Reinventing the Propeller

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Jeremy R. Kinney is a curator in the Aeronautics Department at the Smithsonian National Air and Space Museum.

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Aeronautical Specialty and the Triumph of the Modern Airplane

JEREMY R. KINNEY
Smithsonian National Air and Space Museum

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To Mom and Dad, for never hesitating to buy their little boy books about airplanes

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Preface

When I was a small boy, my parents gave me a little wood airplane with a big red plastic propeller. Holding the fuselage in one hand, I turned the propeller to wind up the rubber band "engine." The power of the rubber band spun the propeller and I could feel a breeze flow over my airplane until I let it go. If I did not wind enough, the airplane would jump and skid along the ground, unable to take off. If I wound too much, the propeller would "race" and the airplane would vibrate and careen out of control. I spent hours in our backyard learning how to wind the propeller so my airplane would fly straight and level.

During one of our many family visits to museums and air shows during my childhood, I got close to some of my favorite airplanes. One of those was the Curtiss Jenny, a fabric-covered biplane that the wandering barnstormers flew from town to town across America in the 1920s selling rides to brave and curious folks. As I looked at the Jenny's wood propeller, I could see a long, flat curve that moved all the way along its length, from the tip at one end, through the hub in the center, and on to the tip at the other end. This aerodynamic twist, called pitch, gave the propeller its shape and allowed it to turn the engine's power into thrust – the "breeze" created by my toy airplane – to propel the Jenny forward.

Another favorite was the Douglas DC-3 airliner from the 1930s. The DC-3 was a very different airplane than the Jenny. It was a sleek twin-engine monoplane capable of carrying twenty-one passengers. Unlike my toy airplane and the Jenny, each of its two propellers had three shiny metal blades that could change pitch in flight. When needed, the propellers generated a lot of thrust for takeoff and prevented "racing" as the

DC-3 cruised through the sky. The technical transformation, or reinvention, of the airplane propeller – from the one found on the Jenny to the advanced design installed on the DC-3 – by a community of specialists and what it had to do with increasing the performance of aircraft over the course of the twentieth century is the focus of this book.

Acknowledgments

I began this project as a graduate student studying the history of technology at Auburn University. Stephen L. McFarland served as my major professor and dissertation chair. James R. Hansen provided an unprecedented opportunity to conduct research at various archives throughout the United States through my involvement in the NASA-sponsored multivolume documentary history of aerodynamics, *The Wind and Beyond*. William F. Trimble's skill as an editor improved the text and the ideas expressed in it immeasurably. All three served as thoughtful and patient guides throughout the dissertation and manuscript preparation process. Special mention must be made of a valued colleague, friend, and recent addition to the Auburn history faculty, Alan D. Meyer, who valiantly read and critiqued the final manuscript draft. I would also like to thank Donna J. Bohanan, Lindy Biggs, John Burkhalter, my fellow graduate students, and the staff of the Auburn University libraries for their assistance.

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The research and writing of history, like the creation of technology, is a communal effort. This book would not have been possible without the gracious help of these and many more individuals and institutions. While that is true, all errors of fact, interpretation, or omission are solely my own.

Final thanks are due to family members Stanton, Margaret, Fannie, Kristopher, Saki, Cassie, and a little white dog named Sneezy for their inspiration and support during the course of this project. My wife, Cheryl, has been a devoted believer in this story from the day we first met and we welcomed our beautiful daughter, Piper, as writing the book drew to a close. I dedicate this book to my parents, Jerry and Susan, because they never hesitated to encourage their youngest son's enthusiasm for the history of flight.

Abbreviations

ASME	*American Society of Mechanical Engineers*
AVCO	*Aviation Corporation of Delaware*
BAP	*Bureau of Aircraft Production*
BATC	*Boeing Airplane and Transport Corporation*
BCA	*Boeing Company Archives*
BEF	*British Expeditionary Force*
BF	*Biography Files*
BMW	*Bavarian Motor Works*
BuAer	*Bureau of Aeronautics*
CAA	*Civil Aeronautics Authority*
CAMC	*Curtiss Aeroplane and Motor Company*
CATD	*German/Japanese Captured Air Technical Documents*
CE	*Claire Egtvedt Files*
CHC	*Chattanooga-Hamilton County Bicentennial Library*
CKC	*Charles Kettering Collection*
CMK	*Clement M. Keys Papers*
CO	*Commanding Officer*
COAC	*Chief of the Air Corps*
COAS	*Chief of the Air Service*
CWC	*Curtiss-Wright Corporation Records*
DAD	*D. Adam Dickey Papers*
DVL	*Deutsche Versuchsanstalt für Luftfahrt*
FWP	*Fred E. Weick Papers*
GE	*General Electric Company*
GHQ	*General Headquarters Air Force*
GM	*General Motors Corporation*
HFM	*Henry Ford Museum and Greenfield Village Research Center*
HRA	*United States Air Force Historical Research Agency*

HSCRD	*Hamilton Sundstrand Community Relations Division*
IAS	*Institute of the Aeronautical Sciences*
JCH	*Jerome C. Hunsaker Papers*
KUA	*Kettering University Archives*
MAA	*Manufacturer's Aircraft Association*
MFRC	*Museum of Flight Resource Center*
MIT	*Massachusetts Institute of Technology*
NAA	*National Aeronautic Association*
NACA	*National Advisory Committee for Aeronautics*
NARA	*National Archives and Records Administration*
NASA	*National Aeronautics and Space Administration*
NASAHO	*National Aeronautics and Space Administration History Office*
NASM	*National Air and Space Museum*
NRC	*National Research Council*
OPEC	*Organization of Petroleum Exporting Countries*
PCF	*Propulsion Curatorial Files*
PTF	*Propulsion Technical Files*
RAE	*Royal Aircraft Establishment*
RAeS	*Royal Aeronautical Society*
RAF	*Royal Air Force*
RCAF	*Royal Canadian Air Force*
RD	*Research and Development File*
RG	*Record Group*
RLM	*Reichsluftfahrtministerium*
RO	*Registrar's Office*
SAE	*Society of Automotive Engineers*
STOL	*Short-takeoff and Landing*
TAC	*Technical Advisory Committee*
TNA	*National Archives of the United Kingdom*
TWA	*Transcontinental and Western Air/Trans World Airlines*
UAC	*United Aircraft Corporation*
UAL	*United Air Lines*
UATC	*United Aircraft and Transport Corporation*
USCC	*United States Court of Claims*
USSBS	*United States Strategic Bombing Survey*
UTC	*United Technologies Corporation*
VDM	*Vereinigte Deutsche Metallwerke*
WFTD	*Wright Field Technical Documents Library*

A Note on Terms

Why do we call this technology a propeller? That is its basic function, to propel an airplane forward through the air by the generation of thrust. Propellers have also been known by other names since the early days of aviation. The Wright brothers first called their creation a "fan screw" in 1902 to express its ability to move air through the fluid medium of the sky in the same way a carpenter's wood screw twists through a pine board. By 1908, they then used "screw propeller" before ultimately settling on "propeller" by 1913, with early American aeronautical enthusiasts following suit.[1] The European aeronautical community chose the English airscrew, French *hélice aérienne*, and German *Luftschraube* since it literally referred to the motion of the technology through the air.

Those different choices stirred a significant debate over whether or not airscrew or propeller was the correct terminology. From the perspective of engineering education, textbooks on both sides of the Atlantic reflected the divide.[2] In 1920, British engineer Dr. Henry C. Watts acknowledged that they were both abbreviations for "air screw-propeller," which described the medium in which the technology operated (air), its specific form

[1] "'Fan Screw Experiments,' December 15, 1902, Wilbur *Wright's Notebook H, 1902–1905*, Appendix III: The Wright Propellers," in *The Papers of Wilbur and Orville Wright, Vol. 1, 1899–1905*, ed. Marvin W. McFarland (New York: McGraw-Hill, 2001), 598; Wilbur and Orville Wright, "The Wright Brothers' Aeroplane," *Century Magazine* (September 1908), and Orville Wright, "How We Made the First Flight," *Flying* (December 1913), both in Peter L. Jakab and Rick Young, eds., *The Published Writings of Wilbur and Orville Wright* (Washington, DC: Smithsonian Institution Press, 2000), 29–30, 41.

[2] Examples include Charles B. Hayward, *Aerial Propeller* (Chicago: American School of Correspondence, 1912); and M. A. S. Riach, *Air-Screws* (London: Crosby, Lockwood, and Son, 1916).

of motion (screw), and its fundamental name (propeller). He admitted his preference for the "more logical" *airscrew*, which was the formal term adopted by the Royal Aeronautical Society (RAeS), but deferred to the "verdict of custom and usage" delivered by aircraft manufacturers and military air services to adopt and use *propeller*.[3] An open letter from an aspiring pilot, W. A. Chase, to the RAeS Technical Terms Committee and to C. G. Grey of the influential British journal *The Aeroplane* reinforced that argument against the use of the impolite and "ill-sounding" "airscrew" in Britain.[4]

Despite Watts's desire for order and Chase's wish to be respectable, the use of both terms persisted. Fred Weick noted in his landmark 1930 engineering textbook, *Aircraft Propeller Design*, that usage continued to reflect international boundaries. The American aeronautical community stuck to propeller while the members of the larger international aeronautical community used their linguistic equivalent of airscrew.[5] Over time, the terms became the synonyms they were intended to be originally, with propeller being the dominant of the two. In fact, while the British aeronautical community remained steadfastly attached to airscrew, at least until the late twentieth century, the rest of the international aeronautical community allowed propeller to become a nonliteral translation.[6] Both propeller and airscrew appear in this book depending on the national locale being discussed.

[3] Henry C. Watts, *The Design of Screw Propellers with Special Reference to Their Adaptation for Aircraft* (London: Longmans, Green, and Company, 1920), v; W. Barnard Faraday, ed., *A Glossary of Aeronautical Terms* (London: Royal Aeronautical Society, 1919), 69.

[4] W. A. Chase, "Terminological Tortuosities," *The Aeroplane* 18 (January 28, 1920): 213.

[5] Fred E. Weick, *Aircraft Propeller Design* (New York: McGraw-Hill, 1930), 2.

[6] John D. Anderson, Jr., *Introduction to Flight*, 7th ed. (New York: McGraw-Hill, 2012), 753. The trend, at least from the perspective of historical writing, in Great Britain is edging toward "propeller." "Airscrew" does not appear in a late twentieth century authoritative work on the technical development of the interwar airplane with an emphasis on developments in Great Britain. See Philip Jarrett, *Biplane to Monoplane: Aircraft Development, 1919–1939* (London: Putnam, 1997).