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Data-Driven Estimating - Quantifying Electronics Complexity Using Public Data

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ICEAA – June 26-29, 2013

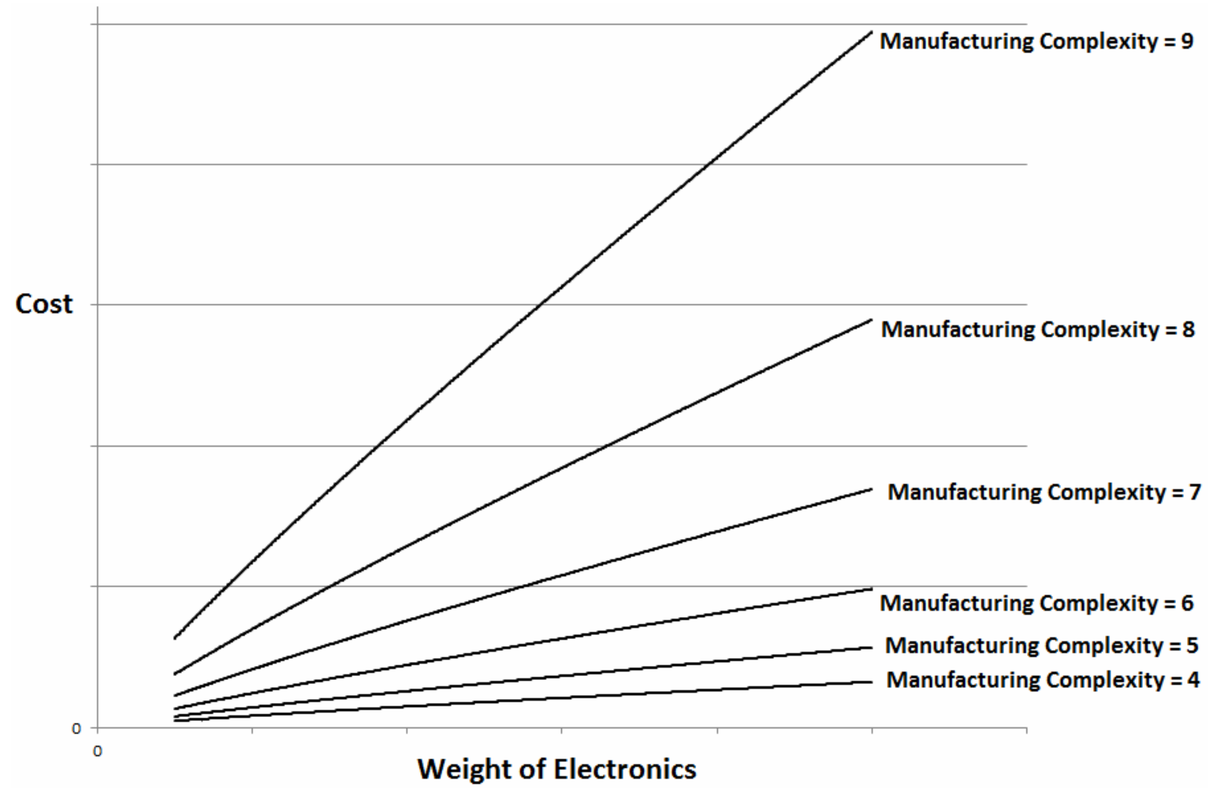
Requirements

- **Must cover a vast majority of electronic equipment types and technologies estimated by the Aerospace and Defense market.**
- **Must be derived from actual electronic cost data that can be redistributed publicly.**
- **Must enable the user to trace recommendations back to the cost data from which it came.**

- **These requirements led to a solution using publicly available data.**

Solution Design

- **Manufacturing Complexity for Electronics is a technology index for the electronics of the item being modeled.**
- **Represents production cost per unit of weight for electronics**



Solution Design

- **Met with electronics engineer, designed a structure to cover most classifications of electronics**
- **Allows user to describe electronics 2 different ways:**
  - Function (receiver, transmitter, filter, signal processor, detector, memory, etc.)
  - Equipment Type (radar, sonar, navigation, countermeasures, GPS, data link, etc.)
- **See new Manufacturing Complexity schema**

Data Collection

- **U.S. Federal Supply Catalog is main data source.**
  - Data from over 70 US Army, Navy, Air Force and other government, military and commercial-related databases, for all items in US Federal Supply Catalog. IHS Haystack tool used to organize/query data. Contains parts, logistics, cost , and technical data.
- **Designed a data collection/analysis process, to model electronic items in TP, and calibrate to find Complexity**
- **MCPLXE calibration requires the following info:**
  - Unit Production Cost (with quantity and date basis)
  - Weight of electronics and structure
  - Operating Specification
  - Manufacturing Complexity for Structure

Unit Production Cost

- ML-C unit price (DLA average price) data is frequently available
- ML-C unit price includes:
  - Acquisition Cost
    - Unit Production Cost
    - G&A (Assumed 15%)
    - Fee/Profit (Assumed 15%)
    - Cost of Money (Assumed 2%)
  - Material Support Division (MSD) Overhead
- Unit Production Cost = (ML-C Price – MSD Overhead) * 0.85 (G&A) * 0.85 (F/P) * 0.98 (COM)
- MSD Overhead is only occasionally available. Used available data to find an average to apply to all data points
- Normalize by date/inflation

Determining Quantity Basis

- For electronics, DLA values generally represent replenishment spares (small batch)
- Will use average lot size from procurement histories, when available
  - If unavailable for a data point, will use average lot size for similar equipment
  - Average lot size is small, average ~24
- Learning Curve assumed very slight (98%), because there is very little room for additional learning when building replenishment spares in small batches.
  - This also means quantity is not a major influence on UPC.

Weight of S/E

- The only weight data generally available is Unit Pack Weight (with an associated quantity), and Packaging Type
- Unit Pack Weight includes:
  - WS
  - WE
  - Weight of packaging
- WE/WT ratio determined 1 of 3 ways:
  - refer to PRICE NDA dataset for similar items
  - predefined rules of thumb (see excel sheet)
  - SME estimate
- Weight of Packaging estimated according to table (see excel sheet)
- WE = (Unit Pack Weight – Weight of Packaging) * (WE/WT Ratio)

Other Drivers

- **Operating Specification**
  - Determined by looking for clues in “Technical Characteristics” database. The “End Item” is often known.
- **Manufacturing Complexity for Structure (MCPLXS)**
  - Determined by MCPLXS generator, or
  - Use MCPLXS of similar items from original PRICE dataset.

Adjustment Equations

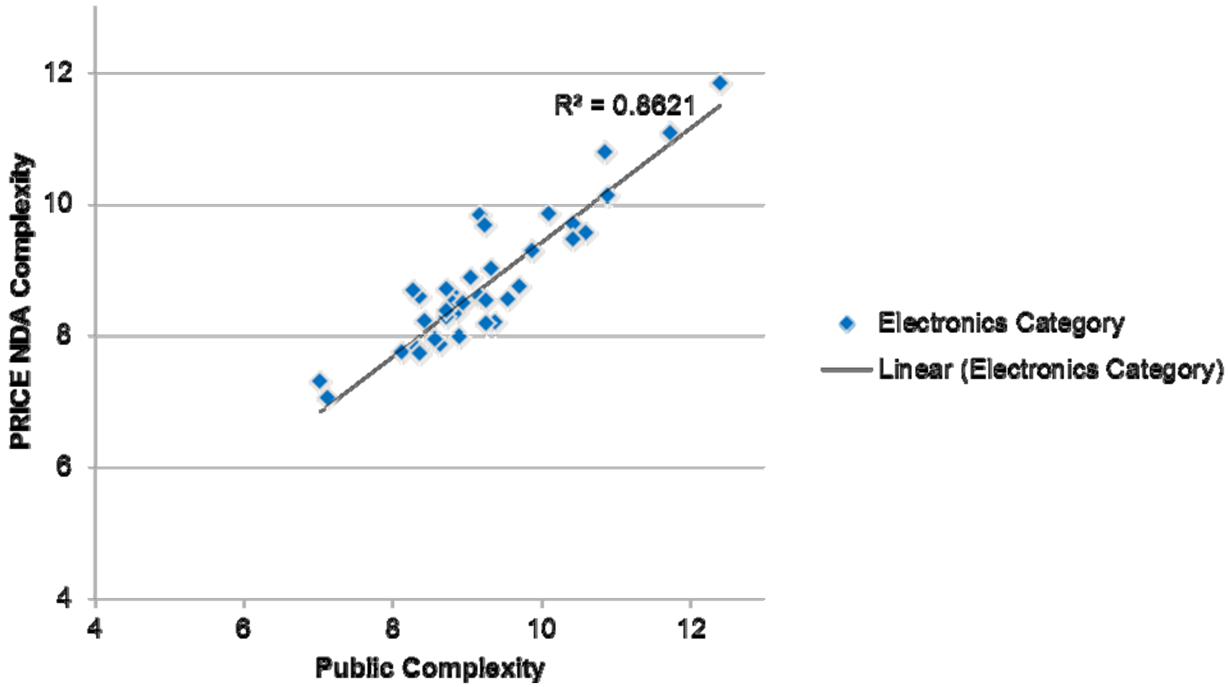
- **Variance exists in the calculated Complexity values that could be explained by other variables**
- **For every item, Operating Specification found to be a significant variable in explaining variation – implemented as an additional adjustment equation.**
- **May find adjustments specific to a category**
  - Example: RF electronics may be adjusted by Frequency.

Adjustment Equations (cont.)

- **Remaining variability may be due to different intended uses that require more advanced technology.**
  - Example: RF Amplifiers might be used in walkie talkies (low complexity), in state-of-the-art electronic warfare equipment (high complexity), or anywhere inbetween
  - This is why RF amplifiers have such a large standard deviation
- **"Technology Adjustment" accounts for remaining variability**
  - The magnitude of effect for this input depends on the standard deviation in our dataset.

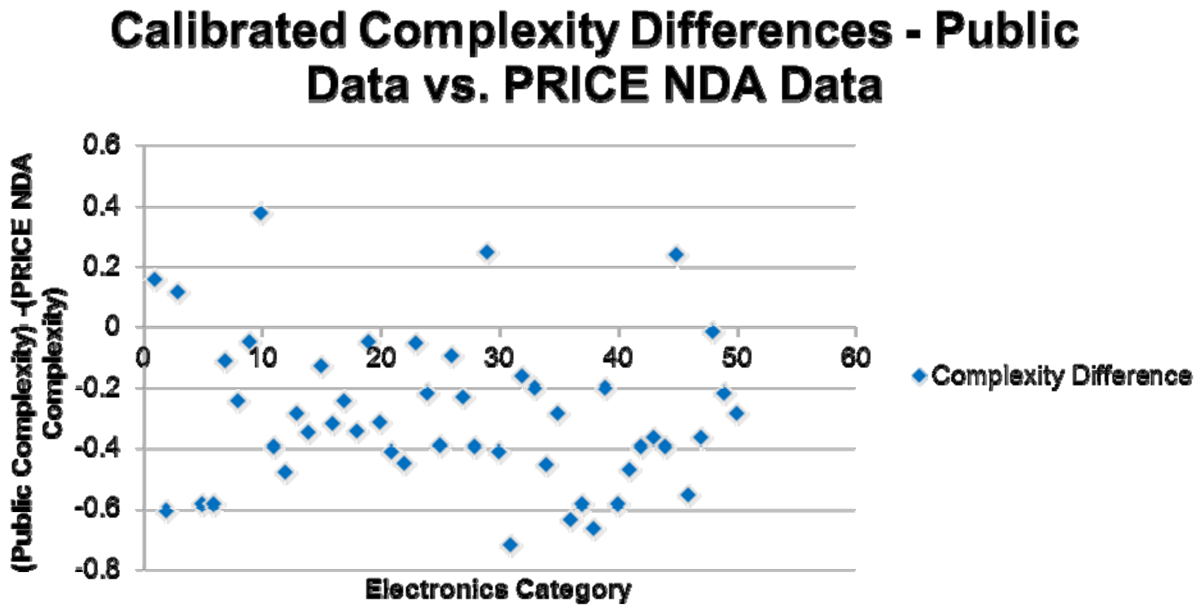
Final Calibration Step

- **By comparing to our private PRICE dataset (protected by NDA), we can see that relative complexities seem correct**



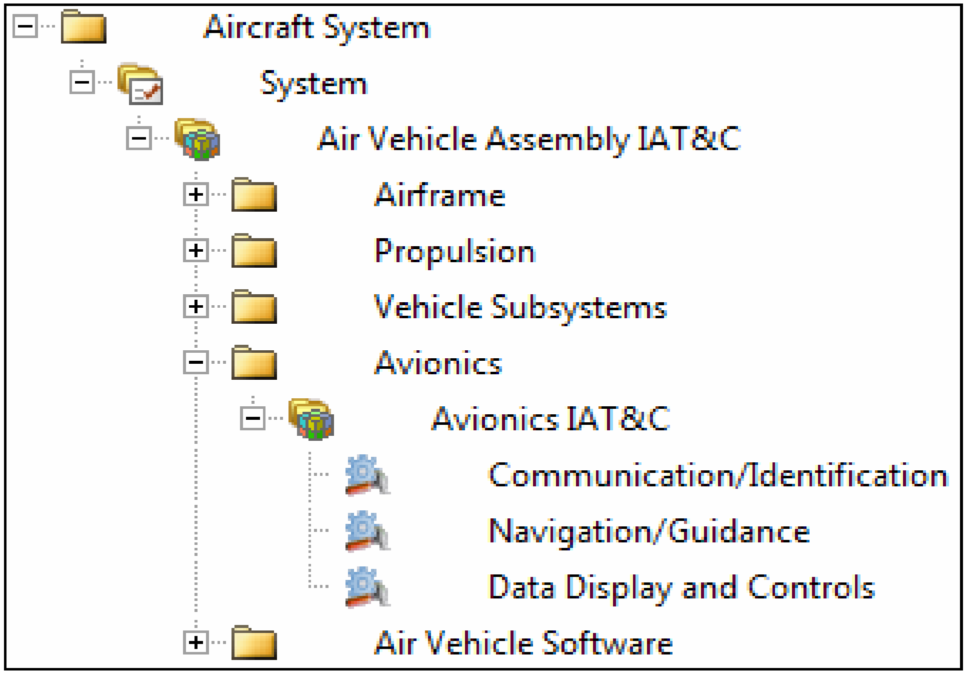
Final Calibration Step

- **Relative complexities match our data, but absolute complexity is off.**



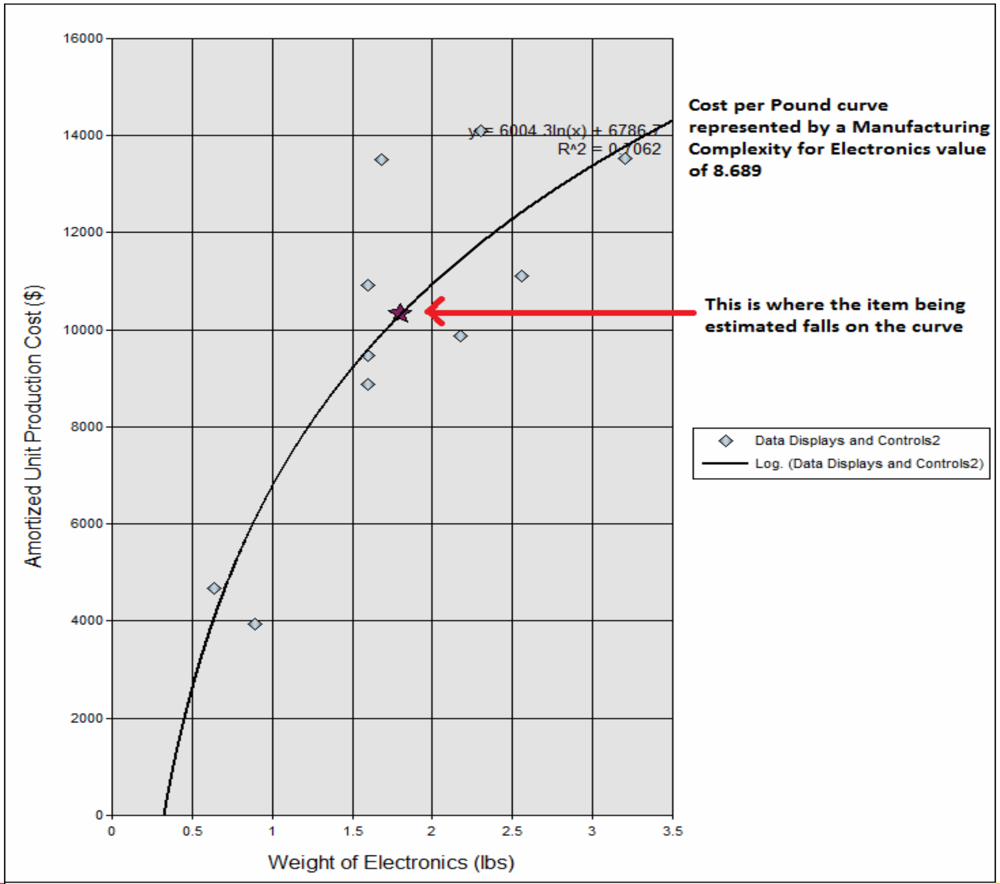
Defending Your Estimate

- **The goal is to empower users to defend their estimates**
- **Example: Aircraft Avionics Cost Estimate**



Defending Your Estimate

- **Quantities, Schedule? From Project Office or RFQ**
- **Weight? From Weight Statement**
- **Manufacturing Complexity for Electronics?**



Questions