
**AIRFRAME DEVELOPMENT COST-ESTIMATING
RELATIONSHIPS**

Airframe development includes four major cost elements: nonrecurring engineering, nonrecurring tooling, development support, and flight test. We independently estimated CERs for nonrecurring engineering (NRENGR) and tooling (NRTOOL) based on recent information obtained from AFCAA and the Naval Air Systems Command (NAVAIR).

NONRECURRING ENGINEERING AND TOOLING CERs

The CER for NRENGR hours was based on the most recent data from 13 military aircraft: A-4A, A-6A, AV-8B, B-2, B-52, F-4A, F-111A, F-14A, F-15, F-18 A/B, F-18 E/F, F-22, and S-3.

The NRENGR hours include the engineering hours spent developing the airframe. We note that such hours are incurred throughout an aircraft program's life, since design change effort, which occurs until program termination, is included in nonrecurring engineering.

The CER for NRTOOL hours was based on the most recent data from 10 military aircraft: A-6A, AV-8B, A-10, F-4, F-14, F-15, F-16, F-18A/B, F-18E/F, and F-22.

Nonrecurring tooling hours are those required to plan, design, fabricate, assemble, and install the initial set of tools, and all duplicate tools required for the planned rate of production.

The NRENGR and NRTOOL CERs are in hours and are listed in Table D.1.

Table D.1
Nonrecurrent Engineering and Tooling Cost-Estimating Relationships
(in hours)^a

CERs	R ²	SEE	N
NRENGR = 7924.314 WE ^{0.561} ADVMAT ^{0.671} (1.034) ^{FF} (1.389)Stealth (5.872) (0.488) (3.653) (1.156)	0.97	0.26	13
NRTOOL = 2769.13 AUW ^{0.685} ADVMAT ^{0.075} RATE ^{0.570} (1.59)Stealth (2.95) (0.95) (3.08) (1.29)	0.86	0.24	11

^a R² = coefficient of determination; SEE = standard error of estimate; N = sample size; numbers in parentheses are the t-statistics for each coefficient.

WE = Weight empty (lb.).

AUW = Airframe unit weight (lb.).

ADVMAT = composite and titanium weights as percentage of structural weight.¹

RATE = maximum production rate that can be sustained by the development tooling (rate per month).

FF = year of first flight minus 1950.

Stealth = 0 for nonstealth aircraft and 1 for stealth aircraft.

¹We used the percentage of advanced materials instead of WMCF because we did not have a complete bill of material for all the aircraft used in the analysis.