JSC/EC5 U.S. Spacesuit Knowledge Capture (KC) Series Synopsis

All KC events will be approved for public using NASA Form 1676.

This synopsis provides information about the Knowledge Capture event below.

Topic: Rules of Thumb for Cost Estimating

Date: April 18, 2008 **Time:** Unknown **Location:** JSC

DAA 1676 Form #: 33156

This is a link to all lecture material and video: \\js-ea-fs-01\pd01\EC\Knowledge-Capture\FY08 Knowledge Capture\20080418_G.Thomas_ Cost Estimating\For 1676 Review & Public Release

*A copy of the video will be provided to the NASA Technical Library and STI Program's YouTube via the Agency's Large File Transfer (LFT), or by DVD using the USPS when the DAA 1676 review is complete.

Assessment of Export Control Applicability:

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For 1676 review use_Synopsis_Thomas_Arizona Geo Trip_3-27-2008.docx

Presenter: Gretchen A. Thomas

Synopsis: Gretchen A. Thomas presented "Rules of Thumb for Cost Estimating" on April 18, 2008.Thomas discussed best practices for estimating project costs.

Biography: Gretchen Thomas has worked for NASA for more than 20 years in PLSS technology development and integration. She has served as the PLSS architecture and integrated testing lead for EVA technology development. Her specialty areas have included carbon dioxide removal systems, thermal control systems, and system integration and analysis. Thomas earned a bachelor of science in mechanical engineering from the University of Houston, and in 2000, she received a master of science in space studies from the University of North Dakota.

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Cost Estimating Knowledge Capture

Gretchen A. Thomas

4/18/08

Realities

- A *good* cost estimate take time to build
- Management will never give you enough time
- The shorter your allowance, the more you must account for uncertainties and things you will forget
- Management will ask for the data again in a different format, so *DOCUMENT* your assumptions and label your cost components well

Words of Encouragement

Everything that we do (hardware, documents, mission support) is created by the hourly work of people—you are people—therefore you can do this. You simply have to boil down your project to the number of hours you think is required to complete a series of tasks.

Where do I start?

- *Get Organized* the first essential step
  - Know what you are building
  - Know your schedule (ideal vs. dictated)
  - Choose your cost estimating method based on your data needs and estimating schedule
  - The quantity of work to complete a job is fixed
    - use an ideal schedule and one labor source to begin then make adjustments to fit your situation
  - Document your assumptions

Cost Estimating Methods

- Cost Estimating Relationships
  - NASA Air Force Cost Model (NAFCOM)
  - Analogy estimate which references a similar piece of hardware
  - Cost estimating relationships (e.g., system weight, uncertainty) that apply statistical equations based on analysis of an existing database
  - Training classes are available, and the model is accessible after training

Cost Estimating Methods

- Parametric Cost Estimating
  - Use a historical database as a reference when estimating the cost of a future project
  - Advantage: Arrives at a fairly quick "ballpark" estimate without requiring a large amount of component detail
  - Disadvantage: High cost risk potential if the actual project is sufficiently different than the database, and those differences are not recognized during initial budgeting exercises
  - Contact: LW/Kelley Cyr

Cost Estimating Methods

- Grass Roots or Bottoms Up Estimating
  - Based on identifying the labor hours and material required for a project
  - Build the estimate from a low-level of component detail
  - Advantages: results in a high level of visibility into the project costs, and the ability to examine the details for missing data. This can lead to more accurate estimates.
  - Disadvantage: requires expert knowledge about the system being estimated, and a high level of system definition

Tools

- Excel is your friend
  - o Use the formulas and defined variables for values
    - used in multiple calculations (e.g., CTSD overhead, number of crewmembers/mission)
    - likely to change over time (e.g., labor rates, inflation factors)
  - o Document your assumptions (a.k.a., basis of estimate or rationale) as you go, in the spreadsheet—
    - more is better
    - keep it simple
- Microsoft Project

Organize Your Project

- EA-WI-023 Based Schedule
  - Essential for capturing all the overhead activities
    - Planning
    - Requirements development
    - Reviews
    - Hardware fidelity
  - Helpful for determining the order of magnitude of activities and the cost profile

Organize Your Project

- Product based Work Breakdown Structure (WBS)
  - Essential for capturing all the hardware pieces
  - Useful for capturing material dollars
  - Try to picture the individual parts in sufficient detail to estimate the design effort
    - Examples:
      - A fan includes rotors, housing, switches, electrical harness, motor, sensors, and an assembly (multiple drawings)
      - A relief valve includes a housing and spring (probably one drawing)

Go!

- A journey of a 1000 miles begins with a single step
- Examples:
  - CY2000 EVAS Estimate
  - FY2006 Umbilical Estimate
  - FY2006 BUR/Reference Architecture

Rules of Thumb

Drawing	Size	Hours
A	8 X 11”	8
B	11 X 17”	16
C	Folded	24
D		32
E	Desk Size	40
J	Rare	80

- Includes initial design and drafting to release
- Add 10% for support, administration, approval
- Document the components and number of drawings chosen

Rules of Thumb

- Document Preparation
  - 4 hrs/page for documents
    - project plans
    - concept of operations
  - 8 hrs/page for more difficult documents
    - analysis intensive
    - trade studies
  - 10 hrs/page for documents requiring intensive research and multiple revisions
    - SOWs
    - Requirements Documents
  - does not include reviewer overhead which should be booked as part of management oversight (10-15%)

Rules of Thumb

- Research, Breadboard, & Prototype Components
  - A research effort takes ~1 person for 3-9 months + materials & testing [~$200K]
  - A breadboard component takes 1 full time + 2-3 supporting (techs, jr engrs) + materials for 9-12 months [~$300-400K] adjust for difficulty or safety
  - A prototype component will be more integrated and have more configuration control than a breadboard [~$500-750K]
  - Packaging or miniaturization of a component is at least as challenging as the physical process being developed and counts as much as another component

Rules of Thumb

- Systems Test Branch (EC4) Guidelines

CTSD TESTING ROM COST GUIDE

BASED ON RATES OF $68.3K/MYE, 15% MAT'LS, $74/TON LN2

FACILITY	MYE'S	MATL'S	LN2	SUBTOTAL	FY97 INDIRECT COST (1.9%)	TOTAL
CH A T/V (COMPLEX TEST)	7.07	$72,432	1000 TONS	$629,313	$11,957	$641,270
CH A T/V (NOMINAL TEST)	5.01	$51,327	1000 TONS	$467,510	$8,883	$476,393
CH B T/V (HUMANNED)	5.00	$51,225	500 TONS	$429,725	$8,165	$437,890
CH B T/V (HUMANNED W/ SOLAR)	5.37	$55,016	550 TONS	$462,487	$8,787	$471,274
CH B (HUMANNED EMU TEST)	3.00	$30,735	500 TONS	$272,635	$5,180	$277,815
CH B T/V	3.01	$30,837	500 TONS	$273,420	$5,195	$278,615
CH B T/V (W/ SOLAR)	3.43	$35,140	550 TONS	$310,109	$5,892	$316,001
CH E (NOMINAL - 2 DAYS)	0.50	$2,732	53 TONS	$40,804	$775	$41,579
CH E (NOMINAL W/ SOLAR)	0.45	$2,459	53 TONS	$37,116	$705	$37,821
CH E (EXTENDED - 5 DAYS)	0.94	$5,136	113 TONS	$77,700	$1,476	$79,176
CH E (EXTENDED W/SOLAR)	1.04	$5,683	113 TONS	$85,077	$1,616	$86,693
ETA AIRLOCK HUMANNED (CREW TRAINING)	0.54	$2,951		$39,833	$757	$40,589
2' CHAMBER GLOVE TEST (1 DAY)	0.50	$2,732	5 TONS	$37,252	$708	$37,960
2' CHAMBER GLOVE TEST (PER ADDT'L DAY)	0.20	$1,093	5 TONS	$15,123	$287	$15,410
8' CH EMU ACCEPTANCE (3 RUNS)	1.25	$12,806		$98,181	$1,865	$100,047
11' CH HUMANNED (CREW FAMILIARIZATION)	0.55	$3,005		$40,570	$771	$41,341
11' CH HUMANNED (MAJOR BUILD-UP)	1.50	$15,368		$117,818	$2,239	$120,056
CH G T/V (COMPLEX - 5 DAYS)	0.30	$2,459	29 TONS	$25,095	$477	$25,572
CH G T/V (NOMINAL - 2 DAYS)	0.15	$0,820	14 TONS	$12,101	$230	$12,331
CH H CERTIFICATION (COMPLEX - 3 DAYS)	0.40	$2,186	19 TONS	$30,912	$587	$31,499
CH H CERTIFICATION (NOMINAL - 1 DAY)	0.20	$1,093	9 TONS	$15,419	$293	$15,712
CH K CERTIFICATION (COMPLEX - 3 DAYS)	0.25	$1,366		$18,441	$350	$18,791
CH K CERTIFICATION (NOMINAL - 1 DAY)	0.10	$0,546		$7,376	$140	$7,517
CH N T/V (COMPLEX - 5 DAYS)	0.40	$3,278	55 TONS	$34,668	$659	$35,327
CH N T/V (NOMINAL - 3 DAYS)	0.30	$1,639	25 TONS	[illegible]8,979	$456	$24,435
CH P T/V (OFF GASSING - 3 DAY)	0.20	$1,093	12 TONS	$15,641	$297	$15,938
CH T CERTIFICATION (COMPLEX - 3 DAY)	0.25	$2,049	16 TONS	$20,308	$386	$20,694
CH T CERTIFICATION (NOMINAL - 1 DAY)	0.10	$0,546	8 TONS	$7,968	$151	$8,120

** LN2 CONSUMPTION DATA FROM STB-F-1113
MATERIALS ESTIMATE BASED ON TEST BUILD-UP

- Contact: EC4/James Hampton

Margin

- You will forget something, and your project will encounter problems that require rework
- Typical project margin is 10-20%
- *Never* apply margin on the top line of the project, you are begging for it to be cut
- Apply margins at project phases, sub-phases, or specific hardware line items according to your comfort level and risk
  - Project Management is low risk, margin is small if not 0%
  - Well known technology can be 5-10% margin
  - New technology should be 10-20% margin

Other Resources

- Past projects of a similar nature
  - Metox = 2 major components, 1 static, 1 powered $15M (1996)
  - ORCA = 1 major powered component $11M (1998)
  - Numerous technology contracts $150K-$1M (1987-2008)
- Ask your Co-workers for their experiences
- Cost estimate in teams of two (more by exception)
- NASA Cost Estimating Website http://cost.jsc.nasa.gov/
- Budget analysts (LE mail code) for labor rates

Don’t Forget

- Miscellaneous / often missed categories
  - Procurement activities
  - Design reviews – preparation of documents + the actual meeting duration
  - Paperwork Closure – do not underestimate this!
  - Team startup / education on project history and goals – allow 2-3 months until full productivity
  - Test buildup – even mature facilities will need calibration and modifications
  - Shipment and stowage of flight items


Questions?