Allied Aircraft Piston Engines of World War II

History and Development of Frontline Aircraft Piston Engines Produced by Great Britain and the United States during World War II

Graham White
This book is dedicated to my late Mom, Peggy White, and my Dad, Arthur White, who have always supported me in my various pursuits.
As in chess, the course of history is determined by a few key moves—often by one false move, one fatal error of judgment. In war one’s enemy is unlikely to grant a second chance, save by ineptitude.

In 1939, Germany invaded Poland, having already annexed Czechoslovakia. Britain and France, though far from prepared, fulfilled the threat and declared war on Germany. Arguably, the darkest phase of this century’s history had begun. It was not at that time a world war. Indeed, it was a very European war, observed, often with journalistic impartiality, from the western side of the Atlantic.

Engineering has, for a long while, been a major contributor to military strength. In recent times the battles have been fought not only between armies, but between design offices, laboratories, test houses, and production lines. Germany had a fine reputation for engineering innovation, quality, and manufacture, and retained these, quite remarkably, until the final weeks of the war in Europe.

This book tells how this strength was countered, and how, with the entry into the war of the Japanese and consequently the United States toward the end of 1941, the engineering battle moved onto a broader front.

Since this book is about the Allied involvement in the struggle for aerial supremacy, or indeed for equality, it can never be more than half the story. It is, however, a part of the story that is not often told, and one that historians of classical or military background find hard to tell because every facet involves some technical development that may at the time have seemed quite trivial, but has in retrospect altered the course of history. In 1940 the outcome of the Second World War was far from certain.

There were many observers (possibly the fathers of those reading this book) who thought, and with some justification, that all of Europe would fall into the hands of Nazi Germany.

During that fine summer of 1940 the likelihood seemed very strong indeed. The Battle of Britain was never a foregone conclusion. Like the game of chess, it was a battle waiting for one side to make a mistake. Numerical superiority was with the Germans. Battle experience was with the Germans. That the battle would be fought over the South of England favored the British, since damaged aircraft could be recovered, and a rescued pilot could fight again. The effectiveness of British radar was a surprise to the attacking force, for without it the battle would have been lost. There was no way the RAF could have flown effective standing patrols.
The aircraft, however, were evenly matched. Both sides eventually withdrew one player each from the front line of daytime combat—the Germans, the Messerschmitt 110, which was out-performed by both the Hurricane and the Spitfire, and the British, the ill-conceived twin-seat Defiant.

Though both the Hurricane and the Spitfire were low-wing, single-seat, eight-gun fighters, their design concepts were different in many ways. They did, however, have one vital unit in common, and that was the engine. Had that engine not been available, had Camm and Mitchell, the respective design leaders of the Hurricane and the Spitfire, been obliged to rely on the next available alternative, there is little doubt that the Battle of Britain would have been lost. Operation Sealion, the German invasion of England, would have been put into effect. It is hard to imagine, despite Churchill’s calls to what few arms the British had, how effective resistance could have been offered. Europe would have been in Axis hands. The rest is deep speculation, but the lessons of the Normandy beaches are enough to tell us that a counter-offensive from the American continent would have been decades away.

For a brief but crucial period of history, the survival of Europe, and indeed Western democracy, rested on the availability of one twelve-cylinder engine. The contribution to that engine’s development by a small band of individuals was such that, had any one been eliminated, one knight or even one pawn lost in the game, the delicate balance of history’s scales could have been inexorably tipped. The balance between catching and being caught was that delicate. Without Meredith’s work on radiators, Miss Shilling’s on carburetors, Hooker’s on superchargers, the American Hamilton license for constant speed propellers (one could go on naming them), the battle might well have been lost.

The story of the piston engine in World War II is the story of the ending of an era—an era that was terminated by the acceleration of history. The piston engine never had the opportunity to reach its full development, for it had dawned on some by 1942 that the future lay with the jet. As a consequence of this, many who were involved with the piston engine changed horses, almost in mid-stream. Halford, who had been responsible for later efforts with the de Havilland Goblin gas turbine, abandoned the Napier Sabre, one of the last—and most powerful—aircraft piston engines. Hooker, somewhat reluctantly, left the Merlin to work with Whittle. Of the major builders, only Wright kept faith with the piston engine, getting as close to the ultimate in piston aero-engine development as engineering was to see, though this honorable, if short-sighted, conservatism was to cost them their very existence.

Had the war lasted three more years the jet engine would have been the decisive factor. In fact, the piston engine remained the key player. Only two jets had a measurable effect on the events of the war: the German Messerschmitt 262 and the British Gloster Meteor. The two were never to meet in battle.

The technology of the aircraft piston engine reached its climax against the accelerating ground-bass of war, often at the tempo of panic. This was particularly so for the European factories (which, in the context of this book, means the English factories), for these were prime targets for bombardment.
Just once in a while, and I hope not from SAE members, one is told that history is irrelevant to engineering. I dispute this: I have known engineers who may be indifferent to the foundations of their profession, but I have yet to find among them one who doesn’t aspire to more than mediocrity.

Everything in engineering is interpretation. Interpretation is impossible without data. Data is history. History (and we don’t need to haggle over semantics) is not the learning by rote of names and dates, any more than knowledge of a language is the ability to recite a table of verbs. It is about consequences, strategy, motives, and resources, and the way these are molded by speculation. Engineering is asking the right questions. It requires intelligence plus wisdom, and applies to a deep fund of knowledge based on experience that others have accrued.

History is subject to many misconceptions—as many, one might suggest, as is engineering to historians. It has much in common with astronomy, which is also a study of history. The further you are away from it (and the more finely tuned your tools of observation), the more you see. Much that is written shortly after an event is grossly distorted. Now, at a distance of more than 50 years, more information is available, though much has been lost in the intervening years through the passing of many who were, as they were called, the back-room boys.

Often the privilege of writing a Foreword falls on one whose name or contribution to the field in question is well known. My qualification, though my background is in aircraft, is simply that I was in on this project from the beginning. It began over a lunch in Pittsburgh, Pennsylvania, where I shared a drink with the author and listened to his story. I looked at photos of aircraft engines he had renovated and rebuilt as others might a classic car, and found that I was in conversation with someone who could talk with equal authority and enthusiasm on the products of GM Allison and Rolls-Royce, Wright and Bristol. I was not surprised to hear that Graham White had been born English but had become American.

White is no armchair historian, and he is certainly not an armchair engineer. His curiosity and quest for information took him many thousands of miles, to many libraries, factories, museums, and homes. His energy never seemed to wane. Every morning of the week he spent under my roof in North Kent, under the very skies in which the Battle of Britain had been fought, he was off at the crack of winter’s dawn for a two-mile run amid the marshland farms. Each day was filled with the frenetic search for information, anecdotes, and pictures, from sources ranging from London’s Science Museum to such treasures as might turn up in a rural Kentish barn. I was witness to much of this, and have little doubt that he carried this enthusiasm wherever he went in England or America.

The result, and every historian must come to this realization, tells part of the story. It pulls back the curtains of time to reveal just a little more of one theater of war in which the part played by engineers was more than significant—it was vital to the freedom that we enjoy today.

Don Goodsell
Faversham, U.K., 1994
Describing the complex inner workings of military aircraft engines is not the easiest of endeavors! Gathering the information has required the invaluable help of many people to whom I am deeply grateful.

In the United States:

Aviation historian extraordinaire Dan Whitney has provided not only priceless technical assistance, but Dan also took the time to review the manuscript chapter by chapter. The General Electric turbo-supercharger information was supplied by Dan along with many other anecdotes and pieces of long-buried, technical information.

Kevin Cameron, technical editor of *Cycle World* magazine, lit the original fire under me to write this book. Kevin has always been a source of inspiration with his encyclopedic knowledge of the internal combustion engine and his enthusiasm for anything mechanical. He was kind enough to loan me his valuable *High Speed Internal Combustion Engine*, 1968 edition by Sir Harry Ricardo and his copy of Robert Schlaifer's and S. D. Heron's *Development of Aircraft Engines and Development of Aviation Fuels*.

Retired Pratt & Whitney archivist Harvey Lippincott reviewed the Pratt & Whitney chapter. In addition to his review, Harvey related to me many anecdotes concerning Pratt & Whitney engines.

Dr. Max Bentele subjected himself to my questions for an afternoon that I found to be totally enlightening. Dr. Bentele shared many pieces of technical information with me that have never been published before, such as German ingenuity in salvaging shot-down Allied aircraft engines and using components from them.

Despite suffering horrendous health problems, the late Gerry Abbamont supplied invaluable information on Wright engines. Sadly, Gerry passed away in June 1994, just a scant two and a half months after our interview.

I first met Jack Wetzler at an SAE seminar on World War II aircraft engines that I presented in 1992. Afterward Jack shared with me his experiences as an engineer with Allison and gave me a copy of his SAE paper, written in 1946, on the turbocompounded V-1710. Several of the V-1710 photographs are from Jack’s collection. Jack later headed up the design team that produced the Allison 250, one of the most successful small aviation gas turbines.
Acknowledgments

Jack Hovey, Merlin magician and a hive of information on Rolls-Royce's finest, was always willing to take time out of his schedule to be subjected to my constant queries.

The staff at the National Air and Space Museum patiently dug out numerous manuals and files for review.

Others who provided help were: Frank Hill, owner of Hill Air; Willie Walter, who has probably rebuilt more Pratt & Whitney R-1830s and R-2800s than any other man alive; The New England Air Museum staff, including Norm Mullings for providing access to the museum's extensive collection of aircraft manuals; Al Marcucci, owner of Savage Magneto Services; John Morgan, who is restoring the ultra-rare P-51G; Irv Rosenblum, who kindly loaned me his large collection of Jane's; Bob Scott, owner of AeroTropic; Carlos Arana, owner of Florida Airline Services; and many others who supplied moral and technical support.

In England:

Thank goodness Rolls-Royce has such a profound interest in its history; it made my job a lot easier! Dave Birch, editor of the Rolls-Royce Archive magazine, was kind enough not only to review the Rolls-Royce chapter but got me into the holy grail at Rolls-Royce, the company archives. Mike Evans, founder of the Rolls-Royce Heritage Trust, opened up his office and supplied many photographs of engines and aircraft. Both Dave and Mike continually went "above and beyond" to assist me in my endeavors.

My good friend Keith Gough, author of The Vital Spark, has always been an inspiration and valued friend. Keith's hospitality during a visit to England in December 1993 was invaluable. He took time out to help me go through the Fleet Air Arm Museum archives in Yeovilton.

Don Goodsell, a distinguished author in his own right, was kind enough to extend his hospitality to me in December 1993. He greased the skids in numerous ways by gaining access to various archives and collections. Don also critiqued my work and added several interesting and little-known anecdotes that added immeasurably to the interest of the book.

Another company dedicated to preserving their history is Napier. The Napier Power Heritage, and in particular Alan Vessey, Hon. Secretary of the NPH, always came through for me with definitive answers to my constant requests for information.

Andrew Nahum, Curator of Aeronautics of the Science Museum in South Kensington, provided priceless information on the often overlooked and misunderstood Napier Sabre.

During the preparation of this book, I was dating my future wife. To Diane, I owe a sincere debt of gratitude for her understanding and forbearance while I pursued this project.

For those I have not mentioned who have contributed in some way, my most sincere apologies.
For any errors which may be contained in the text, I take full responsibility.

On a final note, it is heartwarming to see people like Mike Evans, Dave Birch, Harvey Lippincott, Alan Vessey and the late Gerry Abbamont preserving their respective company’s history and heritage. Despite the efforts of these gentlemen, a depressing amount of technical information and hardware has been systematically destroyed. This is knowledge and hardware lost to historians and future generations forever.

Graham White
August 1994
Preface

Development of technology is not a steady and predictable endeavor. Likewise, having an advancement in technology without an apparent application is practically meaningless. Furthermore, practical people do not want to squander their time and tangible resources inventing and developing better “mousetraps.” At least this is the ardent fervor often found in Chief Executive and Government offices. It is all the more satisfying, then, when we find individuals and teams with the intuition, knowledge, and foresight to look over the horizon and do what needs to be done. This is the atmosphere that energized many in the pioneering days of aviation.

While it took the demands of two World Wars to bring aviation into acceptance by the general public, it was a relative handful of engineers, entrepreneurs, and pilots who positioned the technology and resources necessary to make aviation practical and the deciding factor in ending World War II.

This book attempts to illuminate some of the historically significant technical developments and achievements that directly contributed to the execution and tactics of the war. Many writers have focused on technical incidents that impacted particular aircraft or events—for example, that early Merlin-powered Spitfires and Hurricanes would “cut-out” during negative g maneuvers, giving the Luftwaffe a critical advantage. We have all heard that a British woman engineer came up with an elegantly simple and expedient fix, and now you can find out how it worked and how she did it!

Tactics are dictated as much by the capabilities of the combatants and their equipment as they are by the tactical situation. It was no accident that when the United States chose to fly high-altitude daylight bombing raids over “Festung Europa,” they had turbosupercharged engines and the Norden bombsight.

The World War I lesson, beware of the “Hun-in-the-Sun,” was not lost on planners in the 1930s; having the altitude advantage was significant to surviving combat in the air. Flight into the stratosphere required development of many new and highly advanced technologies. The specific differences between aircraft and engines, which in turn dictated their tactical order, are described and explained in the following text.

Much has been written about the organization of the production capability of the Allied nations to produce and equip their armies and navies with the necessary machines of war. Interestingly, little of a comprehensive nature has been compiled about the technological development that was incorporated into the engines that powered the aerial armadas of the war.
The following text is specific to the British- and American-developed engines. Collecting material for a book such as this has been difficult, for much of it was “secret” during the war, and after the war everyone was “tired” of the old technology, anxious to get into “jets,” and simply weary of anything to do with “the War.” Sources of information, to a similar level of detail, on the engines used by the Axis belligerents of World War II are far from comprehensive and superficial at best. Still, the belligerents countered practically every Allied technical advance and introduced many themselves. The story of their engine developments has yet to be told.

Although first-class engines were developed by other British manufacturers—such as de Havilland, with their range of Gipsy engines; Armstrong Siddeley, who produced the Cheetah; and Blackburn, who produced their range of Cirrus engines—these secondary-role engines are not covered in this book.

Likewise, in the United States, excellent engines were produced by Jacobs, Ranger, and Kinner but are not covered, and only the hyper- and/or large-engine developments of Lycoming and Continental are covered, since the focus of this book is on front-line combat engines.

Examples are given of the applications of the engines covered. By no stretch of the imagination are all applications covered. As an example, so many aircraft were powered by the Rolls-Royce Merlin that it would be impossible to cover all applications with any degree of detail. In the same vein, not all variations or dash numbers of a particular engine are covered. For example, Pratt & Whitney produced a dizzying array of variations and permutations on the R-2800; indeed there were several examples of the Pratt & Whitney R-2800 that they did not even manufacture but instead were built by licensees.

Although numerous excellent books have been published on all of the more common World War II aircraft and several books have been published on engines, rarely have the two been brought together.
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