Information Technology Estimation & Measurement

PRICE Systems
PSM
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Outline

- Overview
- Approach
- Why Size IS Critical
- Application Complexity & Personnel Capability
- Measurement Leads To Better Decisions

Overview

History

- Customers since 1986
  - NASA
  - Alcatel
  - Fidelity Investments Systems Company
  - FESCO
  - FICL
  - FIRSCO
  - US Navy
  - US Navy ERP Implementation
  - US Army
  - City of Los Angeles
  - National Archives

Customer Goals

- Baseline existing capability
- Evaluate critical projects and or products
- Manage portfolios of projects
- Prepare budget submittals for OMB

Value Statement

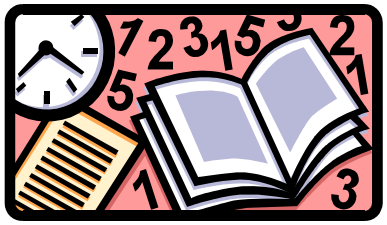
- We can provide our clients with accurate IT Project Cost Estimates using our 18 years of experience in the field, well defined processes & methods, and state of the art tools.
- By providing auditable budget submittals we will enable OMB acceptance of exhibit 300 submittals, produce positive results from GAO audits and improve relationships with Congress.
- We also provide detailed cost estimates with reasonable schedules, requirements linked to their marginal costs and the identification of programmatic risks.
- We provide our clientele with objective, independent status for ongoing multi-year IT investments
- We enable our clients to meet cost objectives, provide user functionality in a predictable fashion and intelligently manage cost expansion.

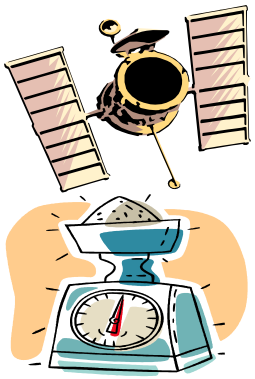
Key Points

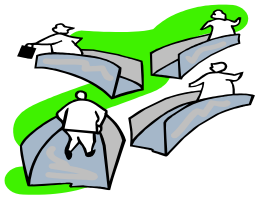
1. We use a repeatable process to develop estimates
2. Local historical data provides an improved estimation capability
   - PRICE Tools can fill the gap if no data is available
   - Tools work best if calibrated with local data
3. We collect data initially based upon our estimation process
   - Set up a feedback loop within the estimation process to refine it with local data
4. Initially we focus on a few key areas
   - Size
   - Complexity
   - Personnel attributes
5. We expand focus on a as needed basis

People Tools and Processes

(q6,7)







Requirements

- What does it do?
- When do we need it?
- Where will it work?

Size

- How much Software?
- How much Hardware?
- What Life Cycle?
- How much new
- How much reuse ?
- How much changed ?

Complexity

- Contractual situation?
- What types of software?
- Who will build it?
- What will it be built with?
- What kinds of Hardware
- Hardware vs. Software

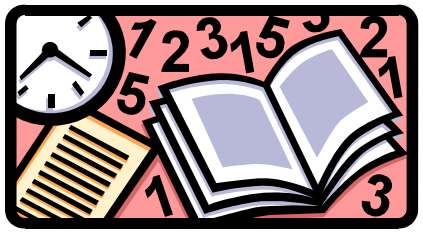
Risks

- What can go wrong?
- New Technology?
- Market risks?

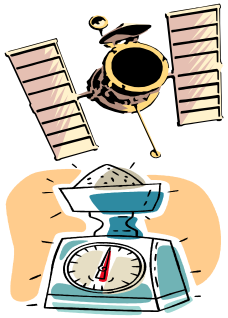
PRICE Tools

PRICE Experience and Processes

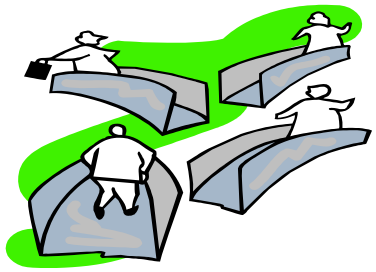
Expertise



- Requirements discovery
- Map requirements to Size
- Document requirements



- Function Point Analysis
- Historical Size Data Collection
- SW Size Models
  - ❖ SLOC
  - ❖ Functional



- Application Complexity
- Effort Data
- Quality Data

- Identify Standard Risks
- Identify Unique Risks
- Risk Mitigation

7 Questions

(To determine level of trust in a software estimate)

1. Are the objectives of the estimate clear and correct?
2. Has the task been appropriately sized?
3. Are the estimated cost and schedule consistent with demonstrated accomplishments on other projects?
4. Have the factors that affect the estimate been identified and explained?
5. Have steps been taken to ensure the integrity of the estimation process?
6. Is the organizations historical evidence capable of supporting a reliable estimate?
7. Has the situation changed since the estimate was prepared?

Software Engineering Institute

http://www.sei.cmu.edu/pub/documents/95.reports/pdf/sr004.95.pdf

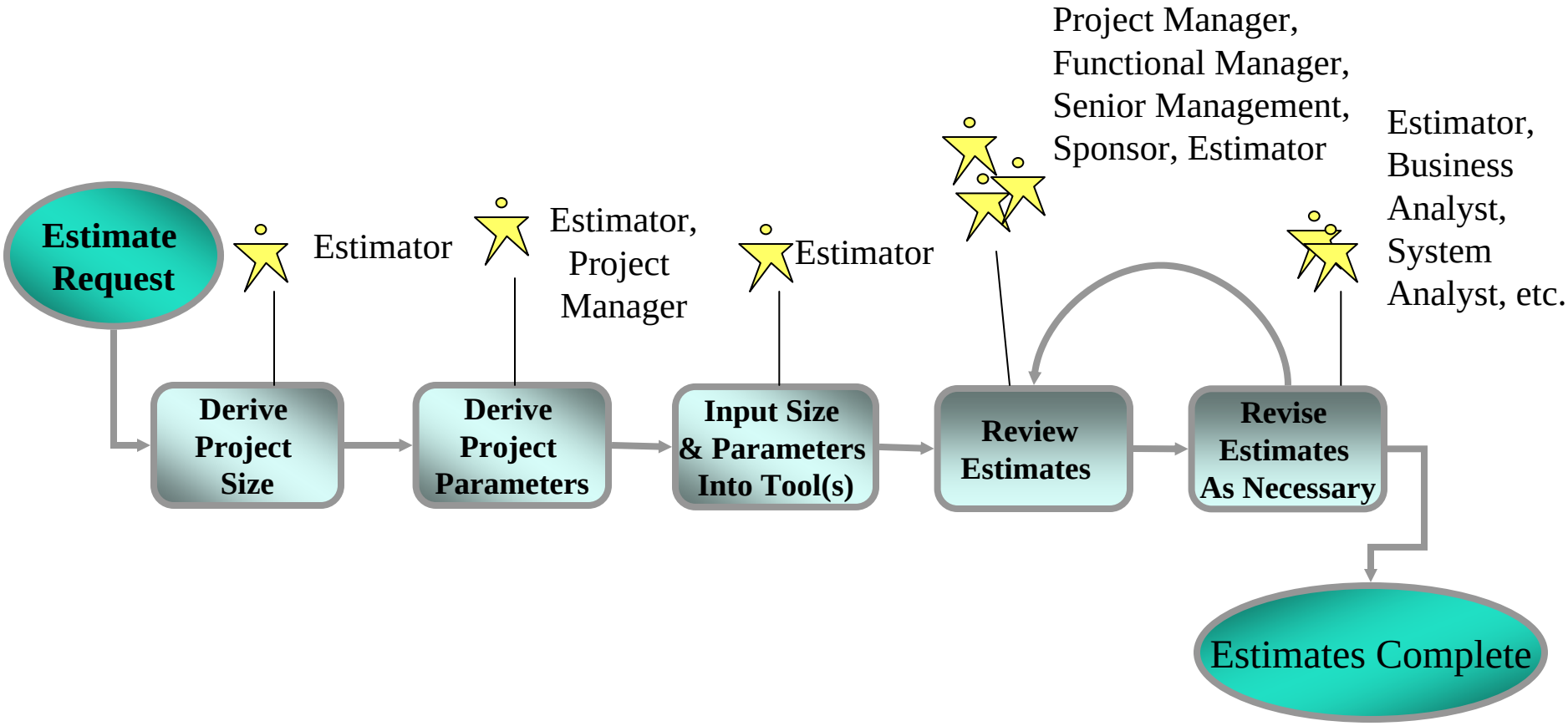
6 Organizational Characteristics

(Required to have a Reliable Estimation Capability)

1. A corporate memory (historical database)
2. Structured process for estimating product size and reuse
3. Mechanism for extrapolating from demonstrated accomplishments on past projects
4. Audit Trails, values for cost model parameters used are recorded and explained
5. Integrity in dealing with dictated cost and schedules
6. Data collection and feedback processes that foster capturing and correctly interpreting data from work performed

We apply the above characteristics to develop organizational measurement programs

Cost Estimation Process



Name	Purpose
Estimation Process	• To develop estimates for a software development/enhancement project at the endpoint in the life cycle that the requirements have been baselined (i.e. through existence of a System Prospectus, SDS).

Input	Activities	Output
☐ Request to develop an estimate, accompanied by: ☐ Set Of Requirements ☐ System Context Diagram ☐ System Data Model ☐ System Process Model	1.0 Derive Project Size. Analyze Requirements and identify unit counts of transactions and data entities: • Screens, • System Feed, • Files or Data Tables, • Report, • Data Queries. Translate unit counts into function points utilizing the Function Point Spreadsheet 2.0 Derive Project Parameters. Analyze Requirements and Identify Pertinent Project Parameters • Processes/Systems Hardware Environment in use • Business imposed limitations (budget, staff, dates) • Personnel capabilities/Experience • Application type (Web, Client Server, etc.) • Project classification (development vs. enhancement) • Dependencies (systems and other projects) • Identify other project related costs not typically associated with software development (e.g. data scrubbing). 3.0 Input size and parameters into appropriate estimation tool (s)to generate estimates of effort, schedule, quality and cost. 4.0 Review Estimates With Managers • Validate estimate and associated assumption • Review atypical costs • Obtain buy-in • Identify risk to project objectives • Create action plan to mitigate risks 5.0 Revise Estimates As Necessary • Modify size • Modify parameters • Return to step 3	☐ Software Estimate Document ☐ Project Description/Context Setting ☐ Size (Function Points) ☐ Effort ☐ Resource Categories By Task ☐ Duration ☐ Schedule ☐ Quality ☐ Cost ☐ Unit Count of ☐ Screens ☐ System Feed ☐ Files or Data Tables ☐ Reports ☐ Data Queries
Entry Criteria		**Exit Criteria**
☐ System Prospectus completed ☐ Project Charter completed		☐ Software Estimate Document completed ☐ Review with management and stakeholders completed ☐ Action items resolved

Approach

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Process Overview

- Step 1: Document purpose of the estimate
- Step 2: Develop size estimate
- Step 3: Document pertinent project parameters
- Step 4: Estimate effort and schedule
- Step 5: Review estimate

Technical Approach

- Develop size estimates from requirements
- Work with technical team to extend requirements to develop a technical baseline
  - Transactions
    - Inputs (create, update, delete) transactions
    - Outputs (reports – processed data)
    - Inquiries (read data only)
  - Data Objects
    - Data group owned by new systems
    - Data groups owned by other systems but read by new system

Technical Approach

- Map requirements to technology
  - Assign requirements to applications
  - Identify COTS for applications
  - Identify reuse potential
  - Identify where new development is required
- Run iterations for architectural options
- Same process applied for development or maintenance costs

Why Size Is Critical

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Case Study

Cost Categories	CEO	VP	USER
Function Points	93	819	1,436
total hours	947	8,859	15,788
Total Cost	$99,481	$930,169.8	$1,657,743
rate/hour	105	105	105
person months	6	57	102
person years	0.5	4.8	8.5
Defects	13	147	273
FP/PM	15	14	14
Project Start	6/1/2000	6/1/2000	6/1/2000
SRA/PPI Complete	6/10/2000	7/25/2000	8/8/2000
TSD Complete	8/1/2000	11/21/2000	1/4/2001
TPD Complete	9/7/2000	2/14/2001	4/21/2001
SIT Complete	9/7/2000	2/14/2001	4/21/2001
System Test Complete	9/21/2000	3/24/2001	6/7/2001
Install Complete	9/27/2000	4/8/2001	6/25/2001

- Management wants to know how cost went from $100K to $1.7M
- You can use your size estimate to explain changes in the estimate
- You can use your size estimate as an early warning system to keep trouble away
- You can use your size estimate to identify marginal cost for features

Functionality/CEO

Estimate for CEO	8	2	4	3	0	93	83	34	11	15	22
Name	**inputs**	**outputs**	**inquiries**	**files**	**ex files**	**Index**	**Note**	**inputs**	**outputs**	**inquiries**	**files**
maintain core personnel data	3	2	1	1			35 data elements,	13	11	4	7
online help	2		2	1			add, edit, delete	9	0	8	7
maintain users access data	3		1	1				13	0	4	7

Assumption

- System developed in Oracle
- Team has completed several Oracle Projects
- Team has completed several projects of this type
- Team has experience in this industry
- Requirements are stable

Estimate/CEO

Function Points	Function Point Per Person Month	Defects/ Function Points								
93	**15.2**	**0.14**								
Activity	**System Designers/ Analysts**	**Programmers**	**Test Engrs.**	**Project Mgt.**	**QA/ CM**	**Tech Pubs**	**Total Hours**	**Activity Length (Days)**	**Start Dates**	**End Dates**
Requirements Analysis	104	0	49	12	17	7	189	9	6/1/2000	6/10/2000
Preliminary Design	76	24	30	10	12	6	157	28	6/2/2000	6/30/2000
Detail Design	115	36	45	15	18	9	236	54	6/7/2000	8/1/2000
Code and Unit Test	8	45	11	3	12	2	80	58	6/21/2000	8/18/2000
Integration and Test	35	24	59	7	39	7	171	72	6/27/2000	9/7/2000
System Integn & Test	20	7	20	3	16	3	68	112	6/1/2000	9/21/2000
Installation	17	6	9	2	11	2	47	**62**	**7/27/2000**	**9/27/2000**
Total	374	141	223	51	124	35	947	**118**	**6/1/2000**	**9/27/2000**

Functionality VP of Development

Size Estimate for VP	74	13	24	34	0	819	731	318	70	91	252	0
Name	**inputs**	**outputs**	**inquiries**	**files**	**ex files**	**Index**	**Note**	**inputs**	**outputs**	**inquiries**	**files**	**ex files**
Initial Size Elements	8	2	4	3	0	93	83	34	11	15	22	0
add 4 other data types	12	4	4	4			support 5 different data feed formats	52	22	15	30	0
international data differences 1	2		1	1			UK	9	0	4	7	0
international data differences 2	4		1	1			Japan	17	0	4	7	0
international data differences 3	10		1	5			Germany	43	0	4	37	0
international data differences 4	2		1	1			Taiwan	9	0	4	7	0
Data Providers		7		7			7 data providers	0	38	0	52	0
Data Consumers	36		12	12			12 data consumers	155	0	46	89	0

Assumption

- System developed in Oracle
- Team has completed several Oracle Projects
- Team has completed several projects of this type
- Team has experience in this industry
- Requirements are stable?

Estimate @ VP

			Estimate @ VP							
Function Points	**FP/Person Month**	**Defects/ Function Points**								
819	**14.3**	**0.18**								
Activity	**System Designers/ Analysts**	**Prog.**	**Test Engrs.**	**Project Mgt.**	**QA/ CM**	**Tech Pubs**	**Total Hours**	**Activity Length (Days)**	**Start Dates**	**End Dates**
Requirements Analysis	958	0	451	107	155	63	1733	54	6/1/2000	7/25/2000
Preliminary Design	725	225	283	92	113	54	1490	81	6/19/2000	9/9/2000
Detail Design	1087	337	424	138	169	81	2235	118	7/26/2000	11/21/2000
Code and Unit Test	61	359	90	26	94	14	643	104	9/17/2000	12/30/2000
Integration and Test	343	229	571	68	382	69	1662	119	10/18/2000	2/14/2001
System Integn & Test	190	68	195	27	152	27	659	296	6/1/2000	3/24/2001
Installation	155	56	89	18	100	18	436	**163**	**10/27/2000**	**4/8/2001**
Total	3519	1273	2102	475	1164	326	8859	**311**	**6/1/2000**	**4/8/2001**

Functionality from Users

	124	47	25	54	0	1436	1282	533	254	95	400	0
Name	inputs	outputs	inquiries	files	ex files	eferenc	Note	inputs	outputs	inquiries	files	ex files
Second Size Estimate	74	13	24	34	0	819	731	318	70	91	252	0
								0	0	0	0	0
Data Encryption	5			5			encryp any standard phone inputs if international	22	0	0	37	0
Ad HOC report Writer	3	6	1	1				13	32	4	7	0
error notification		14					initial error notification and correction notification	0	76	0	0	0
data push	21	7		7			initiate data correction to providers	90	38	0	52	0
data pull	21	7		7			initiate data correction from consumers	90	38	0	52	0

Assumption

- System developed in Oracle
- Team has completed several Oracle Projects
- Team has completed several projects of this type
- Team has experience in this industry
- Requirements are stable?

Estimate @ User

				Estimate @ User						
Function Points	FP/Person Month	Defects/ Function Points								
1,436	14.1	0.19								
Activity	System Designers/ Analysts	Programmers	Test Engrs.	Project Mgt.	QA/ CM	Tech Pubs	Total Hours	Activity Length (Days)	Start Dates	End Dates
Requirements Analysis	1699	0	800	190	274	111	3074	68	6/1/2000	8/8/2000
Preliminary Design	1297	402	506	165	201	96	2667	100	6/26/2000	10/4/2000
Detail Design	1945	603	759	247	302	145	4000	145	8/12/2000	1/4/2001
Code and Unit Test	104	611	153	45	160	23	1095	131	10/13/2000	2/21/2001
Integration and Test	617	411	1029	122	688	124	2991	151	11/21/2000	4/21/2001
System Integn & Test	342	122	350	48	272	49	1185	371	6/1/2000	6/7/2001
Installation	277	99	159	32	179	32	777	**204**	**12/3/2000**	**6/25/2001**
Total	6281	2248	3754	847	2077	581	15788	**389**	**6/1/2000**	**6/25/2001**

Lessons Learned

- Document business problem, not sufficient to produce realistic estimates
- Involve all of the key players
- Examine existing capabilities
  - Nothing is 100% brand new
  - Nothing is really not like anything else
- Translate between business language and technical language

Application Complexity, Personnel Capability, Requirements Instability

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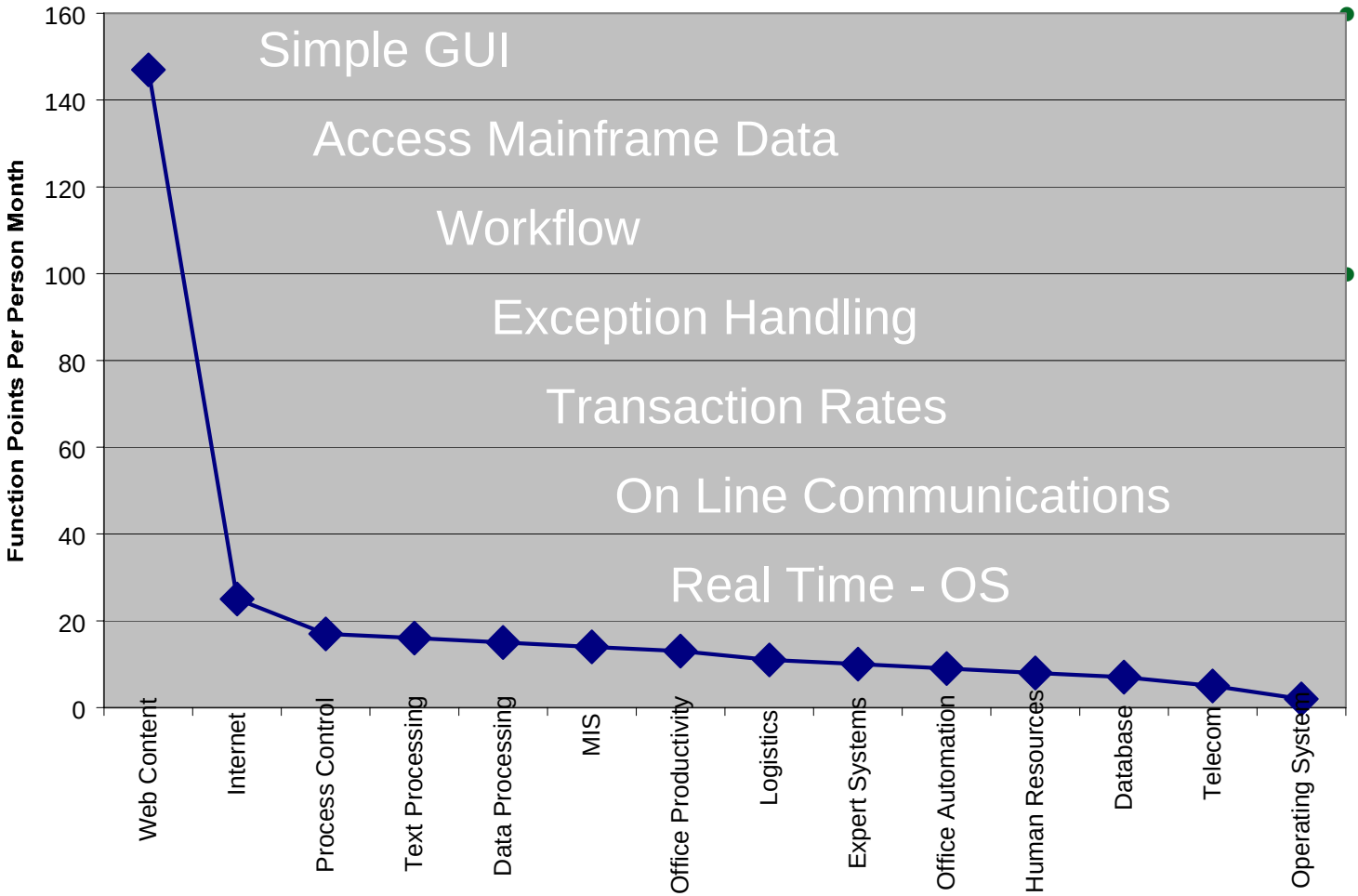
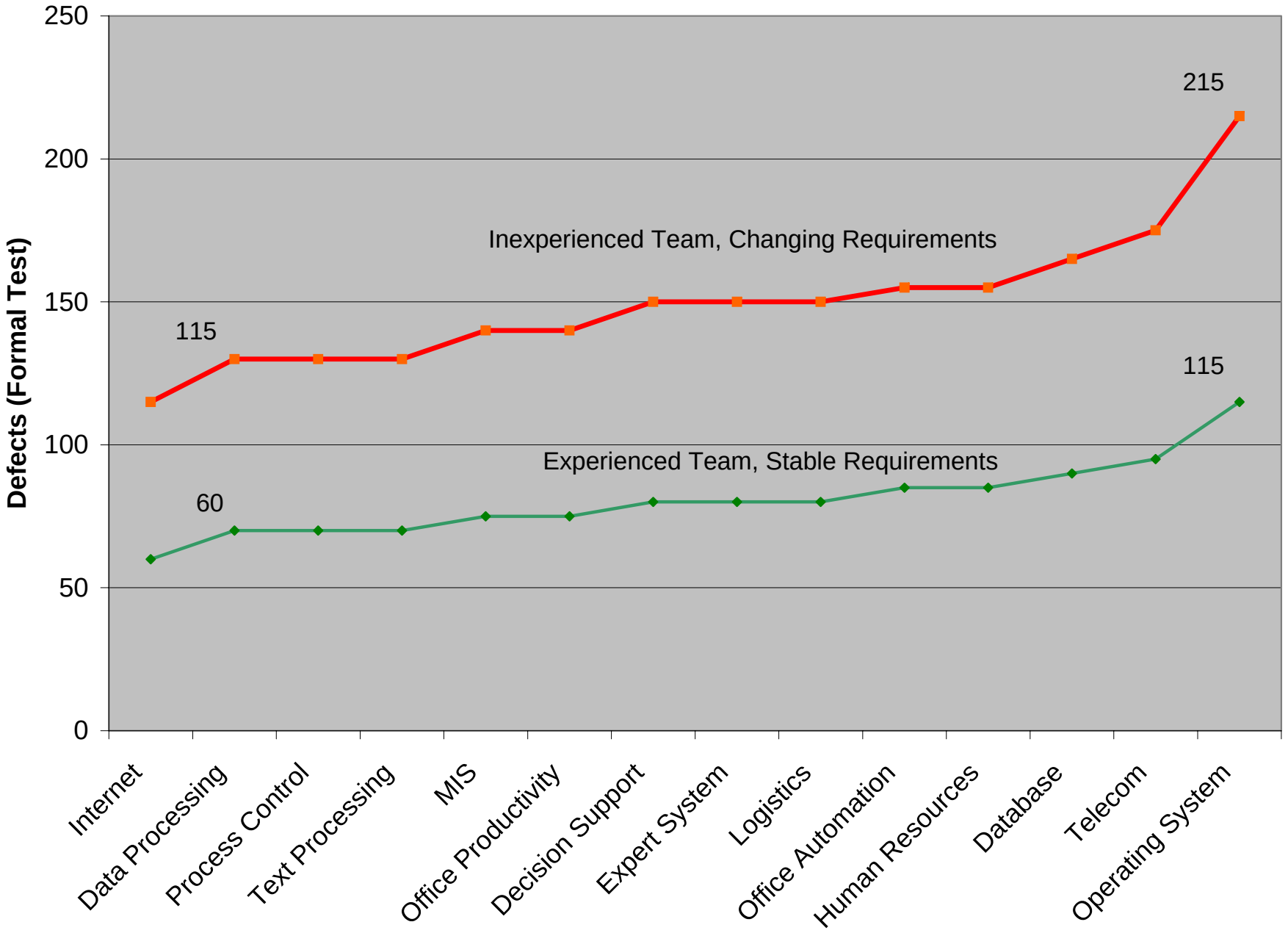
Application Complexity



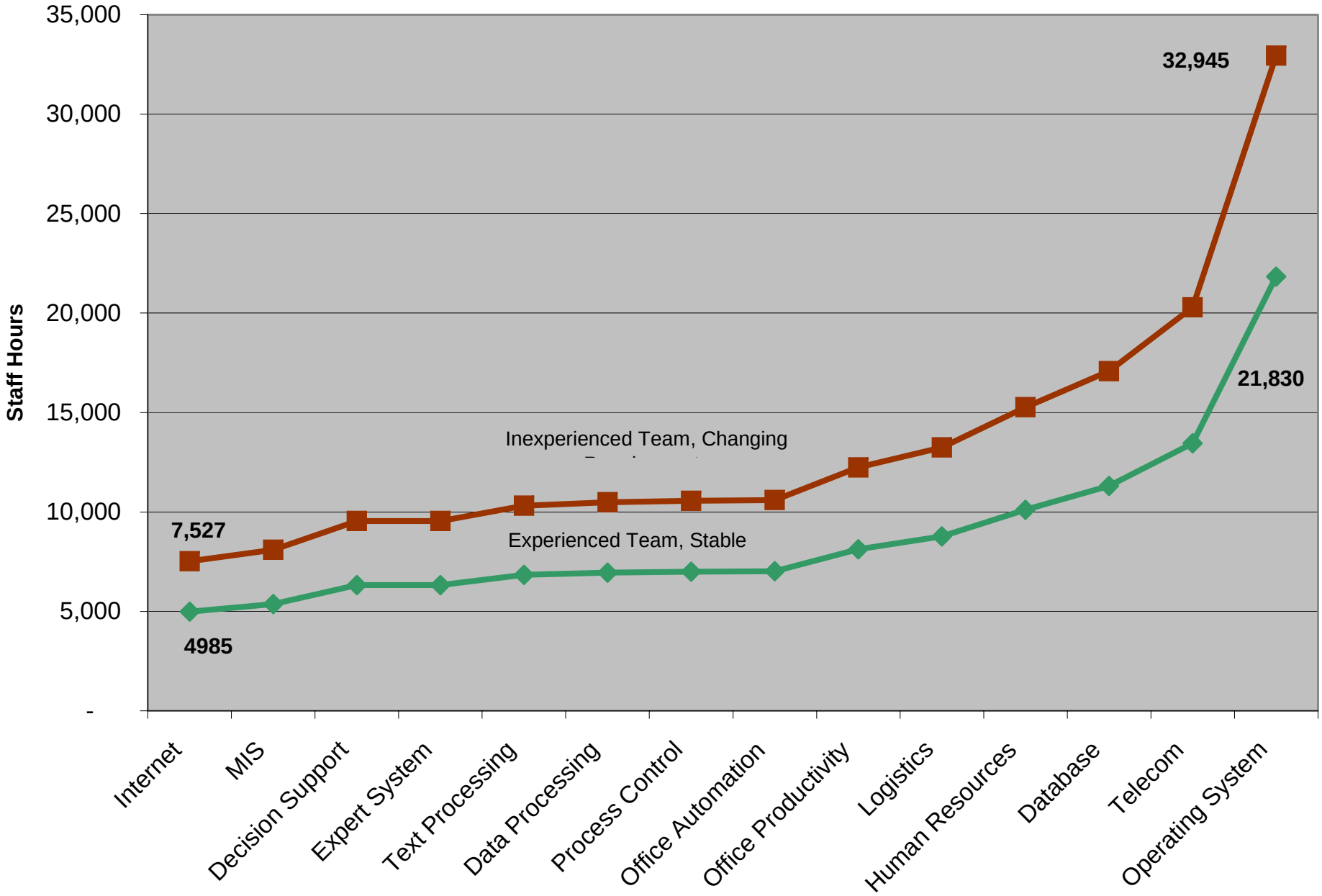
- **Productivity varies significantly. Application type/complexity is a key driver**
- **This chart illustrates the difference in productivity .**
  - **Applications which provide web content are typically very easy to create**
  - **Operating System functions are very difficult & expensive**

Data Source PRICE Systems LLC Catalog


Defects (Formal Test)
250
200
150
100
50
0
215
115
115
60
Inexperienced Team, Changing Requirements
Experienced Team, Stable Requirements
Internet
Data Processing
Process Control
Text Processing
MIS
Office Productivity
Decision Support
Expert System
Logistics
Office Automation
Human Resources
Database
Telecom
Operating System

Quality: Application Complexity, Team Experience and Requirements Stability

- As applications increase in complexity (same size project) the defect potential also increases (+92%)
  - *Range is 60 (Internet) to 115 (Operating System) defects*
- Inexperience and changing requirements also increase defect potential (+87%)
  - *Range from 115 to 215 defects*



Effort: Complexity, Experience & Requirements Stability

- As applications increase in complexity the development effort also increases (+338%)
  - Range is 4995 (Internet) to 21,830(Operating System) hours
- Inexperience and changing requirements also increase required effort
  - Average total impact of 51%
- As applications increase in complexity the development effort also increases (+338%)

  Data Source PRICE Systems LLC Catalog

Measurement Leads To Better Decisions

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Approach Used

- Select completed projects from past year or completing in near future
  - Business significance
  - Typical
  - New technology
  - New process/process change
- Needs to be pertinent for next years work
- Schedule work sessions with each project team based upon project schedule
  - Minimize impact on the project

Approach 2

- Work with the project managers and key technical resources for each of the project
- Standard approach was to walk through each application on a screen by screen basis and count
  - Transactions
  - Data

Approach -3

- Document with project manager
  - Technology used for development
    - Programming languages
    - Tools
    - Architecture
  - Team capability and experience
  - Application type
  - Issues which impacted development
    - Multi-site development
    - Personnel availability
    - Requirements stability

Organizational Report Card

	Multisite	App. Exp.	Dev. Tool Exp.	Turnover	Mgt Exp.	Req. Vol	Vendor Issues	Misc.	HW	Total Impact	Cost/ Benefit Hours
1		-10%	-9%	-12%		-8%				-39%	(2,730)
2		12%	9%							21%	1,890
3										0%	-
4		12%	9%				-10%			11%	87
5		-10%	-9%	-12%				-5%	-15%	-51%	(4,080)
6		12%	9%							21%	77
7		-10%	-5%		-15%					-30%	(300)
8		12%	9%			-10%				11%	174
9										0%	-
10		12%	9%							21%	497
11		12%	9%							21%	950
12										0%	-
13	-9%									-9%	(233)
14	-9%					-10%				-19%	(1,239)
											-

Measures

- The core set of measures are:
  - Size (functional size count of transactions and data)
  - Effort (staff hours)
  - Schedule (requirements through installation)
  - Quality (defects found during formal testing)

- The core set is based upon the common/applicable industry standards
  - SEI CMM
  - IEEE and ISO
  - Practical software measurement (PSM) (industry & govt. Working group)

Core Measures Extensions

- Core set of measures in place to apply to any development organization.
- Picking other measures to showcase beyond that set is very dependent on the organizations goals and objectives.
- Measures beyond the core set usually require additional effort to set up data collection schemes in order to develop them.
  - Examples are customer satisfaction and employee satisfaction.
    - Surveys need to be developed, scheduled and initiated in order to get the data.
- The typical extensions from the core set above are:
  - Root cause analysis of defects,
  - A more detailed breakout of effort by resource type & by development phase, and
  - Requirements changes.
- Additional measures related to organizations goals
  - Presidents Agenda
  - Agency Agenda

Success Stories

- Defense Contract Management Agency (DCMA) is utilizing PRICE Systems to monitor its IT Modernization Program for the Standard Procurement System.
  - DoD wide acquisition management applications (world wide sites over 16,000 users)
  - Received multiple awards since 2002 as best in class application
- National Archives Electronic Record Archive (NARA ERA): Processes put in place for initial exhibit 300 submittal were re-used to submit a more sophisticated & detailed estimates

