

Project Estimation Techniques

2 day workshop

AXA Technologies Shared Services

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Faculty & Participants

An Introduction

Name, Role, Expectations, Hobby

Workshop Ground Rules

- ✓ Please keep your mobile on the silent mode. Always take your calls outside the training room.
- ✓ No corner talk! Discussions only when group discussion is allowed
- ✓ Keep your focus on the ongoing topic. Await your turn during the questionnaire round.
- ✓ Strictly follow the workshop schedule for management of time.
- ✓ There is parking lot. Write you questions and post with your name on parking lot.
- ✓ Breaks only on agreed time
 - ✓ Tea
 - ✓ Lunch
 - ✓ Tea
- ✓ Everybody need to contribute
- ✓ Use your experience only for relating the processes and best practices. To avoid confusion keep it outside of the class. Unlearning is first and biggest learning to learn something new.

Objective is to Understand & Learn

- What is project, project boundary, project phases?
- Budget and Estimate
- What to estimate on project?
- Ranges of Estimates
- Estimation & Metrics
- Meaning of Baseline of Estimates
- Cost Management Approach
- Estimation Methods

Objective is to Understand & Learn

- Type of Estimates
 - Effort Estimates
 - Duration Estimate
 - Resource Estimate
 - Cost Estimates
- Component of Cost
- Input Consideration for Estimates
- Cost Management Plan
- Schedule Management Plan
- Cost Performance Baseline
- Monitoring and Controlling Cost/Efforts/Schedule

Objective is to Understand & Learn

- Earned Value Management
- Forecasting Cost/Efforts/Schedule
- Introduction to Software Size Estimating Techniques
- Function Points Based Estimation
- Component Based Estimation
- Use Case Base Estimation
- Benchmarking Marking Productivity
- Calculating effort and cost using size and productivity

Topics

- Day 1
 - Concepts of Estimation
 - Earned Value Management
 - Forecasting
 - Metrics
 - Estimation Techniques
- Day 2
 - Function Point Analysis (FPA)
 - FP Calculation: Thumb Rules
 - Efforts , Cost & Duration Calculation
 - Use Case Estimation
 - Recap Workshop Learnings



WELCOME TO THE
WORLD OF
COUNTING

Quotes

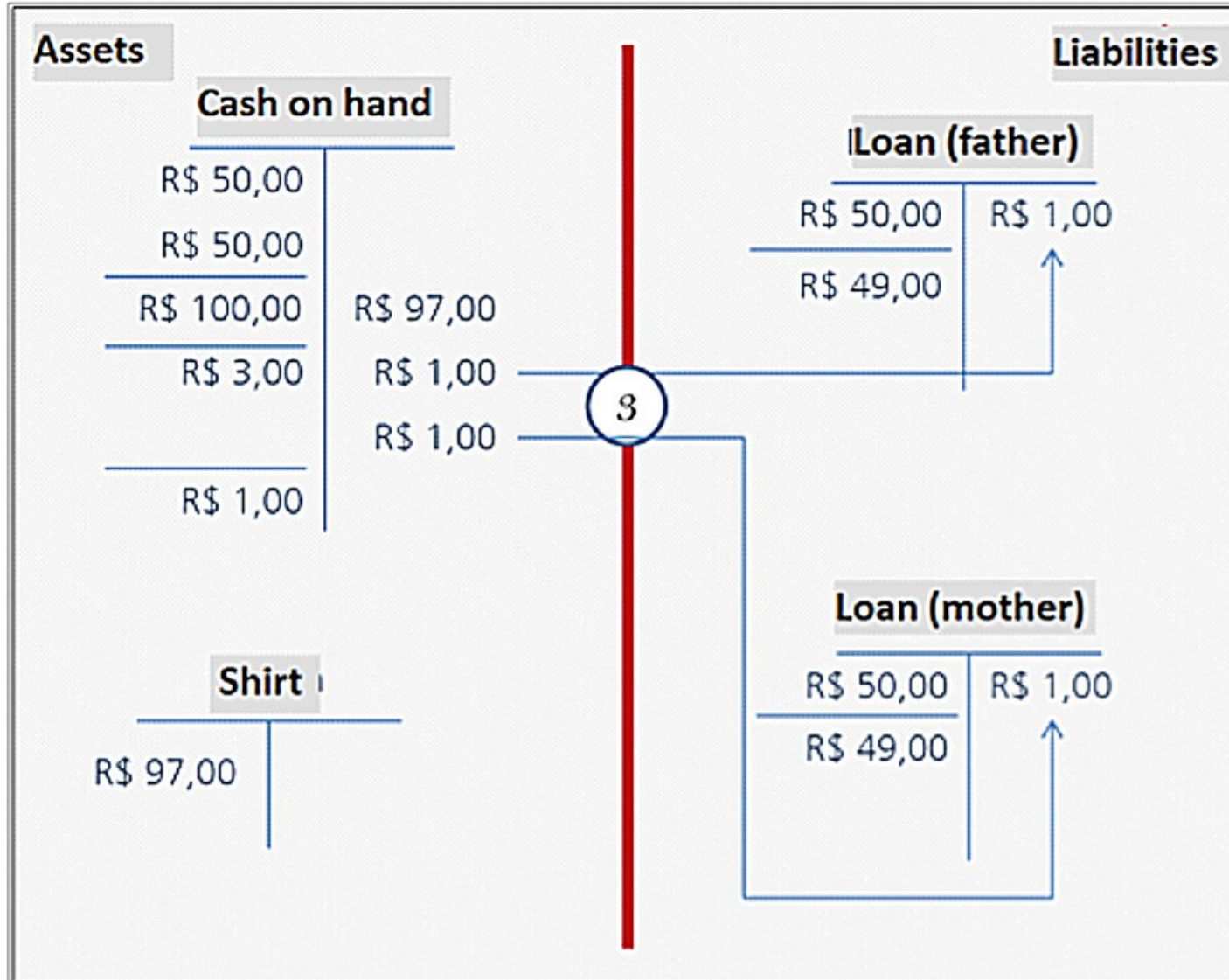
- If you cannot measure it you cannot manage it.
- Ten different estimator will provide 10 different estimate of the same piece of work. Still estimation is worth exercise.
- Estimation is starting point of planning
- I can provide you accurate estimate once I complete the work.
- Estimates without basis of estimates are **NOT** estimates

Concepts of Estimation

A Counting Game

- You've found a shirt for US\$ 97.00.
- But, you have no money, so you've borrowed US\$ 50.00 from your mother and US\$ 50.00 from your father. So:
- $\text{US\$ } 50.00 + \text{US\$ } 50.00 = \text{US\$ } 100.00$
- You've bought the shirt, and there is change of US\$ 3.00.
- You pay US\$ 1.00 back to your father, US\$ 1.00 to your mother and keep the other US\$ 1.00 to you.
- Now you owe US\$ 49.00 to you mother and US\$ 49.00 to your father.
- $\text{US\$ } 49.00 + \text{US\$ } 49.00 = \text{US\$ } 98.00 + \text{your US\$ } 1.00 = \text{US\$ } 99.00$
- What about the other US\$ 1.00?

Solution of Game



Estimate Time



How much time is required to produce these fruits in your farm house
OR How much time is required to collect these fruits from your farm house

- **Can a 4,000 Hour Project be of Smaller size than One of 1,000 Hours ?**
- **If yes, then what are the reasons?**

How do you estimate?

How will you know these numbers?

- How many bricks this building has?
- How many ton of steel used in making this building?
- Number of hair you have on your head
- Number of shoes you wore in your life till today
- Population of India after one year of census
- Amount of rice required for party of 500 people
- Number of bricks required for a building construction work

How do you estimate?

How will you know these numbers? Do you estimate this?

- Number of brother and sister you have
- Your age
- Number of uncles and aunts you have
- Total of your marks in secondary school exam

Some More Questions..

- Do you estimate about past?
- Do you estimate about present?
- Do you estimate about future?
- Why do we estimate?
- In what circumstances you estimate?
- What do you consider when you estimate?
- What do you estimate?
- When do you stop estimating?

Estimation...

- Known is counted with 100% confidence
- Unknown is estimated
- When time is constraint to count then you estimate

Importance of Size of Work

- To know the cost of house you need to know “How big is the house?”
- To know the cost of item you need to know “What is the weight or length of an item?”
- To know the cost of travel you need to know “What is the distance between two places?”

But to know the cost knowing “Size” is not enough.

- You also need to know Quality of material to be used, Quality of output defined, Performance, Reliability, Portability etc.
- You should also consider Inflation, Availability of Resources
- Though there are many factors (like quality, complexity, skill) that affect the cost, schedule and effort for development, **size is the primary factor that helps to estimate these.**
- Do you measure dimension of house at the time of final handover? If yes then you should also measure size of software at the time of final handover.

Work Size Estimate

- Work size is independent of Productivity, Availability, Efficiency and Work Calendars
- Knowing size of work is first step towards planning

Lets think little more about estimation....

Estimate

- How much time is required to go from your city to your favorite past time vacation place?

Duration Depends Upon - Mode



Duration Depends Upon- Roads



Duration Depends Upon- Traffic and Other People on Road



Duration Depends Upon- Driver



Duration Depends Upon- Distance



Project Duration Depends Upon

- Environmental Factors (climate, politics, regulator, policies, willingness, project working time, resource availability, technology maturity)

How Many Candies in Jar?

- What will you do to know the candies in jar without opening and physically counting them?

Factors affecting number are

- Size of unseen candies
- Distribution is equal in whole jar?
- Is there anything else in jar
- ??



Realities of Estimation

Why we tend to underestimate?

- Optimistic individuals and have a desire to please
- Incomplete recall of previous experiences
- Not generally familiar with the entire job to be required.
- Murphy, of Murphy's Law fame, will not work on this project.
- Key estimating factors dramatically change estimates

Schedule is Influenced By

- Historical Data
- Intuition
- PERT (3 Points)
- Delphi
- Your Experience
- Productivity
- Time of the year
- Availability
- Waiting
- Team Configuration
- Vacations
- Holidays
- Work Schedule
- Elapsed Time
-

Availability is Influenced by

A calendar has 365 days in a year.

- Weekends
- Holidays
- Vacations
- Sickness
- Training
- Conferences
- Snow Days
- Strikes
- Floods
- Terrorist Activities
- Election
-

Productivity is Influenced by

Availability is 8 Hours/day.

- Bio-Breaks
- Networking
- Personal Phone Calls
- Wasted Meeting Time
- Interruptions
- E-Mail, Voice, In-Box
- Emotional and Physical Health Disturbances
- Unrelated IMs & Chats
- Travel, Elevator
- Surfing, Games
-

So you estimate....

- Work Size
 - Resources
 - Efforts
 - Duration
 - Elapsed Time
 - Scheduled Time
-
- Project Budget
 - Project Cost Estimates
 - Cost Baseline
-
- Contingency Reserve
 - Management Reserve

Metrics

Estimation Definition

- Effort Estimation: The number of **labor units** required to complete an activity or WBS component. **Work-Hours**
- Duration Estimation: The number of **work periods** required to complete an activity or WBS component. **Business-Days**
- Resource Estimation: **Type and amount of resources** required to complete an activity or WBS component
- Cost Estimation: The amount of **money required (in any currency)** to spend upon the resources working WBS component.
- Cost Budget: **Cost Estimates + Contingency Reserves**
- Timeline : Indicates **start date and end date** of activity/WBS component/phase/project

Metrics

- Function Points
- Use Case Points
- Lines of Code
- Effectiveness
- Productivity
- Efficiency
- Efforts
- Duration
- Defects/FP

What do you do with Metrics

- Plan & Capture Actuals
- Calculate Variances
- Tracks Trends
- Perform Root Cause Analysis when exception occurs

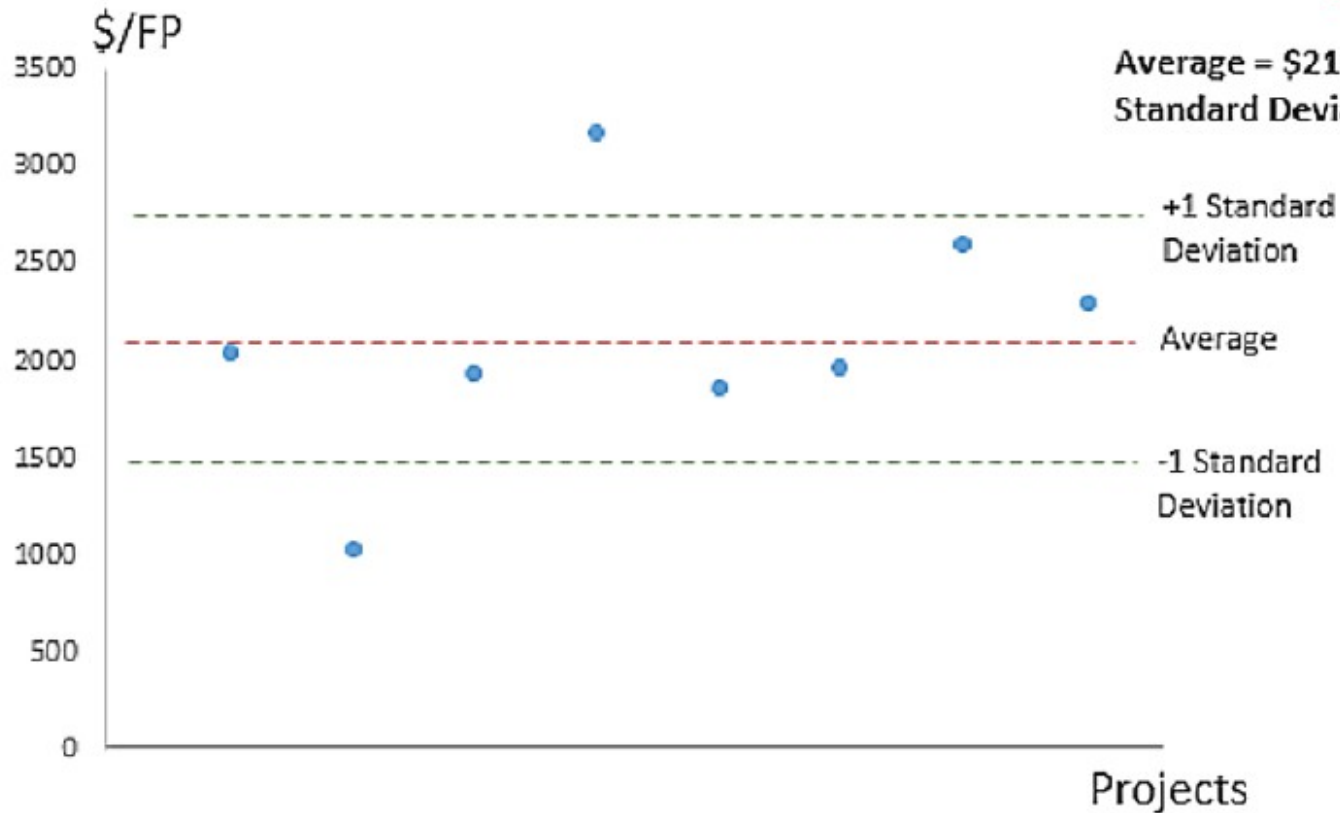
Effectiveness, Efficiency & Productivity

- Effectiveness: Time (what could be theoretically produced and what is actually produced)
 - In 20 hours we can write 4 FP but we have written 5 FP
(Ratio) $\Rightarrow 5/4 \Rightarrow 1.25$
- Efficiency: Cost (usage of resources against delivery)
 - Using INR 100,000 Resources and delivering 10 FP vs using INR 90,000 Resources to deliver 10 FP \Rightarrow
- Productivity (produce more in less time and cost)

Productivity Trend

SAMPLE

Average = \$2106/FP
Standard Deviation = 621



Effectiveness, Efficiency & Productivity

	Theoretical	Actual			
20 Hours	4	5	125%	Effectiveness (with respect to Time)	25% More Effective
	Cost of 20 hours Earlier	Now			
5 FP	100000	80000	125%	Efficiency (with respect to Resource Cost)	25% More Efficient
Efficiency/Effective	100%			Productivity	100% Productive

Estimation Techniques

Good Estimates

- Professors S.D. Conte, H.E. Dunsmore, and V.Y. Shen proposed that a good estimation approach should provide estimates that are within 25% of the actual results 75% of the time (Conte, Dunsmore, and Shen 1986)

Estimation real purpose

- Suppose you're preparing for a trip and deciding which suitcase to take. You have a small suitcase that you like because it's easy to carry and will fit into an airplane's overhead storage bin. You also have a large suitcase, which you don't like because you'll have to check it in and then wait for it at baggage claim, lengthening your trip. You lay your clothes beside the small suitcase, and it appears that they will almost fit. What do you do? You might try packing them very carefully, not wasting any space, and hoping they all fit. If that approach doesn't work, you might try stuffing them into the suitcase with brute force, sitting on the top and trying to squeeze the latches closed. If that still doesn't work, you're faced with a choice: leave a few clothes at home or take the larger suitcase

Estimation Real Purpose

- Benchmarking Software Development & Maintenance
- Outsourcing Management
- Measurement and Estimating Programs
- Function Point Analysis
- CMMI Assessments
- Software Development Methodologies
- Project Management Techniques
- Quality Assurance Methods
- Continuous Process Improvements

Planning Processes



Planning Processes

- Develop Project Management Plan
- Plan Scope Management
- Collect Requirements
- Define Scope
- Create WBS
- Plan Schedule Management
- Define Activities
- Sequence Activities
- **Estimate Activity Resources**
- **Estimate Activity Durations**
- Develop Schedule
- Plan Cost Management
- **Estimate Cost**
- **Determine Budget**
- Plan Quality Management
- Plan Human Resource Management
- Plan Communication Management
- Plan Risk Management
- Identify Risks
- Perform Qualitative Risk Analysis
- Perform Quantitative Risk Analysis
- Plan Risk Response
- Plan Procurement Management
- Plan Stakeholder Management

How do you Estimate?

- Take your best guess and multiply by two
- Take the best guess, multiply by two and raise it to the next higher unit of time
- Add 54%”(An algorithmically determined fudge factor)
- Ask the boss which number they want
- Take the remaining time until the deadline and multiply it by the number of people on the team
- Look Up
- **What are the advantages?**

Good Estimation Guidelines

- Use ranges to know a confidence factor
- Include basis of estimation (documented)
- Perform at the appropriate level of detail
- Should be performed by the person doing the work (experiential estimating)
- Identify constraints and risks
- Do not confuse between estimates of work and duration
- Do not confuse between duration and project schedule
- Considers experience and availability
- Uses lessons learned at organization level
- Never negotiates numbers without basis

Project Management Body of Knowledge 5th Edition

Estimation Types

- Estimation at Initiation Stage
 - Rough order of Magnitude (ROM) – [-25% - +75%]
 - Budget Estimate [-10% - 25%]
- Estimation when Project Work or Solution Approach is known
 - Bottom up or Definitive Estimates. When WBS & details are available [-5% - +10%]

Estimation Techniques

- Expert Based Techniques
 - Analogous Estimation
 - Parametric Estimation
 - Bottom-up Estimation
 - Three point Estimation
 - Published Data Source
 - Delphi Estimation
 - Wideband Delphi Estimation
 - Planning Poker
- Scientific Techniques
 - IFPUG Function Points (FP)
 - Use Case Points
 - Lines of Code
 - Cosmic Function Points

Analogous Estimation

- Two years ago your brother got married and he spent INR 5 lacs. Now your close friend is planning to get married and he is asking how much it will take to get married if arrangement of similar type

Parametric Estimating

- To make 500 SF flat you need 10000 bricks.
How many bricks required to make a bungalow of 2500 SF
- To travel 30 km it takes one hour **how much time** is required to travel 250 km

Bottom Up Estimating

		Duration	Cost ('000)	Size
Implementation		64	440	210
	HR Operations	20	100	80
	Payroll	18	120	60
	Benefits Administration	12	90	40
	Employee Self Service	14	130	30
Interfaces				
	HR			
	Payroll			
	Benefits Administration			
Reporting				
	HR			
	Payroll			
	Benefits Administration			
Testing				
	HR			
	Payroll			
	Benefits Administration			
	Employee Self Service			
Launch				
	Training			
	Change Management			

Three Point Estimation

- Optimistic
- Pessimistic
- Most likely

Expected Value = $(O + 4xM + P) / 6$

Standard Deviation = $(P-O)/6$

Published Estimating Data

If you do not have experts and experience around then from where you will get data to know

- How much food is required to feed all the poor of your state?
- How much paint is required to paint your complete duplex home?
- How much time required to get business visa of Germany?
- What is productivity in Core Java Technology?
- How much time is required to convert 500 GB flat file database into Oracle DB?

Delphi Estimates

- Only experts participates in estimation processes
- Estimates are anonymous
- Extreme estimates are discussed

Summary of Estimation

- Understand project boundary
- Estimate size of work first
- Use multiple methods for estimating
- Estimation is not a one time process
- Consider productivity, availability, efficiency, calendar when determining time line
- Estimation of duration, timeline, cost, resource is iterative process
- Maintain a repository of estimates
- Automate as much as possible
- Establish metrics for your organization, department and project and keep refining benchmarks
- Estimation is not only science but also art because lots of imagination, creative and sometime intuitive input involved

Function Point Analysis (FPA)

History of Function Points

- 1970 - Invention By A.J.Albrecht at IBM
- 1979 - Release of Function Point Methodology
- 1984 - Revision of Function Points by Albrecht
- 1986 - Formation of IFPUG
- 1990 - Release of Version 3.0 by IFPUG (standard Counting Practices Manual)
- 1994 - Release of Version 4.0 By IFPUG
- 1999 - Release of Version 4.1.1 By IFPUG
- 2004 – Release of Version 4.2 by IFPUG
- 2009 - Release of Version 4.3 By IFPUB

FP Sizing is

- Based on
 - Functional requirements as seen by the user. User functionalities
 - Screens
 - Reports
 - Data stores
 - Interfaces.
- Not based on
 - Technical aspects of the development
 - Number of programs
 - Lines of code
 - Physical architecture etc.

FP is

- FP is Repeatable and Reproducible
- Provides functional and non-functional insights
- Can be used in early development stages
- Independent of implementation technology
- Based on well defined rules so no technical skills required to count. Thus auditable.

FP is not

- Efforts required to count FP is 0.1% to 0.5% of project efforts
- Counting efforts depends upon knowledge of FP expert on application and domain and support provided to him by business.
- It is important to note that FP is a functional sizing method. That means it cannot size non-functional requirements.
- FP Productivity Varies (7 FP to 17 FP/ person month for Java). It does not mean productivity metrics is useless. It may be because of
 - Non-functional requirements
 - Application Size
 - Skills
 - Process maturity
 - Efforts required to implement NFR
 - Process logic complexity
 - Implementation Technology

FP can be used to

- Compare projects size
- Productivity
- Costing
- Tentative duration

FP is Costly for Large Size Applications

- The first problem is that some software applications are now so large
- (greater than 300,000 function points) that normal function point analysis
- is too slow and too expensive to be used.
- There are gaps at both ends of normal function point analysis. Above
- 15,000 function points, the costs and schedule for counting function point
- metrics become so high that large projects are almost never counted.
- (Function point analysis operates between 400 and 600 function points
- per day per counter. The approximate cost is about \$6.00 per function
- point counted.)

At the low end of the scale, the counting rules for function points do not operate below a size of about 15 function points. Thus, small changes and bug repairs cannot be counted. Individually, such changes may be as small as 1/50th of a function point and are rarely larger than 10 function points. But large companies can make 30,000 or more changes per year, with a total size that can top 100,000 function points.

FPA Variants

- The industry will have 20+ variations for counting LOC
- 50+ variations for counting function points
- 20+ unreliable metrics such as story points, use-case points, cost per defect, or using percentages of unknown numbers.

FPA Variants

- Standard IFPUG function points
- COSMIC: [ISO/IEC 19761:2011](#) Software engineering. A functional size measurement method.
- FiSMA: [ISO/IEC 29881:2008](#) Information technology - Software and systems engineering - FiSMA 1.1 functional size measurement method. Finnish function points
- [IFPUG: ISO/IEC 20926:2009](#) Software and systems engineering - Software measurement - IFPUG functional size measurement method.
- Mark-II: [ISO/IEC 20968:2002](#) Software engineering - MII Function Point Analysis - Counting Practices Manual
- NESMA: [ISO/IEC 24570:2005](#) Software engineering - NESMA function size measurement method version 2.1 - Definitions and counting guidelines for the application of Function Point Analysis. Netherlands function points
- Story points
- Feature points
- Web-object points, and many others

Constraints of LOC

- LOC is issue when more than one languages are being used
- Work of architects, designers, database administrators, quality assurance, technical writers, project managers, and many other occupations cannot be counted in LOC

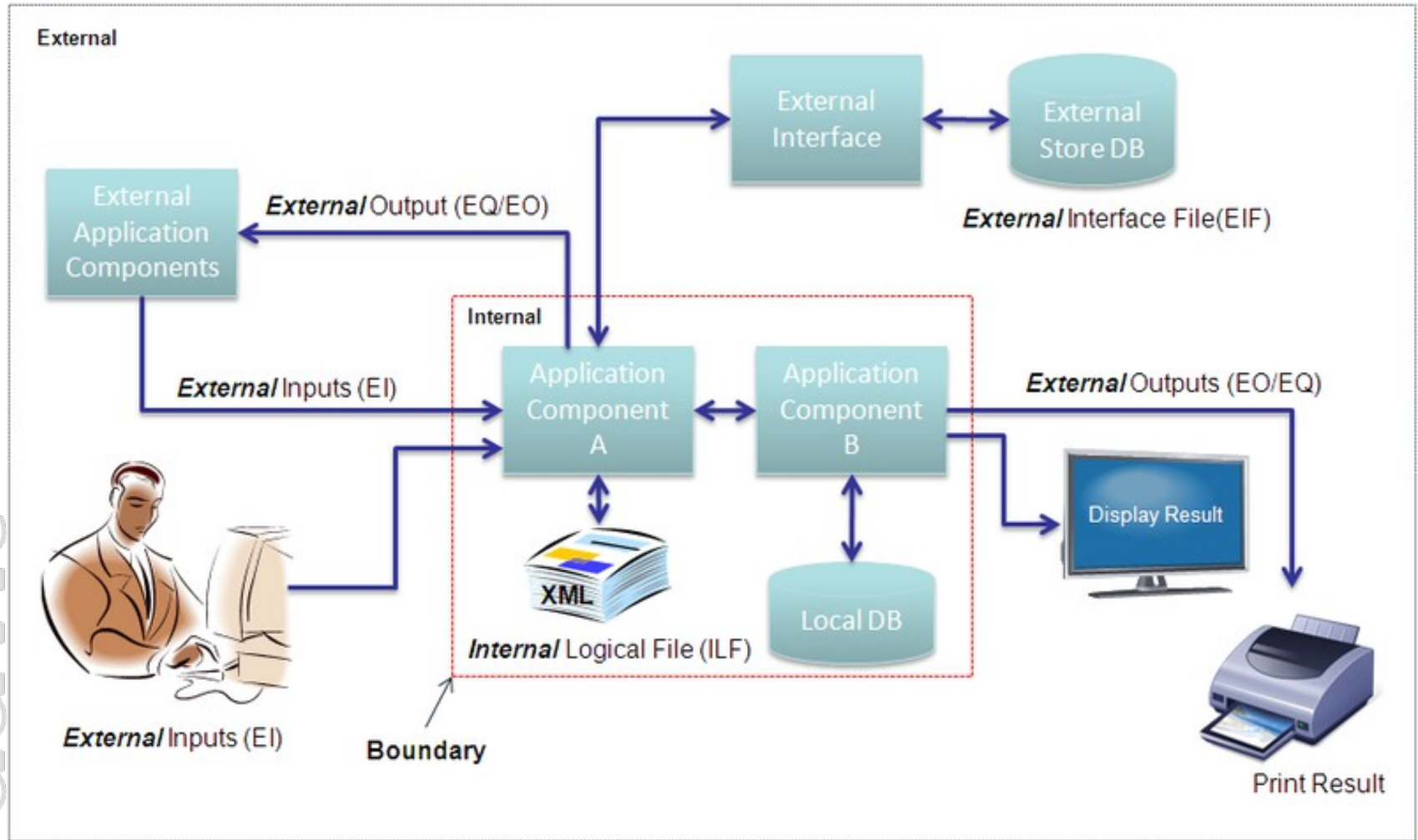
Reality of Functional Sizing Methods (FSM)

- For all current FSM methods two trained counters will achieve size figures of $\pm 10\%$ if the user requirements are known and well specified.
- if ten project managers from different business areas try to estimate project effort without a systematic approach, including FSM methods, the ratio between the smallest and biggest estimate is 1 to 6, the worst as high as 1 to 12.

FPA : Key Terms used

- Project Boundary
- DET: Data Element Type
- RET: Record Element Type
- FTR: File Type Reference
- Transactional Function Types
 - Internal Logical File (ILF)
 - External Interface File (EIF)
- Data Function Types
 - External Input (EI)
 - External Output (EO)
 - External Query (EQ)
- UFPC
- AFPC
- VAF
- Degree of Influence

Project Boundary



DET: Data Element Type

RET: Record Element Type

FTR: File Type Reference

How to calculate?

Component	RET's	FTR's	DET's
External Inputs (EI)		✓	✓
External Outputs (EO)		✓	✓
External Inquiries (EQ)		✓	✓
External Interface Files (EIF)	✓		✓
Internal Logical Files (ILF)	✓		✓

Internal Logical Files (ILF) ***&*** ***External Interface Files (EIF)***

Definition

An Internal Logical File (ILF) is a user identifiable group of logically related data or control information maintained within the boundary of the application

ILF Identification Rules

- The group of data or control information is a logical, or user identifiable, group of data that fulfills specific user requirements.
- The group of data **is maintained within** the application boundary.
- The group of data is modified, or maintained, through an elementary process of the application.
- ***The group of data identified has not been counted as an ELF for the application.***

Hints for ILF/EIF Counting

- **Is the data a logical group that fulfills specific user requirements?**
 - An application can use an ILF or EIF in multiple processes, but the ILF or EIF is counted only once.
 - **Do not assume that one physical file equals one logical file when viewing data logically from the user perspective.**
 - Although some storage technologies such as tables in a relational DBMS or a sequential flat file relate closely to ILFs or EIFs, do not assume that this always equals a one-to-one physical-logical relationship.
 - If a group of data was not counted as an ILF or EIF itself, count its data elements as DETs for the ILF or EIF which includes that group of data.
 - **Do not assume all physical files must be counted or included as part of an ILF or EIF.**

Hints for ILF/EIF Counting

- **Where is data maintained? Inside or outside the application boundary?**
 - Look at the work flow.
 - In the process functional decomposition, identify where the user and other application interfaces occur.
 - Work through the process diagram to get hints.
 - Credit ILFs maintained by more than one application to each application at the time the application is counted.
- **An application can use an ILF or EIF multiple times, but you count the ILF or EIF only once.**
 - Work through the process diagram to get hints.
 - Credit ILFs maintained by more than one application to each application at the time the application is counted.

Hints for ILF/EIF Counting Middleware

- File structures that are used by an elementary process to analyze transaction data for the duration of the transaction is an ILF, even though the data itself is not retained.

Data Element Types

A *data element type* (DET) is a unique user recognizable, non-recursive field on the ILF or EIF.

DET Rules

- Count a DET for each unique user recognizable, non recursive field on the ILF or EIF.
- Count a DET for each piece of data in an ILF or EIF that exists because the user requires a relationship with another ILF to be maintained.
- Count the following physical implementation techniques as a single DET for the entire group of fields.
 - Fields that appear more than once in an ILF or EIF because of technology or implementation techniques.
 - Repeating fields that are identical in format and exist to allow for multiple occurrences of a data value.

Record Element Types

- A *record element type* (RET) is a user recognizable subgroup of data elements within an ILF or EIF.
 - Optional
 - Mandatory
- ***Optional subgroups*** are those that the user has the option of using one or none of the subgroups during an elementary process that adds or creates an instance of the data.
- ***Mandatory subgroups*** are those of which the user must use at least one of the subgroups.

Record Element Types: Example

- In a Human Resources Application, information for an employee is added by entering some general information. In addition to the general information, the employee is a salaried or hourly employee (The user has determined that an employee must be either salaried or hourly). Either type can have information about dependents. For this example, there are three subgroups or RETs as shown below:
- Salaried employee (mandatory); includes general information
- Hourly employee (mandatory); includes general information
- Dependent (optional)

RET Rules

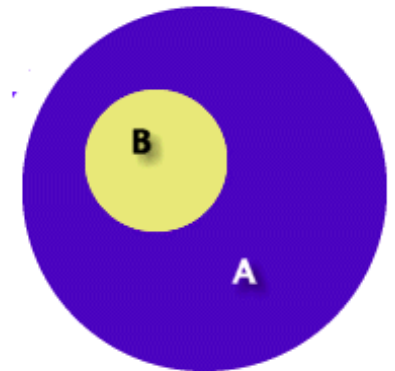
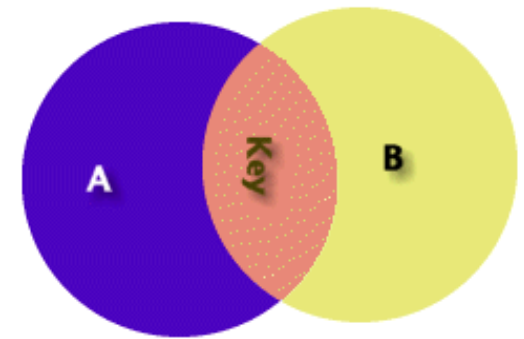
- Count an RET for each optional or mandatory subgroup of the ILF or EIF.
 - *Or*
- If there are no subgroups, count the ILF or EIF as one RET.

Example: RET

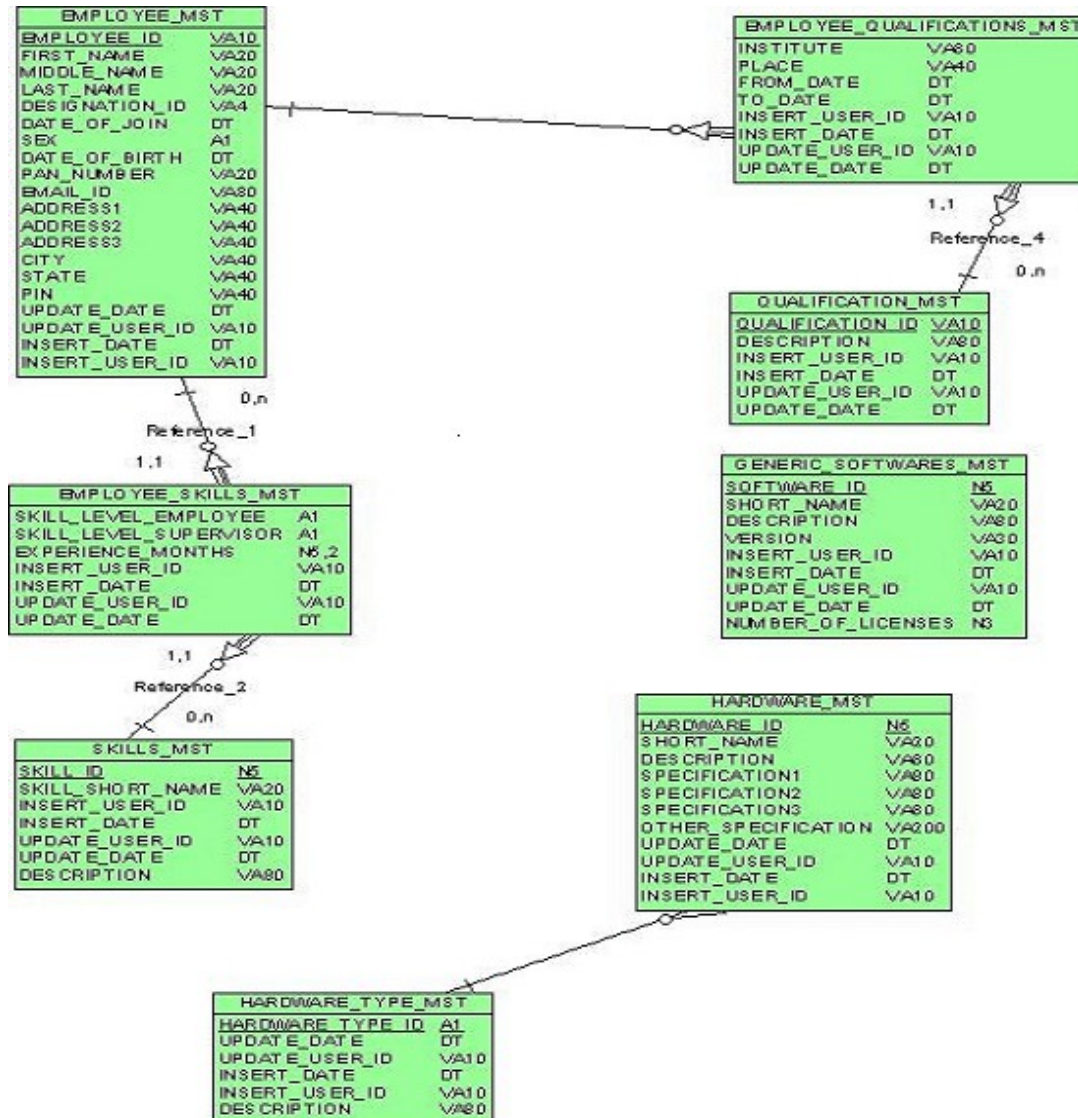
Some A are B – The first diagram represents two separate logical groups of data A and B (with key information between). This represents two internal logical files one RET each

All B are A – The second diagram represents one logical group of data A with two record types. B is a complete subset of A

Example – Imagine a music CD. Songs are a subset of a music CD. They do not exist independent of this. All Songs are part of the Music CD (all B are A). It has CD information and the song information. There are 5 data elements (singer, group, producer, label, date) for the CD RET and there are 3 data elements (song name, author, and length) for the Song RET. Hence in this example, there are 2 record element types and 8 data elements.



ILF: Example1



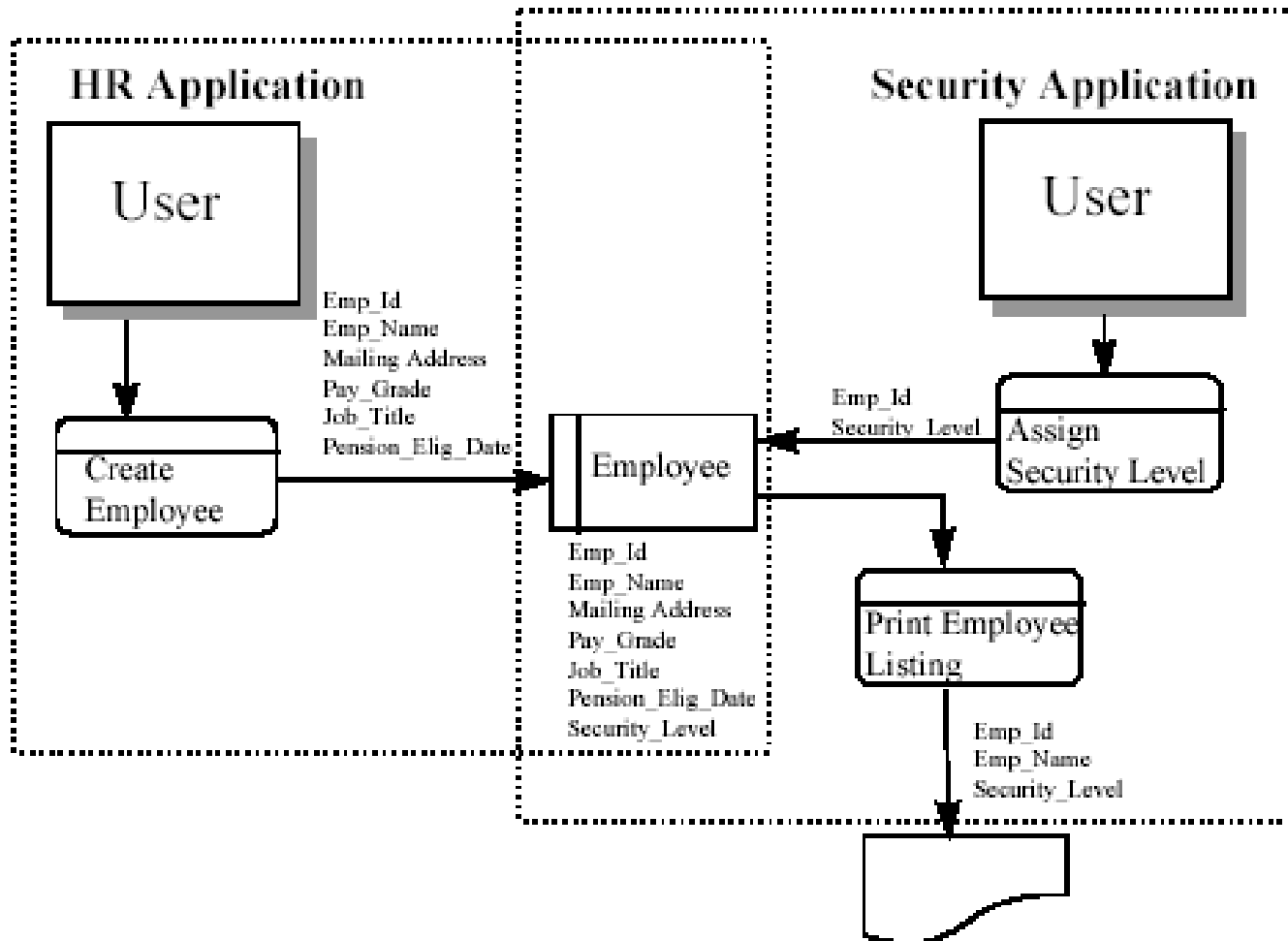
ILF: Example2

Determine whether the employee information is an ILF for the HR application.

The following table shows the summary analysis.

ILF Identification Rules	Does the Rule Apply?
The group of data or control information is logical and user identifiable.	Yes. This information is recognized and required by the HR users.
The group of data is maintained through an elementary process within the application boundary being counted.	Yes. The process of creating an employee record is within the boundary of the HR application.

ILF: Example3



ILF: Example4

The following table shows the summary analysis.

ILF Identification Rules	Does the Rule Apply?
The group of data or control information is logical and user identifiable.	Yes. This information is recognized and required by the Security users.
The group of data is maintained through an elementary process within the application boundary being counted.	Yes. The process of assigning the employee security level is within the boundary of the Security application.

ILF: Example5

ILF DET Counting Rules	Does the Rule Apply?
Count a DET for each unique user recognizable, non-repeated field maintained in or retrieved from the ILF or EIF through the execution of an elementary process.	The following fields are recognized by the HR user: <ul style="list-style-type: none">• Employee ID• Employee Name• Employee Mailing Address• Employee Pay Grade• Employee Job Title• Pension Eligibility Date
When two applications maintain and/or reference the same ILF/EIF, but each maintains/references separate DETs, count only the DETs being used by each application to size the ILF/EIF.	There is data of this type. All of the fields are used within the HR application <i>except</i> the Employee Security Level.
Count a DET for each piece of data required by the user to establish a relationship with another ILF or EIF.	There is no data of this type.

ILF: Example6

For **RETs**, identify subgroups based on the RET counting rules.

RET Counting Rules	Does the Rule Apply?
Count a RET for each optional or mandatory subgroup of the ILF or EIF. <i>Or</i>	The employee information does not have subgroups.
If there are no subgroups, count the ILF or EIF as one RET.	Because there are no subgroups, count the employee ILF in the HR application as one RET.

There are no subgroups, therefore count one RET for the employee ILF in the HR application.

ILF: Example7

Counting DETs and RETs for Security Application

The RET and DET totals for the employee ILF in the Security application are shown in the following table.

RETs	DETs
<ul style="list-style-type: none">Employee information group	<ul style="list-style-type: none">Employee IDEmployee NameEmployee Security Level
Total 1 RET	Total 3 DETs

External Interface File

Definition

An external interface file (EIF) is a user identifiable group of logically related data or control information referenced by the application, but maintained within the boundary of another application. ***This means an EIF counted for an application must be an ILF in another application***

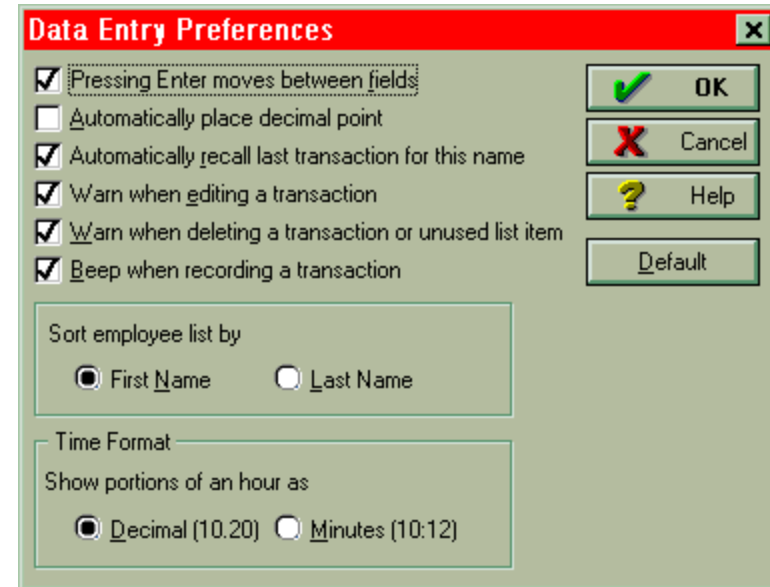
EIF Identification Rules

- The group of data is referenced by, and external to, the application being counted.
- The group of data **is not maintained** by the application being counted.
- The group of data is counted as an ILF for at least one other application.
- The group of data identified has not been counted as an ILF for the application.

Estimation of GUI Elements

GUI Estimation: Example

- **Check Boxes** – This may represent one data element or multiple data elements. The screen listed as Data Entry Preferences has numerous check boxes. In this case, each check box is considered a data element type (DET). Each check box is independent from other check boxes and provides different business functionality. The sort employee name and Time format are two additional data element types (DET's) also.



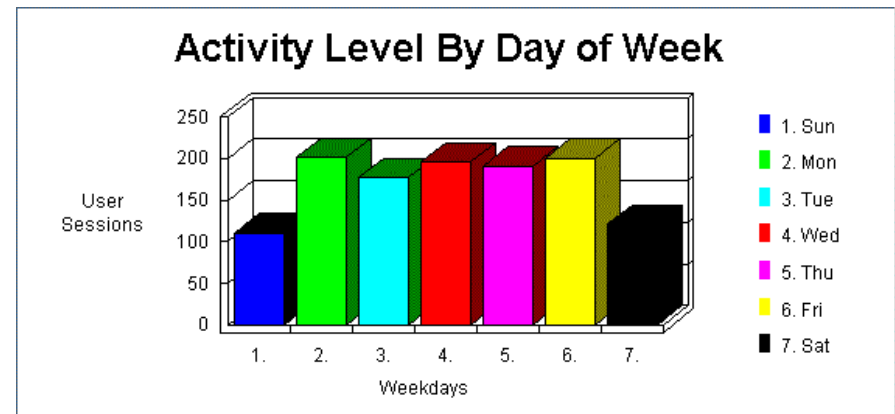
- **How many DET's..?**
- **This particular screen has X data elements (Y DET's and action key).**

GUI Estimation: Example

There are 10 data elements in the following table

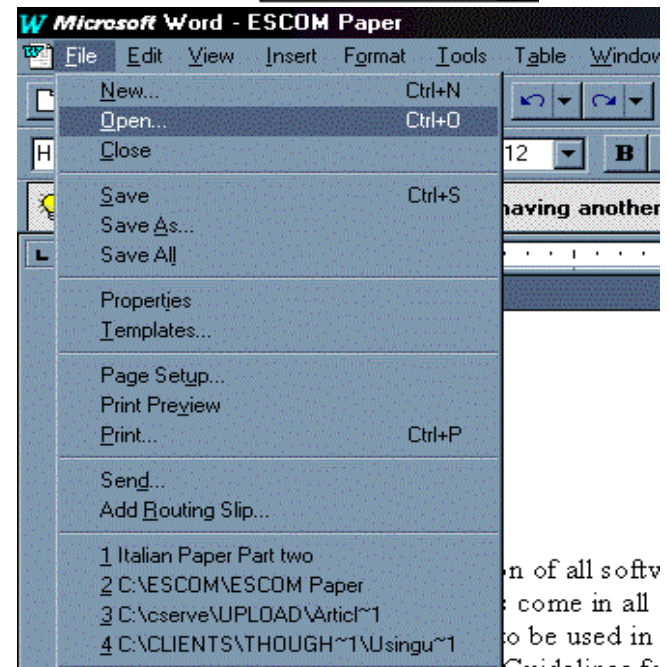
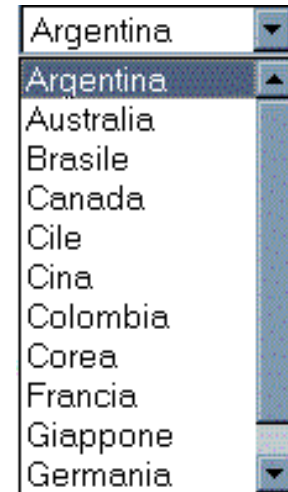
- Days
- Hits
- % of Total Hits
- User Sessions
- Total Hits (weekday)
- Total % (weekday)
- Total User Sessions (weekday)
- Total Hits (weekend)
- Total % (weekend)
- Total User Sessions (weekend)

Activity Level by Day of the Week				
	Day	Hits	% of Total Hits	User Sessions
1	Sun	1004	8.73%	111
2	Mon	1887	16.41%	201
3	Tue	1547	13.45%	177
4	Wed	1975	17.17%	195
5	Thu	1591	13.83%	191
6	Fri	2209	19.21%	200
7	Sat	1286	11.18%	121
Total Weekdays		9209	80.08%	964
Total Weekend		2290	19.91%	232



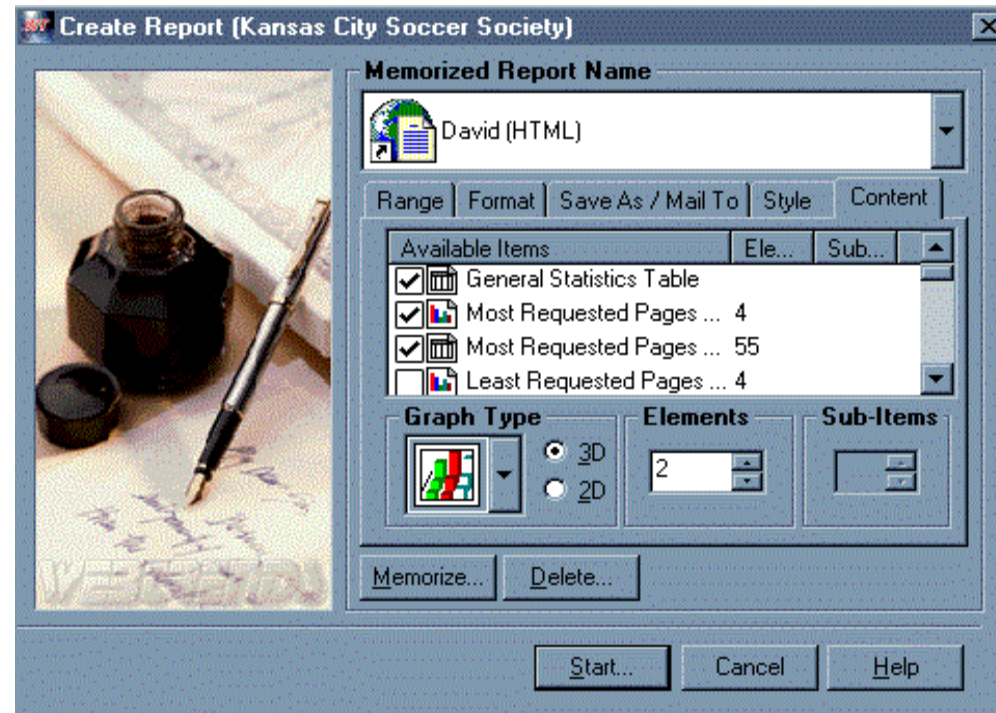
GUI Estimation: Example

- Pick List – A dynamic pick list (drop down box) is an EQ if the country names are contained in an internal logical file or external interface file.
- Menu – The menu displayed to the right is a dynamic menu. Word displays the last several files that have been opened. We can easily conclude that this information is being read from some type of internal file. Hence, the information is dynamic. The menu would be counted as an EQ. The real distinction is if a menu is dynamic or static. That is, are the contents of the screen or report dynamic (read from some file) or are they static.



GUI Estimation: Example

- It is common for GUI applications to have External Inputs preceded by serial inquiries. That is, a user may be able to select a customer name from a pick list (first EQ), the customer name is used as input for the second EQ which provides address, phone, zip and other contact information. From this point forward a user can add, change or delete the customer information (3 EI's). In this case, this one screen would represent 2 EQ's and 3 EI's.
- In the "Create Report" control screen, the user has the ability to select reports. This particular screen has several data elements types such as check box, graph type, dimensions, elements, sub-items and actions keys.
- User can choice each report individually. In fact each report is as an object. The generated report is a combination of several reports (or objects). Each object has several attributes.



External Inputs

Definition

An *external input* (EI) processes data or control information that comes from outside the application's boundary. The external input itself is an elementary process. The processed *data* maintains one or more ILFs. The processed *control information* may or may not maintain an ILF.

OR

External Inputs (EI) is an elementary process in which data crosses the boundary from outside to inside. This data may come from a data input screen, electronically or another application. The data can be either control information or business information. If the data is business information it is used to maintain one or more internal logical files. If the data is control information it does not have to update an internal logical file.

Identification Rules

Input Data Counting Rules

- The data is received from outside the application boundary.
- The data in an ILF is maintained through an elementary process of the application.
- **The process is the smallest unit of activity that is meaningful to the end user in the business.**
- The process is self-contained and leaves the business of the application being counted in a consistent state.
- *For example, the user requirements to add an employee include setting up salary and dependent information. If all the employee information is not added, an employee has not yet been created. Adding some of the information alone leaves the business of adding an employee in an inconsistent state. If both the employee salary and dependent information is added, this unit of activity is completed and the business is left in a consistent state.*

Identification Rules

Input Data Counting Rules

For the identified process, one of the following two rules must apply:

- Processing logic is unique from other external inputs for the application.
- The data elements identified are different from other external inputs for the application.

Identification Rules

Control Information Processing Rules

- The control information is received from outside the application boundary.
- The information is specified by the user to ensure compliance with business function requirements.
- For the identified process, one of the following two rules must apply:
 - **Processing logic is unique from other external inputs for the application.**
 - **The data elements identified are different from other external inputs for the application.**

⇒ The processed control information may or may not maintain an ILF

File Types Referenced

Definition

A file type referenced is

- An internal logical file read or maintained by a function type
- An external interface file read by a function type.

FTR Rules

- Count a file type referenced for each internal logical file (ILF) maintained.
- Count a file type referenced for each internal logical file (ILF) or external interface file (EIF) read during the processing of the external input.
- Count only one FTR for each ILF that is both maintained and read by the external input.


Data Element Types

A *data element type* (DET) is a unique user recognizable, non-recursive field maintained on the Internal Logical File by the External Input

DET Counting Rules

- Count a DET for each unique user recognizable, non-recursive field maintained on an ILF by an external input.
- Count a DET for each field that is not entered by the user, but through an external input, is maintained on an internal logical file.
- Count the following physical implementation techniques as a **single DET for the entire group of fields**:
 - A logical field that is stored physically as multiple fields, but is required by the user as a single piece of information.
 - For example, an account number or date physically stored in multiple fields, but required by the user as a single piece of information, is counted as one DET.

DET Counting Rules: GUI

- **Radio Buttons** – One DET is counted for all the radio buttons contained in the frame.
- **Check Boxes** – Each check box, within a frame, that can be selected should be treated as a data element.
- **Command Buttons**  – According to IFPUG counting rules each command button would be counted as a data element for the action it invokes.
- **Display of Graphical Images or Icons** – A display of a graphical image or schematic is treated as a single DET.
- **Sound Bytes** - Sound byte is one DET.
- **Photographic Images** – A photographic image is one DET.
- **Messages** – Error message and Confirmation message are treated as a one DET each for the appropriate transaction.

DET Counting Rules: GUI

- **Command Buttons** – Command Buttons are one DET each. Command buttons may specify an add, change, delete or inquire action. For example, a simple application to track Distributors could have fields for Distributor Name, Address, City, State, Zip, Phone Number, and Fax Number. This would represent seven data elements (7 DET's) and the add command button would represent the 8th data element. In short, the add external input represents a one external input with eight data elements, the change external input represents another external input with eight data elements (7 fields plus the change command button), and the delete external input represents the last external input with eight data elements (7 fields plus the delete command button).
- Graphic Images are one DET
- **Sound Bytes** – This represents one data element. The number of notes played is simply recursive information. If the length of the sound byte increases, then the data element remains one. If it is played for two seconds or four seconds, then this is still one data element.

DET Counting Rules: GUI

- In a GUI or OO environment it is common for information to move from one window to the next. The actual movement of data is not considered an external input because it has not crossed the application boundary (outside to inside) and does not maintain an ILF.

DET Counting Rules..GUI

- **Messages**

- Error Messages / Confirmation Messages – It indicates that a process will be or has been completed. A message, “Zip code is required” would be an example of an error message. A message, “Are you sure you want to delete the customer?” is an example of a confirmation message. Neither of these type of messages are treated as a unique External Output, but they are treated as data elements for the appropriate transaction. Each is one DET
- Notification Messages – It is the basis of processing and a conclusion being drawn. For example, while withdrawing from an ATM machine more money than you have in your account. You may receive the message, “You have insufficient funds to cover this transaction.” This is the result of information being read from a file and a conclusion being drawn. A notification message is treated as an EO.
- ***Notification Messages may be the result of processing and the actual processing or derived data may not be seen. If a message is created to be sent to a pager (beeper) at a given time. This is much like an alarm. The pager message has one data element the text message.***

DET Counting Rules: GUI

- **External Inputs**

- In GUI external inputs are preceded by serial inquiries
- Each Add, Delete or Change function would be one External Input

- **Radio Buttons in a group are treated as one DET**

Within a group of radio buttons the user has the option of selecting only one radio button at a time, so only one data element type is counted for all the radio buttons contained in the entire frame.

DET Counting Rules: Examples

- **Example:** An account number that is stored in multiple fields is counted as one DET.
- **Example:** A before or after image for a group of 10 fields maintained for audit purposes would count as one DET for the before image (all 10 fields) and as one DET for the after image (all 10 fields) for a total of 2 DETs.
- **Example:** The result(s) of a calculation from an elementary process, such as calculated sales tax value for a customer order is counted as one DET on the customer order ILF.
- **Example:** Accessing the price of an item which is saved to a billing file or fields such as a time stamp if required by the user(s) are counted as DETs.

DET Counting Rules: Examples

- **Example:** If an employee number appears twice in an ILF or EIF as (1) the key of the employee record and (2) a foreign key in the dependent record, count the DET only once.
- **Example:** Within an ILF or EIF, count one DET for the 12 Monthly Budget Amount fields. Count one additional field to identify the applicable month.
- When two applications maintain and/or reference the same ILF/EIF, but each maintains/references separate DETs, count only the DETs being used by each application to size the ILF/EIF. **For example,** Application A may specifically identify and use an address as: street address, city, state and zip code. Application B may see the address as one block of data without regard to individual components. Application A would count four DETs; Application B would count one DET.

DET Counting Rules: Examples

- **Example:** Application X maintains and/or references an ILF that contains SSN, Name, Street Name, Mail Stop, City, State, and Zip. Application Z maintains and/or references the Name, City, and State. Application X would count seven DETs; Application Z would count three DETs.
- Count a DET for each piece of data required by the user to establish a relationship with another ILF or EIF. **For example**, in an HR application, an employee's information is maintained on an ILF. The employee's job name is included as part of the employee's information. This DET is counted because it is required to relate an employee to a job that exists in the organization. This type of data element is referred to as a *foreign key*.
- **Example:** In an object oriented (OO) application, user requires an association between object classes, which have been identified as separate ILFs. Location name is a DET in the Location EIF. The location name is required when processing employee information; consequently, it is also counted as a DET within the Employee ILF.

When to Count Single DETs ?

- Fields that appear more than once in an internal logical file because of technology or implementation techniques.
- Fields that indicate an error occurred during processing or confirm that processing is complete.
- Example: Error Message Fields.
- Count a single DET for the capability to specify the action to be taken by the external input.
- Example: count as one DET command lines or function/action (PF) keys that provide the capability to specify the action to be taken by the external input. Count this as one additional DET per external input.

DET Counting Rules- Real Time System

- Real time and embedded systems – The time of diagnostics, hardware state during diagnostics, temperature, voltage etc. would all be examples of one DET each.
- Operator Controls, Volume Controls, Sensor Readings, Radio Frequencies, Standards and Limit Settings (Alarms Settings etc.) would be counted as one DET each.

Hints for EI Counting

- Is data received from outside the application boundary?
 - Look at the work flow.
 - Identify where the user and other application interfaces occur in the process functional decomposition.
- Is the process the smallest unit of activity from the user perspective?
 - Look at the different forms used.
 - Review the ILFs to identify how the user groups the information.
 - Identify where the user and other application interfaces occur in the process functional decomposition.
 - Look at what happened in the manual system.
 - **Note that one physical input or transaction file or screen can, when viewed logically, correspond to a number of EIs.**
 - Note that two or more physical input or transaction files or screens can correspond to one EI if the processing logic is identical.

Hints for EI Counting

- **Is the process self-contained and does it leave the business in a consistent state?**
 - Review external outputs and external inquiries to understand how the user works with the information.
 - Work through the process diagram to get hints.
 - Look at what happened in the manual system.
 - Check for consistency with other decisions

Hints for EI Counting

- **Is the processing logic unique from other EIs?**
 - Identify batch inputs based on the processing logic required.
- **Are the data elements different from those for other EIs?**
 - If the data elements appear to be a subset of the data elements of another external input, be sure two elementary processes are required by the user—one for the main data elements and one for the subsets.

Customer Details

Untitled

Go to Save and New ¹⁸ E-mail Save As Outlook Contact Close


General

First Name ¹

Last Name ²

Company ³

Job Title ⁴

 ¹⁶

E-mail ¹⁴

Web Page ¹⁵

Phone Numbers

Business Phone ⁵

Home Phone ⁶

Mobile Phone ⁷

Fax Number ⁸

Address

Street ⁹

City ¹⁰

State/Province ¹¹

Zip/Postal Code ¹²

Country/Region ¹³

Notes

¹⁷

Record: 1 of 1 No Filter Search

External Outputs

Definition

- An *external output* (EO) is an elementary process that generates data or control information sent outside the application's boundary.

OR

- *External Outputs (EO) is an elementary process in which derived data passes across the boundary from inside to outside. The data creates reports or output files sent to other applications. These reports and files are created from one or more internal logical files and external interface file .*
- *Derived Data is data that is processed beyond direct retrieval and editing of information from internal logical files or external interface files. Derived data is the result of algorithms, and/or calculations. Derived data occurs when one or more data elements are combined with a formula to generate or derive an additional data element(s).*

Identification Rules

- The process sends data or control information external to the application's boundary.
- The data or control information is sent through an elementary process of the application.
- The process is the smallest unit of activity that is meaningful to the end user in the business.
- The process is self-contained and leaves the business of the application being counted in a consistent state.
- For the identified process, one of the following must apply:
 - Processing logic is unique from other external outputs for the application.
 - The identified data elements are different from other external outputs for the application.

FTR for Outputs

Definition

A file type referenced is a file read when the external output is processed

Rules

Count a file type referenced for each internal logical file (ILF) or external interface file (EIF) read during the processing of the external output.

DETs for Outputs

Definition

A *data element type* is a user recognizable, non-recursive field that appears on the external output

Rules

- Count a DET for each user recognizable, non-recursive field that appears on the external output.
- Do not count literal as DETs.
- Do not count paging variables or system-generated stamps.

Counting Outputs

When to Count Single DETs ?

- A logical field that is stored physically as multiple fields, but is required by the user as a single piece of information.
- Each type of label and each type of numerical equivalent in a graphical output.
- Text information that may be a single word, sentence, or phrase.
- For example, a message is included on a report to indicate why a transaction to add a job could not be completed successfully.

DET Counting Rules: GUI

- External Outputs
 - Textual, graphical or electronic information
 - Each type of report to be treated as external outputs.
- External Inquiries
 - Serial Inquiries to be counted separately
 - EQs do not contain derived data
 - for e.g.. customer is selective from customer list which in turn is used to extract other customer details

Hints for EO Counting

- **Is data sent outside the application boundary?**
 - Look at the work flow.
 - Identify where the user and other application interfaces occur in the process functional decomposition.
- **Is the process self-contained and does it leave the business in a consistent state?**
 - Review external inputs and external inquiries to get an overall view of how the user works with the information.
 - Work through the process diagram to get hints.
 - Look at what happened in the manual system.

Hints for EO Counting

- **Is the process the smallest unit of activity from the user perspective?**
 - Look at the different forms used.
 - Review the ILFs to identify how the user groups the information.
 - Identify where the user and other application interfaces occur in the process functional decomposition.
 - Look at what happened in the manual system.
 - Remember that one physical report, screen, or batch output file can, when viewed logically, correspond to a number of EOs.
 - Remember that two or more physical reports, screens, or batch output files can correspond to one EO if the processing logic is identical.

Hints for EO Counting

- **Is the processing logic unique from other EOs?**
 - Identify output based on the processing logic required.
 - Remember that resorting or rearranging a set of data does not make processing logic unique.
- **Are the data elements different from other EOs?**
 - If the data elements appear to be a subset of the data element of another EO, be sure two elementary processes are required by the user—one for the main data element and one for the subsets.

External Query

Definition

- An *external inquiry* (EQ) is an elementary process made up of an input-output combination that results in **data retrieval**. **The output side contains no derived data.** No internal logical file (ILF) is maintained during processing.

OR

- *External Inquiry (EQ) is an elementary process with both input and output components that result in data retrieval from one or more internal logical files and external interface files. This information is sent outside the application boundary. The input process does not update any Internal Logical Files and the output side does not contain derived data.*

Identification Rules

- An input request enters the application boundary.
- Output results exit the application boundary.
- Data is retrieved.
- **The retrieved data does not contain derived data.**
- The input request and output results together make up a process that is the smallest unit of activity that is meaningful to the end user in the business.

Identification Rules

- The elementary process is self-contained and leaves the business of the application being counted consistent.
- **The processing does not update an ILF.**
- For the identified process, one of the following two rules must apply:
 - The processing logic on the input or output side is unique from other external inquiries in the application.
 - The data elements making up the input or output side are different from other external inquiries in the application.

FTR for Outputs

Definition

A file type referenced is a file read when the external inquiry is processed

Rules

- For each input/output side of the external inquiry, count a file type referenced for each internal logical file and external interface file read during the processing of the external inquiry.

DETs for Outputs

Definition

A *data element type* is a user recognizable, non-recursive field that appears in the external inquiry.

Rules

- Count a DET for each user recognizable, non-recursive field that appears on the input/output side of external inquiry.
- Count a DET for each field that specifies the data selection criteria.
- Do not count literal as DETs for output queries
- Do not count paging variables or system-generated stamps for output queries.

Counting Inquiries

When to Count Single DETs ?

- Fields indicating that an error has occurred while processing the input DETs or confirming that processing is complete.
- Fields that provide the capability to specify the external inquiry is to be executed
- A logical field that is stored physically as multiple fields, but is required by the user as a single piece of information.
- Fields that, because of technology or implementation techniques, appear more than once in an internal logical file.

Hints for EQ Counting

- **Is data directly retrieved from an ILF or EIF?**
 - Look at the work flow.
 - Identify where the user and other application interfaces occur in the process functional decomposition.
- **Is the process self-contained and does it leave the business in a consistent state?**
 - Review external inputs and external inquiries to get an overall view of how the user works with the information.
 - Work through the process diagram to get hints.

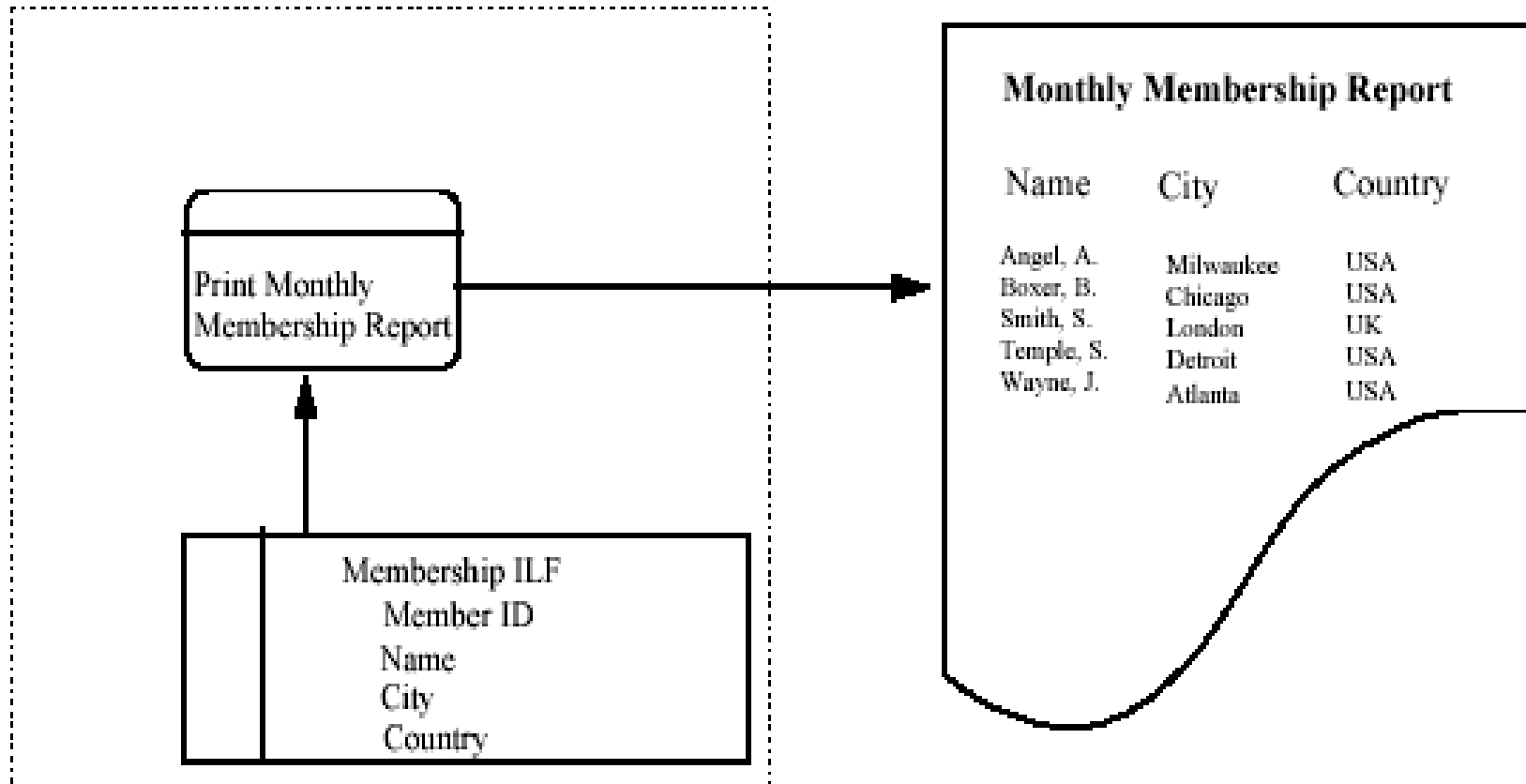
Hints for EQ Counting

- **Is the process the smallest unit of activity from the user perspective?**
 - Look at the different forms used.
 - Review the ILFs to identify how the user groups the information.
 - Identify where the user and other application interfaces occur in the process functional decomposition.
 - Look at what happened in the manual system.
 - Remember that one physical report, screen, or batch output file can, when viewed logically, correspond to a number of EQs.
 - Remember that two or more physical reports, screens, or batch output files can correspond to one EQ if the processing logic is identical.

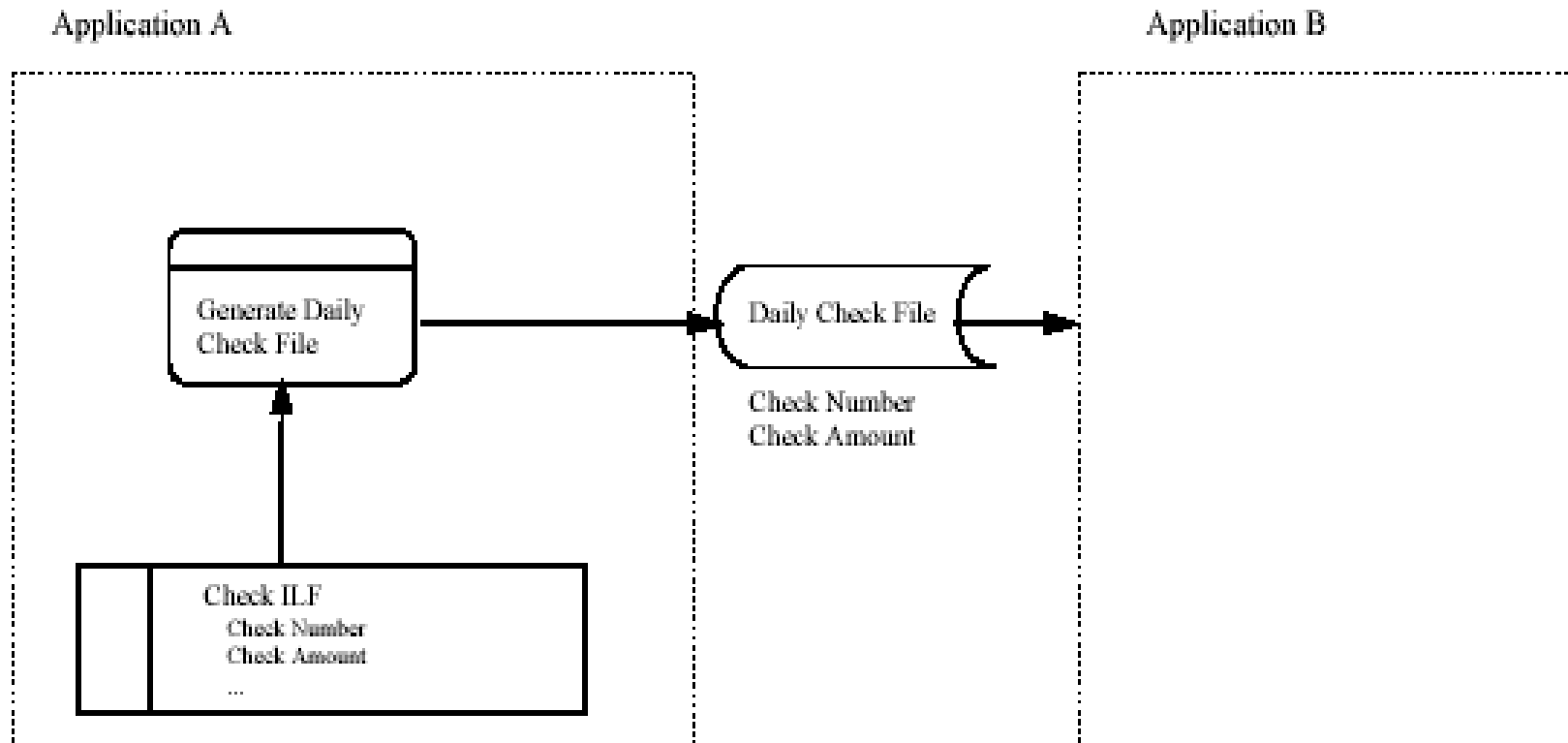
Hints for EQ Counting

- Is processing logic unique from other EQs?
 - Look for derived data to distinguish inquiries from outputs.
 - Remember that resorting or rearranging a set of data does not make processing logic unique.
- Are the data elements different from other EQs?
 - If the data elements appear to be a subset of the data elements of another external inquiry, be sure two elementary processes are required by the user—one for the main data elements and one for the subset.

EQ Counting : Example1



EQ Counting: Example2



Value Adjustment Factor

General System Characteristics

1. Data communications
2. Distributed data processing
3. Performance
4. Heavily used configuration
5. Transaction rate
6. Online data entry
7. End-user efficiency
8. Online update
9. Complex processing
10. Reusability
11. Installation ease
12. Operational ease
13. Multiple sites
14. Facilitate change

Degrees of Influence

- 0 - Not present, or no influence
- 1 - Incidental influence
- 2 - Moderate influence
- 3 - Average influence
- 4 - Significant influence
- 5 - Strong influence throughout

Value Adjustment Factor (VAF)

$$\text{VAF} = \text{SUM}(\text{GSC Weightage})$$

$$\text{AFP} = \text{UAFP} * \text{VAF}$$

Summary Table: FP Counting

Input Complexity Matrix (EI, EQ)							
FTRs	1-4 DETs	5-15 DETs	16+DETs				
0-1	Low	Low	Average		Low	3	
2-3	Low	Average	High		Average	4	
4+	Average	High	High		High	6	
Output Complexity Matrix (EO, EQ)							
FTRs	1-4 DETs	5-15 DETs	16+DETs				
0-1	Low	Low	Average		Low	4	
2-3	Low	Average	High		Average	5	
4+	Average	High	High		High	7	
File Complexity Matrix (ILF, EIF)							
RETs	1-19 DETs	20-50 DETs	51+ DETs			ILF	EIF
1	Low	Low	Average		Low	5	5
2-4	Low	Average	High		Average	7	7
5+	Average	High	High		High	15	10

Thumb Rule of FP Elements Identification

Data Functions

- ILF : Validate any CRUD operation performed on a database, table, file or component including in memory caching within the boundary of the application.
- EIF: Any operation invoked through a web services interface, or remote application interface through some middle-ware technology or remote access through various protocols. The data is stored outside the boundary in another system typically in another application server, content management system or file server but referenced and used by the application concerned.

Thumb Rule of FP Elements Identification

Transaction Functions

•EI : User providing data in an online application form, selecting options, choices, inputs text, uploads files or feeds data into the system. An external application sends data to be stored/processed or both. Receive data from external sources as stream feeds at intervals. Receive a device event such as alarms or triggers with relevant data to be processed.

•EQ

- Data that is fetched from the database displayed as a result of some user action.
- Data which may sent to external devices such as printers or other devices.
- Data which is sent to other external applications outside the application boundary.

•EO

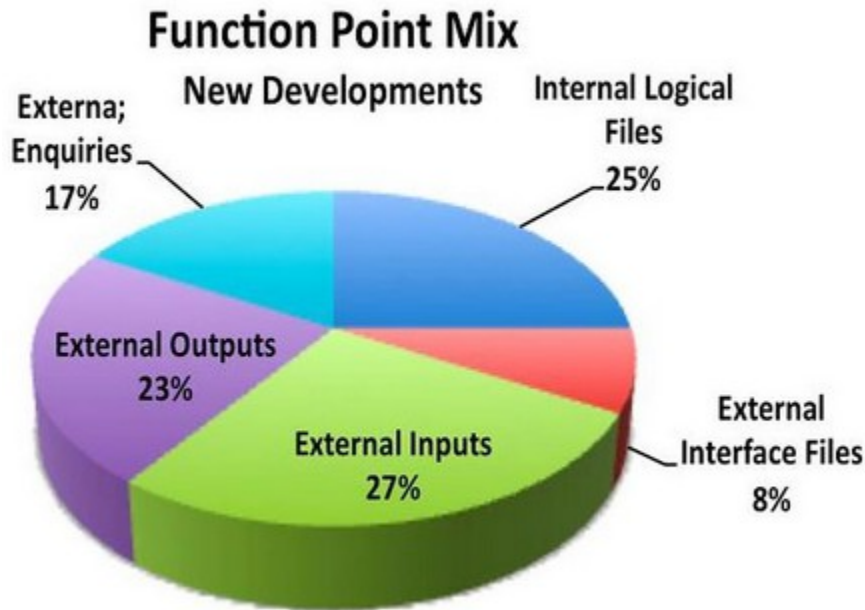
- Data that is fetched from the database displayed as a result of some user action.
- Data which may sent to external devices such as printers or other devices.
- Data which is sent to other external applications outside the application boundary.

•The main difference of an EO from an EQ is that it may contain some mathematical equation, calculation of sum, average, count or other manipulation of data, or may create additional derived fields such as totals, subtotals, calculation of final cost and may also update the ILF to reflect the computed sum.

FP Calculation : Thumb Rule

Thumb Rule for Early Prediction

- Early Prediction of Functional Size from a Logical Data Model



- If an application has 40 ILF
- ISBSG Repository shows that most ILF are low to medium. Thus complexity attributed is 9 FP
- Total ILF = $40 \times 9 = 360$ FP
- Total App size = 360×4 (25%) = 1440 FP
- Many organization has come up 1 ILF = 30 Something. It varies between 31-35 FP.

Thumb Rule for Early Prediction

- The Rule of the "Thirties" - Use Cases

There is a rule of thumb of one Use Case being approximately 35 function points. Obviously this is a very rough approximation as Use Case sizes can vary significantly.

- Use Case Points to Function Points

You can approximate function points from Use Case Points by dividing your Use Case Points by 1.25.

Thumb Rule for Early Prediction

Functional Size and Duration Relationships

Project Class	Equation (Duration=)	Example (Duration)	Project Duration
3GL projects:	$0.971 * FP^{0.351}$	Duration = $0.971 * 1440^{0.351}$	12.47 months
4GL projects:	$0.622 * FP^{0.405}$	Duration = $0.622 * 1440^{0.405}$	11.83 months
Application Generator	$1.472 * FP^{0.280}$	Duration = $1.472 * 1440^{0.280}$	11.28 months

Thumb Rule for Early Prediction

Work Effort and Duration Relationship

- Efforts (Man-hours) = $(\text{Duration} / .38)^{(1/.37)}$

*Duration in Calendar Months

- Efforts = $(11.83 / .38)^{(1/.37)} = 10850$ Man-hours

Function Point Calculation Steps

- Identify and count ILF, EIF, EI , EO and EQ
- For each ILF and EIF, identify the number of RETs and the number of DETs
- For each EI, EO and EQ, identify the number of FTRs and DETs
- Using the complexity matrices, count the number of low, average and high EI, EO, EQ, ILF and EIF items.
- Compute the total unadjusted function points
- Determine the values of the fourteen general system characteristics
- Sum the total characteristics
- Determine the total function points with the Total Function Point Formula
- $[0.65 + (.01 \times \text{total of General System Characteristics})] \times [\text{Unadjusted Function Point Count}] = \text{Total function points}$

Efforts , Cost & Duration Calculation

Use Case Estimation

Recap

- Concepts of Estimation
- Earned Value Management
- Forecasting
- Metrics
- Estimation Techniques
- Function Point Analysis (FPA)
- FP Calculation: Thumb Rules
- Efforts , Cost & Duration Calculation
- Use Case Estimation
- Recap Workshop Learnings

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ISBSF: International Software Benchmarking Standards Group. The Global and Independent Source of Data and Analysis for the IT Industry
- <http://www.ifpug.org/>
International Function Point User Group
- <http://pmi.org/>
Project Management Institute
- <http://www.softwaretestingclass.com/software-estimation-techniques/>
Software Estimation Techniques - Common Test Estimation Techniques used in SDLC
- <http://www.projectmanagementguru.com/estimating.html>
Project Management Estimating Tools & Techniques
- Function Point Counting Practices Manual Version 4.3
- Project Management Body of Knowledge 5th Edition



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