/pc060307_1.shtml

Internet

- www.af.mil/factsheets/factsheet.asp?id=118
- www.answers.com/topic/f-35-joint-strike-fighter
- www.answers.com/topic/boeing-x-32
- <http://archieff.d66.nl/veilige%20wereld>
- www.ccss.nl/publications/2006/20060200_ccss_inklusief_1_en.pdf
- www.dassault-aviation.com/defense/gb/neuron/n_programme.cfm
- www.defenseindustrydaily.com/2006/05/neuron-ucav-project-rolling-down-the-runway/index.php
- www.eda.eu.int
- www.en.wikipedia.org/wiki/2006_Israel-Lebanon_conflict
- www.en.wikipedia.org/wiki/4th_generation_jet_fighter
- www.en.wikipedia.org/wiki/Cold_war#_note-0
- www.en.wikipedia.org/wiki/F-104
- www.en.wikipedia.org/wiki/Global_Information_Grid
- www.en.wikipedia.org/wiki/Rafale
- www.en.wikipedia.org/wiki/RQ-1_Predator
- www.en.wikipedia.org/wiki/Supermarine_Spitfire
- www.en.wikipedia.org/wiki/United_Nations_Security_Council
- www.fas.org/irp/program/disseminate/siprnet.htm
- www.fas.org/irp/program/disseminate/tcdl.htm
- www.fas.org/man/dod-101/sys/ac/f-111.htm
- www.flug-revue.rotor.com/FRheft/FRH0309/FR0309d.htm
- www.globalsecurity.org/military/library/budget/fy2006/usaf-peds/0604400F.pdf
- www.globalsecurity.org/military/systems/aircraft/f-22.htm
- www.globalsecurity.org/military/systems/aircraft/f-22-cost.htm
- www.globalsecurity.org/military/systems/aircraft/mrf.htm
- www.grondweteuropa.nl; article I-41

Dodging UCAVs censured

- www.inflationdata.com/inflation/Inflation_Rate/HistoricalInflation.aspx?dsInflation_curr&entPage=1
- www.js.pentagon.mil/descriptivesum/Y2007/Navy/0604402N.pdf#search=%22%20%22global%20command%20and%20control%20architecture%20for%20the%20war
- www.k5054.com
- www.luchtmacht.nl/vluchtdoortijd/tijdvakken/toekomst/watgebeurdeermeer/onbemandetoestellen.html
- www.minbuza.nl/nl/actueel/persberichten.2006/09/Persbericht-Prinsjesdag-2006.html
- www.mindef.nl/dossier_vervanging_f16/veel_gestelde_vragen/vervanging/index.aspx; question No. 9.
- www.military.com/features/0,15240,85361,00.html?Etopstories.RSS
- www.nl.wikipedia.org/wiki/Joint_Direct_Attack_Munition
- www.osce.org
- www.psychcentral.com/psypsych/Duncan_Sandys
- www.sp.nl/standpunten/cd_223/standpunt_over_jsf.html
- www.washingtonpost.com/wp-dyn/content/article/2006/08/15/AR2006081501288.html.
- www.weeklystandard.com/Content/Public/Articles/000/000/002/089ntkyp.asp

Government Releases

- *Beleidsvisie 2008, Nieuw Evenwicht, Nieuwe Ontwikkelingen*, p14; Hoofddirectie Algemene Beleidszaken; August 2006.
- "Capabilities"; Dutch Ministry of Defence, May 2006.
- van Hoof; Defence Secretary of State; Letter to Parliament M2002000176, 11 February 2002
- van Hoof; Defence Secretary of State; Letter to Parliament M2002002420; The Hague; 2002
- Press Release Dutch Ministry of Foreign Affairs; 19 September 2006; NATO STRATEGY DOCUMENTS 1949-1969, p12; Edited by Dr. Gregory W. Pedlow, Chief, Historical Office Supreme Headquarters Allied Powers Europe; 1997; <http://www.nato.int/docu/stratdoc/eng/intro.pdf>
- *Militaire Strategische Verkenning 2006* (Military Strategic Reconnoitring 2006); Commander Dutch Armed Forces; 2006
- "Netwerkend opreden, Defensie stapt in de toekomst met Network Enabled Capabilities"; Dutch Ministry of Defence, October 2003.
- RNLAf; *Air Power Doctrine*; www.luchtmacht.nl/images/4_20360.pdf

TNO Reports

- Bos, A.H.W. & Visser, B.J., *Mix van Wapensystemen ter Vervanging van de F16*, TNO-rapport FEL-04-A109, Den Haag 2004
- Bos, A.H.W., Visser, B.J. & Stiefelhagen, M.; *UCAV's: het einde van het bemande gevechtsvliegtuig?* (UCAVs: the end of manned combat aircraft?); TNO report TNO-DV1 2004 A104; TNO 2006.

Individual quotes

- USA President Bush's speech to Congress, March 6, 1991
- Defence's Secretary of State, Mr. Van der Knaap, at a NIID conference October 2005.
- RNLAf Lt-Gen. Staring; During the Shepard Air Power Conference 2005
- Major A. Steur, Projectteam Replacement F-16, Defence Materiel Organisation.

Other

- "Big Deal", a 1979 *Granada Television* documentary.

Dodging UCAVs censured

- McNamara, R, former Secretary of Defense in the movie "Fog of War".
- Radio program "De Ochtenden"; www.ochtenden.nl/afleveringen/10558946/
- Radio program "De Ochtenden"; www.ochtenden.nl/afleveringen/9964335/