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ORGINAL ARTICLE

What does the future bring? A look at technologies for commercial aircraft in the years 2035–2050

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Abstract Demographics and economics in the next 20 years are being examined. They reflect a significant GDP growth and with this a strong demand for commercial aircraft not only in the US and Europe but across Asia and the Middle East. The demand will focus on more fuel efficient and more environmentally friendly vehicles.

Significant progress is being made with the new regionals, narrow-body, and wide-body aircraft between now and the year 2020. Looking beyond, the world will examine new airplane architectures, new changes in propulsion systems, and higher thermal and propulsion efficiencies. Distributed propulsion options will come into play. With them, higher operating pressure gas generators will be developed and great attention will have to be given to highly integrated propulsion/airplane systems. Energy transfer requirements will lead to bigger gear systems as well as new hybrid systems. The new machines are forecasted to offer improvements in fuel efficiencies of over 40%.

There are many technical challenges to make all these things happen. The aerospace engineers and scientists of today and tomorrow face unlimited opportunities to make a difference for what looks like a very exciting future.

1. Introduction

The progress in commercial aviation over the last 100 years has been unparalleled. The Wright Brothers flew for 12 s over the shores of North Carolina powered by a 25 HP bicycle engine in 1903. A hundred years later, hundreds of Boeing

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Nomenclature

B	billions of dollars
BPR	bypass ratio
CAEP6	NO_x regulation
CMC	ceramic matrix composite
dB	decibel
Deg F	degrees Fahrenheit
FHV	fuel heating valve
FPR	fan pressure ratio
GTF	geared turbofan
hp/lb/sec	specific core power (horsepower/pounds/seconds)
lbs	pounds
L/D	lift/drag
MMC	matrix composite
η	overall efficiency
$\eta_{thermal}$	thermal efficiency
$\eta_{transfer}$	transfer efficiency
$\eta_{propulsive}$	propulsion efficiency
NO_x	nitrogen oxide
OPR	operating pressure ratio
PW	Pratt & Whitney Aircraft
SFC	specific fuel consumption
Stage 4	relates to FAA noise regulation
V	aircraft velocity
W	aircraft weight

777 airplanes powered by 2. GE 90–115 engines, fly across the globe on 8000 mile journeys. They do it repeatedly, safely, with minimum cost, low fuel consumption, low noise and low pollution. Great achievement! We, however, cannot stop there. This paper analyzes what we need to do for our future. We will attempt to understand what our customers want, what we need to do in propulsion, in airplane aerodynamics, in airplane structures, materials, etc. We will examine the challenges and opportunities.

2. What does the customer want?

There is a delicate balance as we move forward. (Figure 1) The customer wants a good payload, low cost of ownership, low noise and emissions. The manufacturers need to balance these requirements against the development and manufacturing costs.

As Figure 2 shows, while the industry revenues have been going up, the profits have been flat. The cost of fuel has been going up and driving the operating costs significantly (Figure 3).

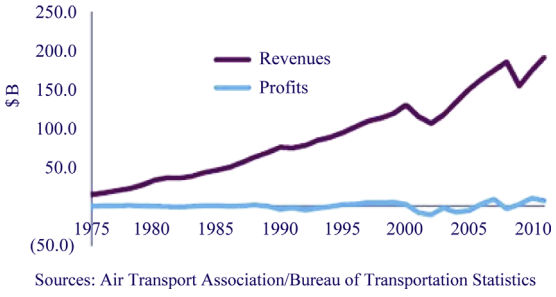

Figure 2 Industry revenue.

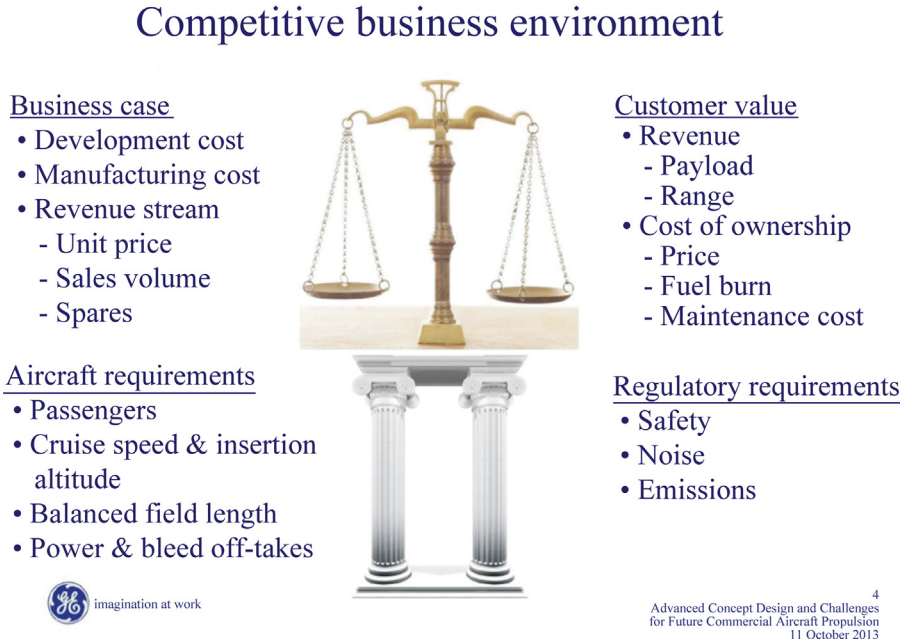

Figure 1 Competitive business environment.