TRUE PROGRAM SUCCESS '05

PRICE Systems' US Symposium
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Tampa Bay, Florida
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Software Sizing Model (SSM)

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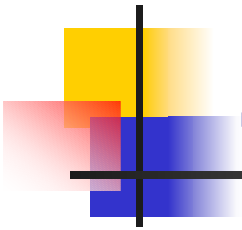
Target Software

PRICE

Why estimate software size?

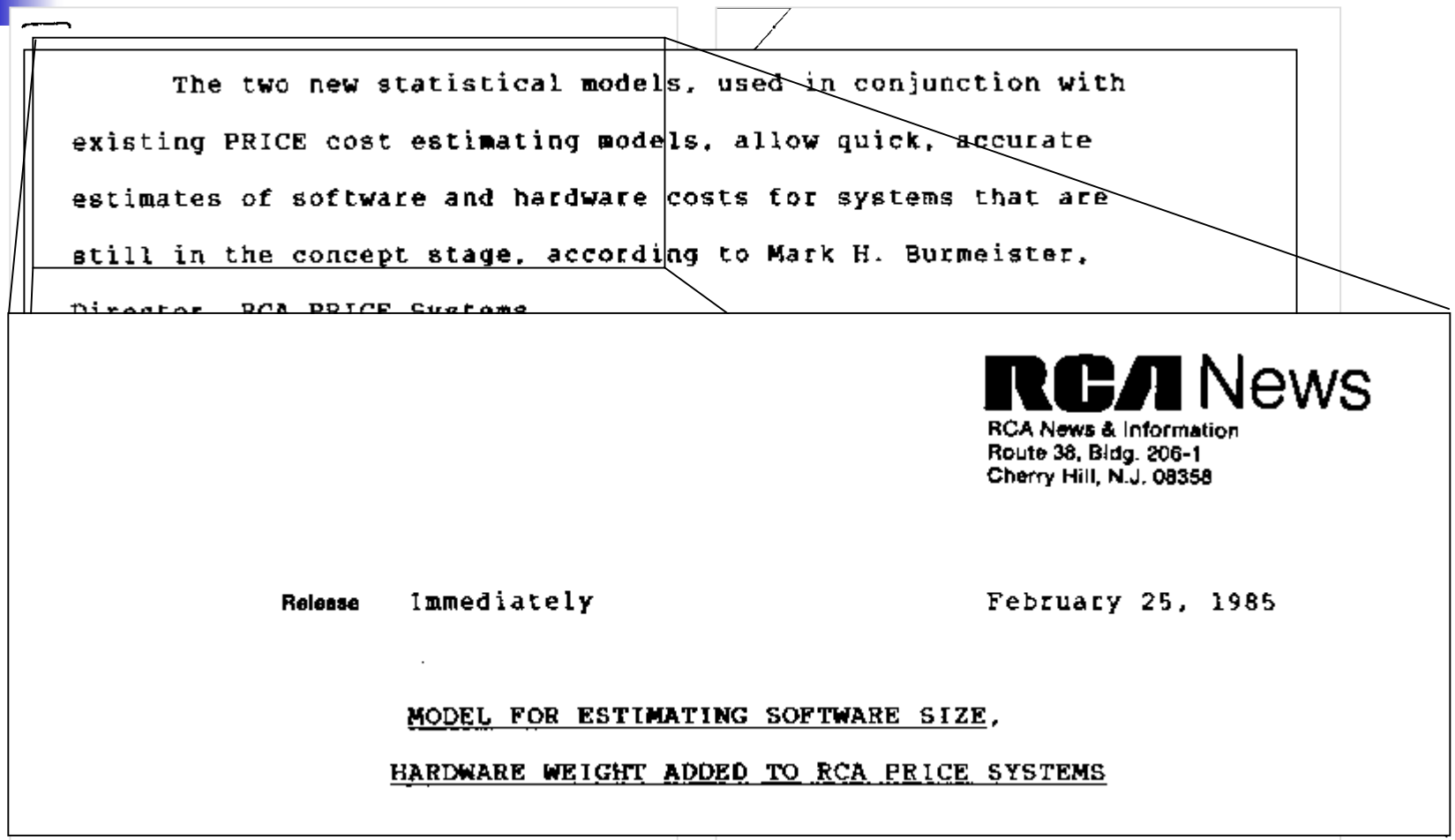
- Because accurately projecting the size of a proposed software product or system remains the weakest link in the software cost estimating chain.
- Due to the lack of definitive information during the proposal and design phases of software product and system development, size estimates made in those phases are characterized by uncertainty, generally resulting in estimates of very low credibility or validity.
- A survey of major software programs has shown that highly inaccurate cost estimates are largely due to erroneous software sizing.
- Underestimating the required number of lines of code frequently causes cost and schedule overruns on software-intensive programs.



SSM History

- The Software Sizing Model is one of the most mature in use today.
  - The model was developed in 1980.
  - It was commercially introduced by RCA PRICE Systems in 1985 and continues to evolve with technology.

SSM History



The two new statistical models, used in conjunction with existing PRICE cost estimating models, allow quick, accurate estimates of software and hardware costs for systems that are still in the concept stage, according to Mark H. Burmeister,

Director, RCA PRICE Systems

RCA News

RCA News & Information
Route 38, Bldg. 206-1
Cherry Hill, N.J. 08358

Release Immediately

February 25, 1985

MODEL FOR ESTIMATING SOFTWARE SIZE,

HARDWARE WEIGHT ADDED TO RCA PRICE SYSTEMS

SSM Advantages

- A key advantage of SSM is that it can be applied very early in the development life cycle, even during the requirements analysis phase. This helps produce accurate cost and schedule estimates for contract and product proposals.
- SSM provides an embedded knowledge base that allows users to start estimating based upon historical data before collecting their own data.
  - This knowledge base contains actual data from 22 modules produced for a variety of commercial and government systems.
  - In addition, ***SSM helps create a corporate repository of sizing data. Accurate sizing history in your own domain enhances the credibility and accuracy of your cost and schedule estimates***.

SSM Overview

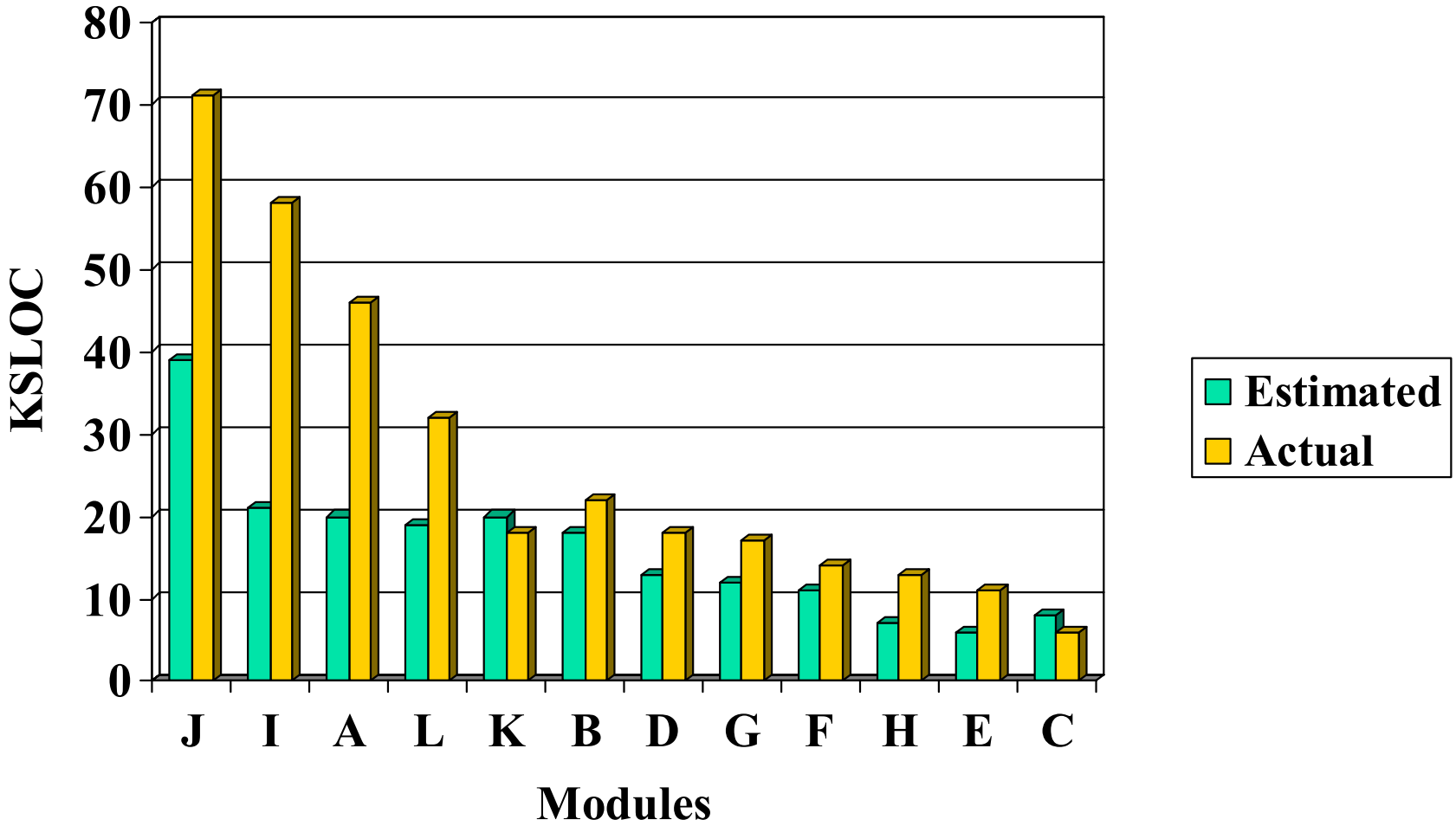
- Is a computerized simulation model providing rapid, accurate estimates of the size of a software project.
- Is a fully interactive, self-documented, menu-driven model with an extensive help facility.
- Is an expert judgement type of model based upon three key facts:
  - The qualitative sizing information available at the proposal stage is more accurate than the corresponding quantitative data.
  - Estimators can make estimates of the relative sizes of modules more reliably than they can estimate their absolute sizes.
  - ***The estimated and actual relative magnitude of software modules are strongly correlated.***

Historical Sizing Data (Bozoki, 1979)

Module	Estimate	Actual	Multiplier
J	39	71	1.82
I	21	58	2.76
A	20	46	2.30
L	19	32	1.68
K	20	18	0.90
B	18	22	1.22
D	13	18	1.38
G	12	17	1.42
F	11	14	1.27
H	7	13	1.86
E	6	11	1.83
C	8	6	0.75
Totals	**194**	**326**	**1.68**
Average Multiplier (Mean) =			**1.61**

83% indicate code growth.

Historical Sizing Data (Bozoki, 1979)

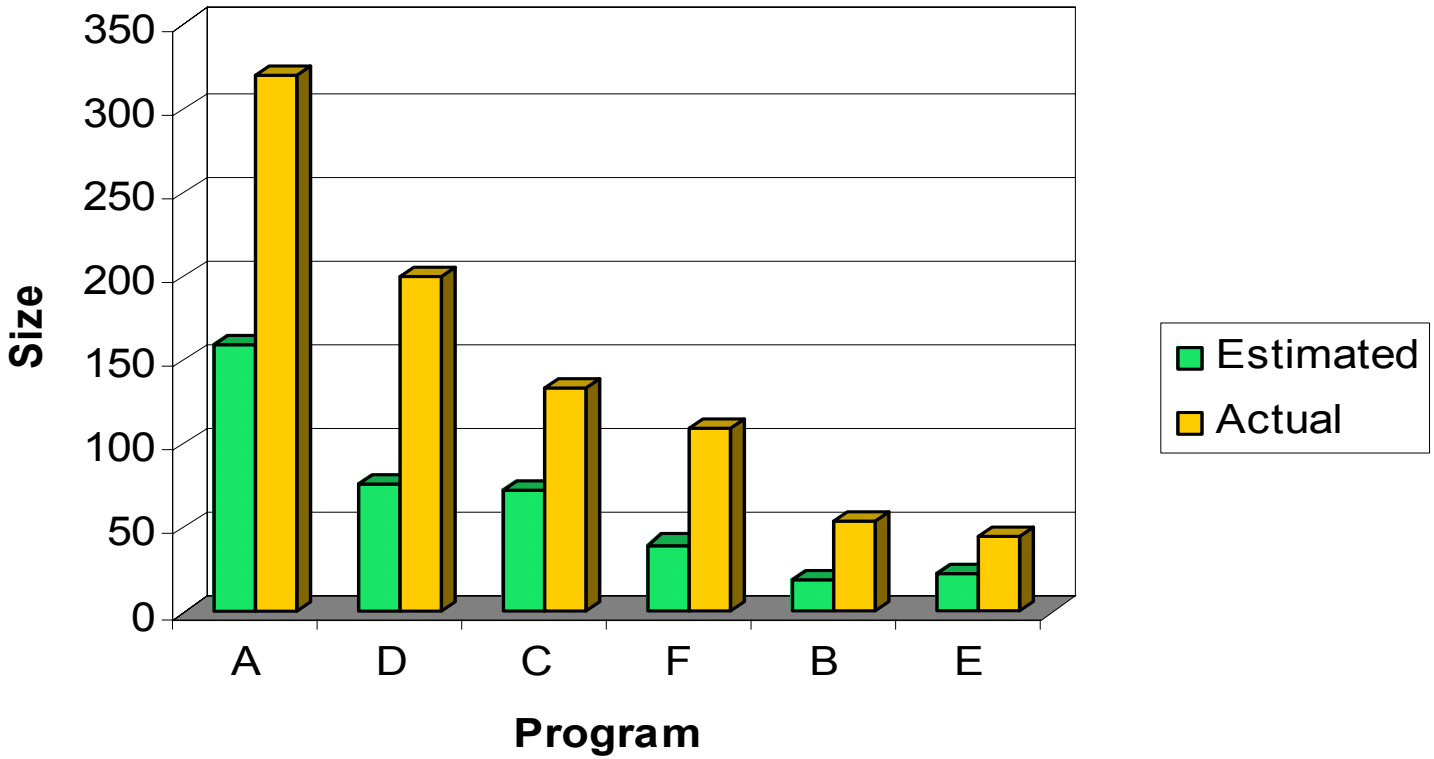


Historical Sizing Data (B. Holchin, 1991)

Module	Estimate	Actual	Multiplier
A	160	320	2.00
D	76	200	2.63
C	73	134	1.84
F	40	110	2.75
B	18	54	3.00
E	22	45	2.05
Totals	**389**	**863**	**2.22**
Average Multiplier (Mean) =			**2.38**

100 % indicate code growth.

Historical Sizing Data (Holchin, 1991)



Historical Sizing Data
(L. G. Long, Aerospace Corp., 2004)

Serial No.	Estimated LOC	Actual LOC	Multiplier
423	532000	877129	1.65
80	618000	709000	1.15
370	100000	122000	1.22
127	39294	119400	3.04
392	14000	70143	5.01
405	39700	60544	1.53
90	41800	46303	1.11
59	34900	44972	1.29
294	22000	30000	1.36
53	21300	29360	1.38
268	18100	26953	1.49

Historical Sizing Data
(L. G. Long, Aerospace Corp., 2004, cont.)

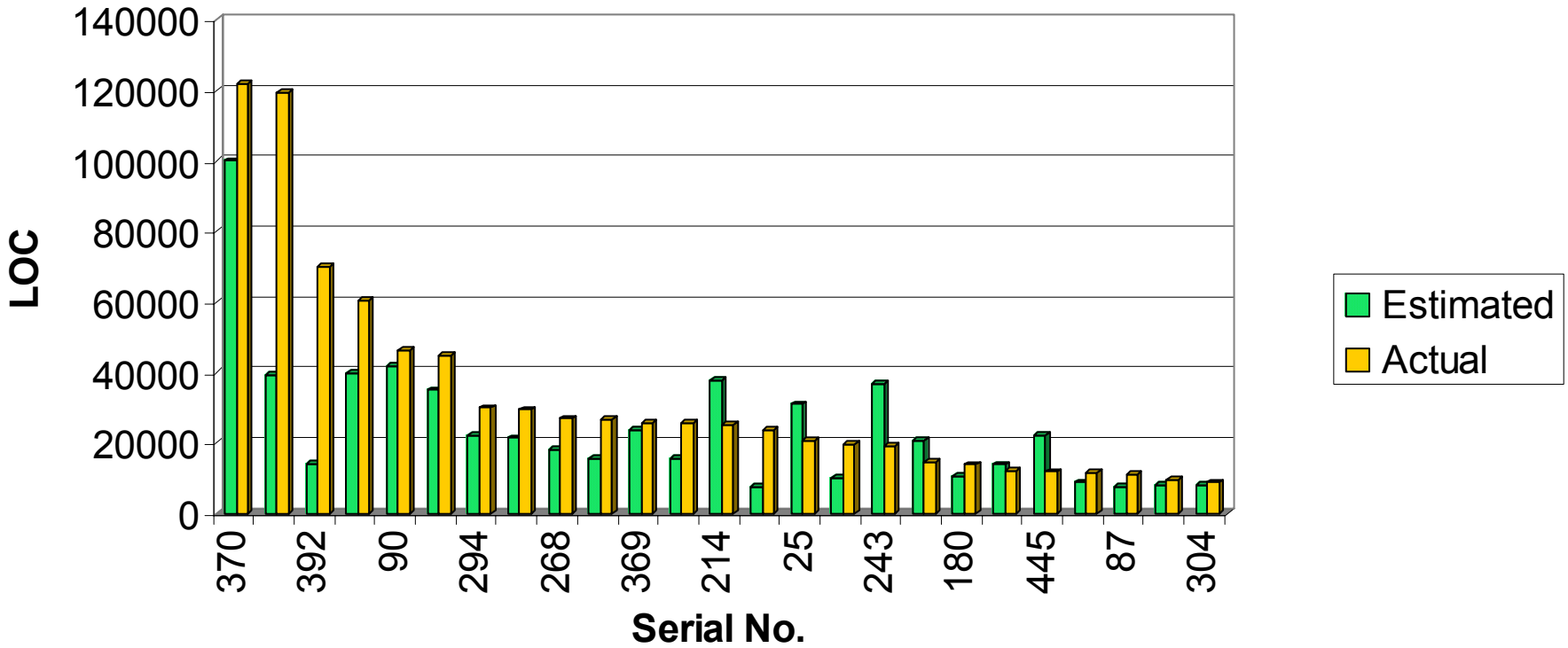
Serial No.	Estimated LOC	Actual LOC	Multiplier
136	15500	26513	1.71
369	23549	25804	1.10
98	15700	25637	1.63
214	37600	25304	0.67
33	7500	23630	3.15
25	30900	20712	0.67
308	10100	19619	1.94
243	36800	19207	0.52
379	20500	14519	0.71
180	10400	13837	1.33
281	13800	12115	0.88
445	22000	11863	0.54

Historical Sizing Data
(L. G. Long, Aerospace Corp., 2004, cont.)

Serial No.	Estimated LOC	Actual LOC	Multiplier
356	8700	11702	1.35
87	7500	11082	1.48
256	7900	9455	1.20
304	7900	8718	1.10
Total LOCs	**1757443**	**2415521**	**1.37**
Average Multiplier (Mean) =			**1.49**

80% indicate code growth.

Historical Sizing Data (L. G. Long, Aerospace Corp., 2004)

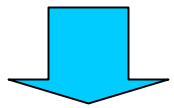


The Four Types of Scales

	No Natural Origin	**Natural Origin**
No Distance	Ordinal Scale	Ordinal Scale with Natural Origin
Distance	Interval Scale	Ratio Scale

Schematic of SSM

Inputs:
- Relative magnitude of modules.
- Reliable estimates of at least one module size.



SSM

(Software Sizing Model)

- Statistically relates individual input to attain ranking of modules.
- ***Maps relative ranking to module sizes with the aid of reference module(s).***

Application of SSM in the Software Life Cycle Phase

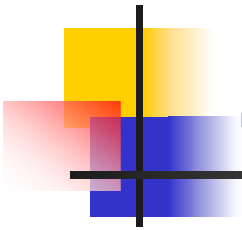
- Can be employed in any phase of the software development cycle in which the user can partition the software project into modules (components, CSCIs, CSCs, etc.) whose operational and functional characteristics are define.
- Key criteria for SSM sizing is that the 'expert' participants must be able to discriminate among the modules with respect to magnitude.

Number of Estimators Required

- Ideally, each of the data sets should be provided by a different expert.
  - Under this scenario the number of estimators should be four (4).
- The number of estimators providing the four Input data sets can range from one (1) to four (4)
- Each data set must be treated independently, and responses should NOT be correlated.
- All inputs deal with size information only.

SSM Data Requirements

- Project Information
- Module Name and Description
- Four Input Data Sets
  - Pairwise Data Sets
  - PERT Sizing Data
  - Sorting Data
  - Ranking Data
- At least one module of known size (Reference Module)



SSM Output

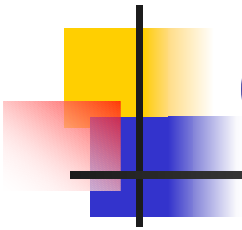
- Output to software cost models
  - Module Sizes
  - System Size
  - Standard Deviations
  - Confidence Limits
- Results in
  - More credible cost estimates

Conclusions

- SSM provides credible size estimates,arguably the most accurate size estimation model in use today.
  - Tests conducted by:
    - Illinois Institute of Technology for the Air Force Cost Center in 1987.
    - Dr. George Bozoki as reported in “Performance Simulation of SSM” at the ISPA 13th Annual Conference in 1991.
    - Bellcore as reported at Eighth International Forum on COCOMO and Software Cost Modeling at the SEI in 1993.
    - Hughes Aircraft Company as reported in the Journal of Parametrics, Volume XII, Number 1, May 1993.

Conclusions

- SMM mitigates code growth.
  - Bozoki, G.J., 2004, *Treatment of Code Growth*, Proceedings, 26th International Conference, ISPA, 2004.
- SSM is very effective for software enhancement and Engineering Change Projects (ECP's).
  - Changing only a few modules; not entire system.
  - n-1,2,3 known software units and estimating only 1, 2, 3…
    - More reference modules yield more accurate predictions.



Conclusions

- SSM is an easy to use, fully interactive, self-documented, menu-driven model with an extensive help facility.
- SMM can be applied early in the software life cycle.
- SSM provides an embedded knowledge base that allows users to start estimating based upon historical before collecting their own data.
  - This knowledge base contains actual data from 22 modules produced for a variety of commercial and government systems.
- SSM helps create a corporate repository of sizing data.
  - Accurate sizing history in your own domain enhances the credibility and accuracy of your cost and schedule estimates.

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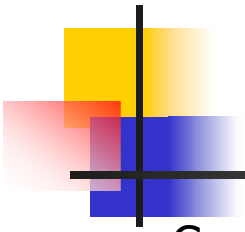

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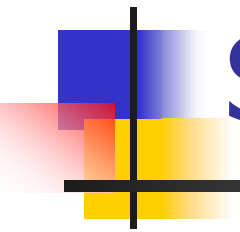


SSM XXI Demonstration

SSM XXI Enhancements

- SSM XXI is implemented with an improved user interface in the following ten (10) forms:
  - Input
    - Project Information – Includes Project Description
    - Module Data
    - Pairwise Data
    - PERT Sizing Data
    - Sort Sizing Data
    - Ranking Data
  - Output
    - Software Implementation Menu
    - Reference Module List
    - Module Size Summary
    - System Size Summary

SSM XXI Enhancements (cont)

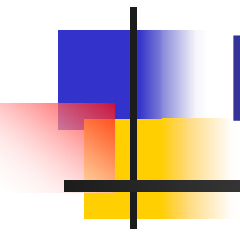
- Ranking Data entry has been redesigned, yielding a 78% reduction in data requirements from $\frac{n(n-1)}{2}$ to n
  - Where n is the number of modules

SSM XXI Enhancements (cont)

- Sizing Notes
  - The new ability to enter notes for each dataset is available via the "Sizing Notes" functionality.
  - Each dataset form has a "Sizing Notes" button in the top right corner.
  - The Sizing Notes are useful for reference during work on the project and to provide rationale for your inputs.
    - Especially good for archive purposes to help remember the rationale at a later date.
  - Sizing Notes reports are accessible via the Reports menu.

SSM XXI Enhancements (cont)

- Capability to copy a module size from the Module Size Summary has been added.
  - The estimates associated with a selected module are copied to the clipboard, which can then be pasted to a software cost model or other application.



Demonstration