



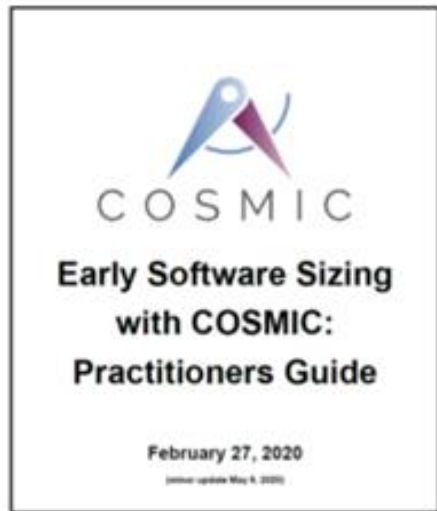
EARLY SIZING OF REQUIREMENTS FOR ESTIMATION PURPOSES

Module 1: Description of Techniques

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Tutorial is based on:



Tutorial modules:

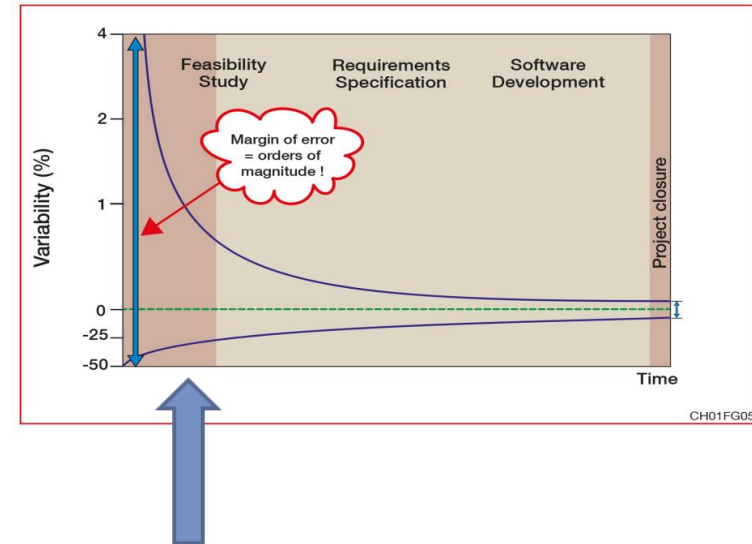
1. Description of techniques
 2. Which one to select?
 3. Early sizing & Non-Functional Requirements (NFR)
- This tutorial **does not** include **effort estimation**.

Key concepts

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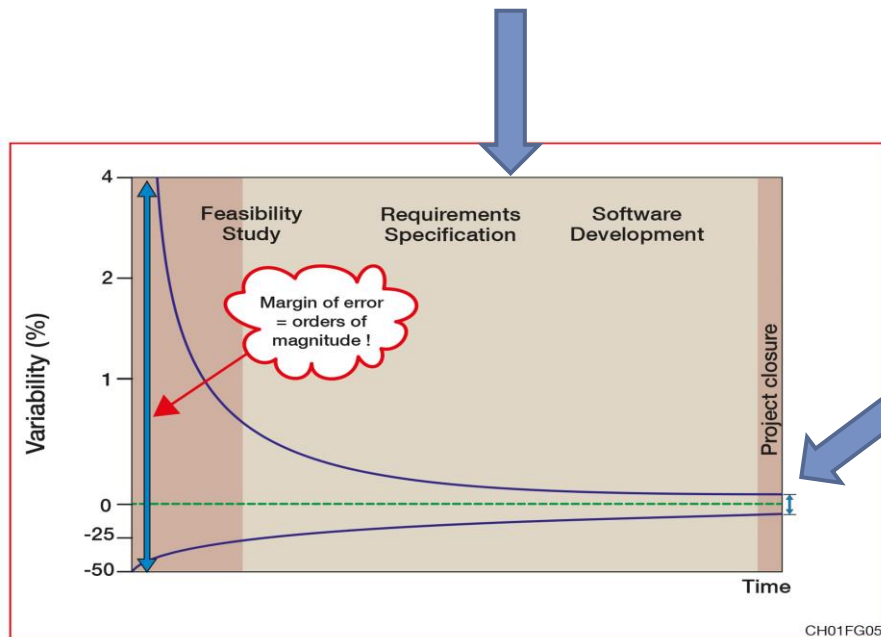
Early in the lifecycle:

- Requirements do not describe the full scope of functionality of the software with all the necessary functional details.
- Most of the time: requirements will be detailed & changed later as the project moves through the life cycle or Sprints.



Key Concepts – Post implementation

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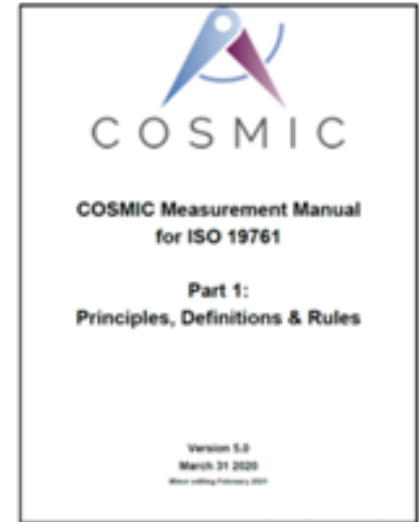
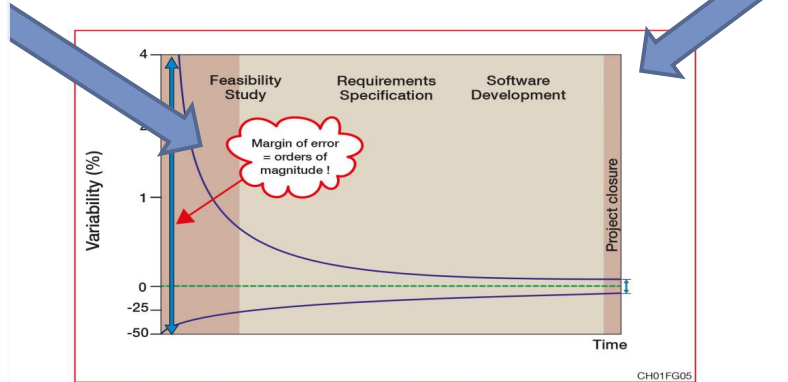
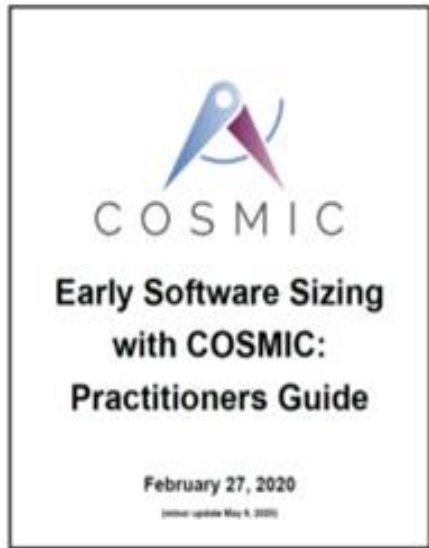
Measurement Standards

Precision of measurement requires: full & complete information



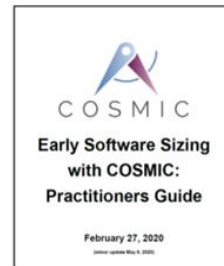
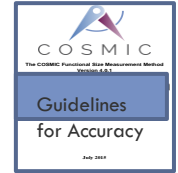
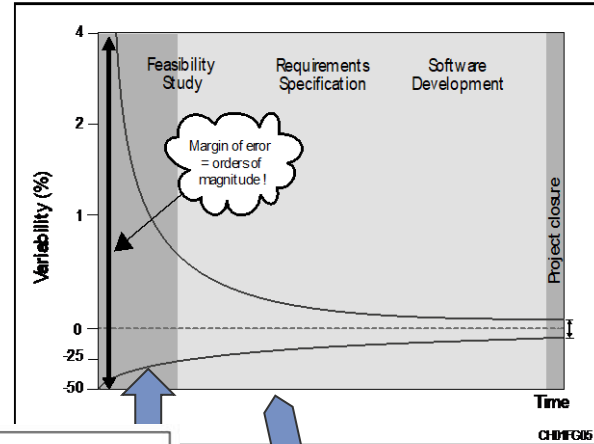
Pre & Post Implementation

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Measurers & developers must develop a clear understanding of:

- 1. The 'completeness' of the information available at the time of measurement &**
- 2. How to deal with such incompleteness with an Early Sizing technique**
- 3. How this impacts the accuracy or estimation of size.**

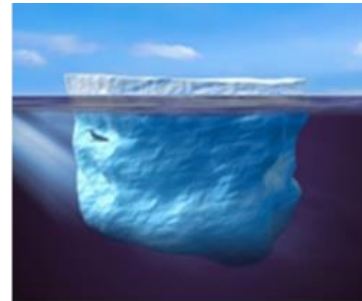
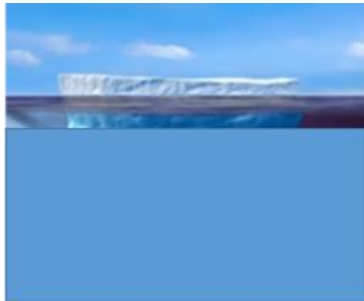


Early Sizing Techniques in this Tutorial

1. Software Iceberg Analogy
2. Average size of a functional process
3. Fixed size classification
4. Equal size bands
5. Average size of use cases
6. Early & Rapid sizing
7. Functional Patterns

1- Iceberg Analogy

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Initially visible
requirements



Visibility increases
Additional sizing is
required

1- Software iceberg analogy & sizing ratios

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Level 1:
Business
functions



Level 2:
Functions
allocated to
software



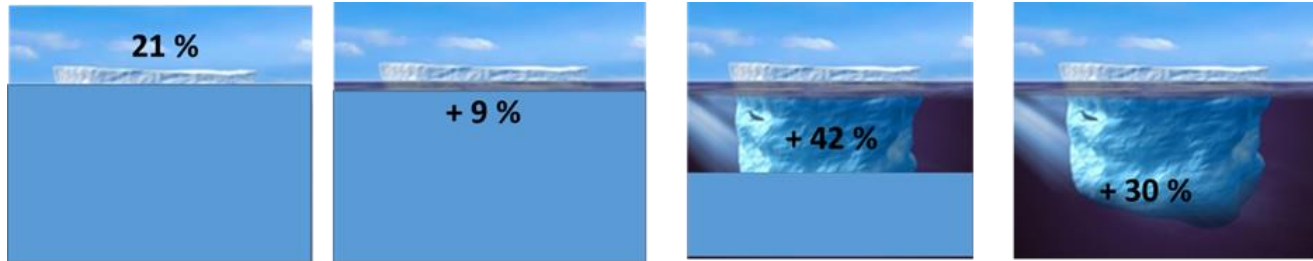
Level 3:
Operational
Functionality



Level 4:
Quality & NFR
allocated to software

1- Case study: **Course Registration System**

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Systems Functions

Details of Business
Functions

Operational
Functions

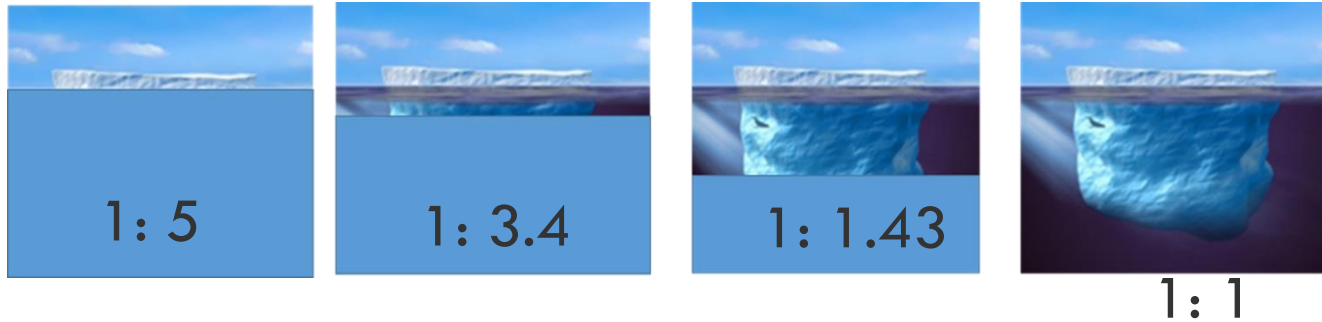
Quality Functions

In the Course Registration Case Study: Distribution of COSMIC CFP size

- **21 %** System functions allocated to software
- **9 %** + Details of business functions
- **42 %** Operational functionality
- **30 %** Implementation of quality (data integrity)

1- Scaling factors of Requirements

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In the Course Registration Case Study:

- System functions: **20%** leads to a **1: 5** scaling factor
 - ✓ Example: a size of 10 FP would lead to $10 \times 5 = 50$ CFP when fully specified, including operational functions and data integrity functions.
- Detailed functions: **20%+9%** (= 29%) leads to a **1: 3.4** scaling factor
 - ✓ a size of 20 CFP would lead to $20 \text{ CFP} \times 3.4 = 68$ CFP
- Operational functionality: **20%+9%+41%** = 70% leads to a **1: 1.43** scaling factor
 - ✓ a size of 20 CFP would lead to $20 \text{ CFP} \times 1.43 = 29$ CFP

Early Sizing Techniques in this Module

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2- Average Size of a Functional Process - Example

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Steps for Sampling & Calculation of an **average functional process**:

1. **Identify a sample** of requirements whose functional processes & data movements have been **defined in detail**.
2. **Identify the functional processes** within this sample.
3. **Measure precisely** the sizes of the functional processes of the sample.
4. **Calculate the average size**, in CFP, of the functional processes in the sample
 - average size = 8 CFP per Functional Process

-> '8' is the scaling factor

2- Average Size of a Functional Process

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Early sizing **using** the average of the sample

1. Identify & count all functional processes

➤ 40 Functional Processes

2. Estimated functional size =

➤ Number of functional processes x scaling factor
= $40 \times 8 = 320$ CFP

✓ **Valid as long as the sample used to calculate the size of the average functional process is representative for the software being estimated.**

2- Average size of a functional process

Exercise: add 20 new FP and Modify 5 existing ones

- ✦ From past projects, or from the few detailed FUR of the current project, calculate the average size of new FPs and modified FPs

Average size of	New FP	Modified FP
(in CFP)	8.0 CFP	3.5 CFP

Solution:

- ✦ Extrapolate the size with the calculated FP averages:

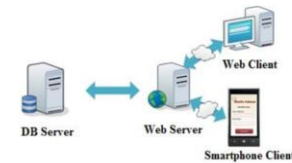
	New FP	Modified FP	Total
Number of	20 FP	5 FP	25 FP
Expected size (rounded)	160 CFP	18 CFP	178 CFP

Example from the Restaurant Case Study

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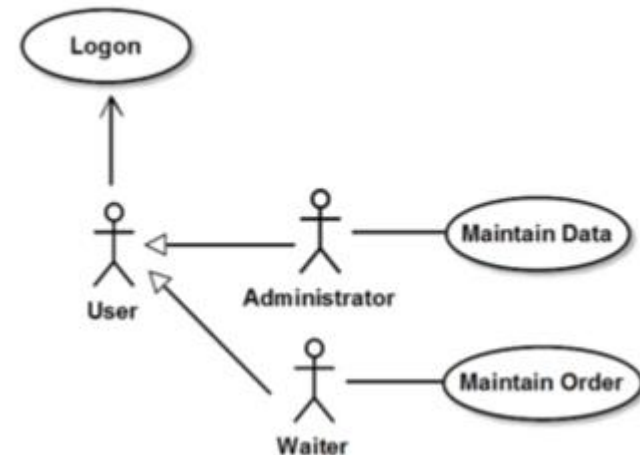
Example - Resto-Sys



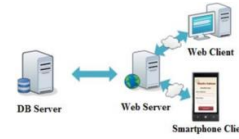
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Users of the "Resto-Sys":

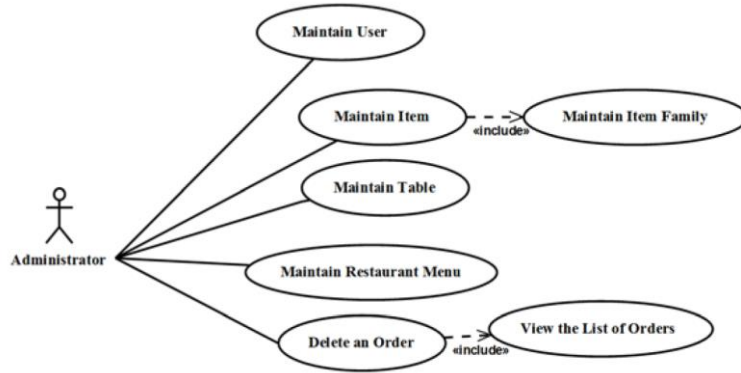
- **Administrator:** manager of the application.
 - Can manage the entire "Resto-Sys".
 - Can access to the web application via his username and his password
- **Waiter:** responsible for customers' orders.
 - Can access to the mobile app via his Smartphone and using his username and his password



Example - Resto-Sys



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- Total Size: 126 CFP
- 31 Functional Processes

FUR	Functional Processes	Triggering Events
FUR 1: Logon	FP 1: Logon	The waiter access to the logon form
FUR 2: Maintain Order	FP 2: Add an Order	The waiter adds a new order
	FP 3: Modify an Order	The waiter modifies an order
FUR 3: Logon	FP 4: Logon	The administrator access to the logon form
	FP 5: Add a User	The administrator adds a user
FUR 4: Maintain User	FP 6: View Users List	The administrator asks for the users list
	FP 7: View a User data	The administrator asks for a user data
	FP 8: Modify User Data	The administrator modifies a user data
	FP 9: Delete a User	The administrator deletes a user
FUR 5: Maintain Item	FP 10: Add an Item	The administrator adds a new item
	FP 11: View Items List	The administrator views the items list
	FP 12: View an Item Data	The administrator views the item data
	FP 13: Modify an Item	The administrator modifies an item
FUR 6: Maintain Item Family	FP 14: Delete an Item	The administrator deletes an item
	FP 15: Add an Item Family	The administrator adds a new item family
	FP 16: View Item Families List	The administrator views the item families list
FUR 7: Maintain Table	FP 17: View an Item Family Data	The administrator views an item family data
	FP 18: Modify an Item Family	The administrator modifies an item family
	FP 19: Delete an Item Family	The administrator deletes an item family
FUR 8: Maintain Restaurant Menu	FP 20: Add a Table	The administrator adds a table
	FP 21: View Tables List	The administrator views the tables list
	FP 22: View a Table Data	The administrator views a table data
	FP 23: Modify Table Data	The administrator modifies a table data
FUR 9: View the List of Orders	FP 24: Delete a Table	The administrator deletes a table
	FP 25: Add a Restaurant Menu	The administrator adds a restaurant menu
	FP 26: View Restaurant Menu List	The administrator views the restaurant menu list
	FP 27: View a Restaurant Menu Data	The administrator views a restaurant menu data
	FP 28: Modify a Restaurant Menu	The administrator modifies restaurant menu
	FP 29: Delete a Restaurant Menu	The administrator deletes a restaurant menu
	FP 30: View the List of Orders	The administrator views the list of orders
	FP 31: Delete an Order	The administrator deletes an order

EXAMPLE - Resto-Sys



19 Total Size: 126 CFP

- 31 Functional Processes
- Average Size: $126/31 = 4.1$ CFP
 - Median: 3 CFP
 - **Std Deviation: 3.2 CFP [range 2 to 7.3 CFP]**
- ❖ Exercise 1:
 - Estimate the size of 7 Functional processes?
 - $= 7 \times 4.1 = 28.7$ CFP = **29 CFP**
 - **[range 14 to 51 CFP]**

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Early Sizing Techniques in this Module

1. Software Iceberg Analogy
2. Average size of functional processes
3. **Fixed size classification**
4. Equal size bands
5. Average size of use cases
6. Early & Rapid sizing
7. Functional Patterns

3- Fixed Size Classification

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- A. Functional Processes are identified & classified according to their size in 1 of 3+ size classes:
 - Example of 3 classes: Small, Medium and Large.
- B. Each actual requirement is assigned:
 1. 1 or more functional processes,
 2. together with their appropriate size classification, and
 3. corresponding size approximation.

3- Fixed Size Classification

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Example 1 of a classification with 3 size classes:

➤ sizes based on an expected number of data movements

Classification	Size (CFP)	#E	#X	#R	#W	Error messages
Small	5	1	1	1	1	1
Medium	10	2	2	3	2	1
Large	15	3	3	4	4	1
...						

3- Fixed size EXAMPLE – Resto-Sys

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Data Set (FP sizes)

Min:	2 CFP
Max:	18 CFP
Average:	4.1 CFP
Median:	3 CFP
Std Deviation:	3.2 CFP

Example with 4 classes of size:

- Small
- Medium
- Large
- Very Large

Range = max – min = 18 CFP - 2 CFP = 16 CFP

-> Class range = 16/4 = 4 CFP

Size Class	Scaling Factor
Small	4
Medium	8
Large	12
Very Large	16

3- Fixed Size EXAMPLE – Resto-Sys

24 Exercise: estimate the size of 8 functional processes, of which:

1. 5 have been classified as Small
2. 2 have been classified as Medium
3. None classified as large
4. 1 has been classified as very large

Size Class	Scaling Factor
Small	4
Medium	8
Large	12
Very Large	16

Estimate size with the 4 classes of the Resto-Sys

Apply scaling factors:

- 5 Small → 5 x 4 CFP
- 2 Medium → 2 x 8 CFP
- 0 Large → 0 x 12 CFP
- 1 Very large → 1 x 16 CFP

~ 52 CFP

3- Fixed size classification

Example 2 of a fixed-size classification based on:

- number of data groups (DGs) within a functional process.

Classification	Size (CFP)	Nbr of DGs
Small	5	1
Medium	10	2
Large	15	3-4

- After identifying the number of Small, Medium and Large functional processes in your project, calculate the total approximated size in COSMIC function points (CFP).

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4- Equal Size Bands

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1. Functional Processes are classified into a small number of size bands.
2. Boundaries of bands are chosen so that the **total size of all the functional processes in each band** is the same for each band.

Examples:

- If 3 bands are used:
 - total size of all functional processes in each band = 33% of total size.
- If 5 bands are used:
 - total size of all functional processes in each band = 20% of total size

4- Equal size bands

To establish a classification of functional processes into equal size bands:

1. Take a sample of precisely measured FPs,
2. Sort them by size;
3. Divide into 3-4 bands of equal size.

Example with 4 bands: Small, Medium, Large and Very Large

Band	Average FP Size (CFP)	% of total size	% of #FPs
Small	4.8	25%	40%
Medium	7.7	25%	26%
Large	10.7	25%	19%
Very large	16.4	25%	15%

4- Equal Size EXAMPLE – Resto-Sys

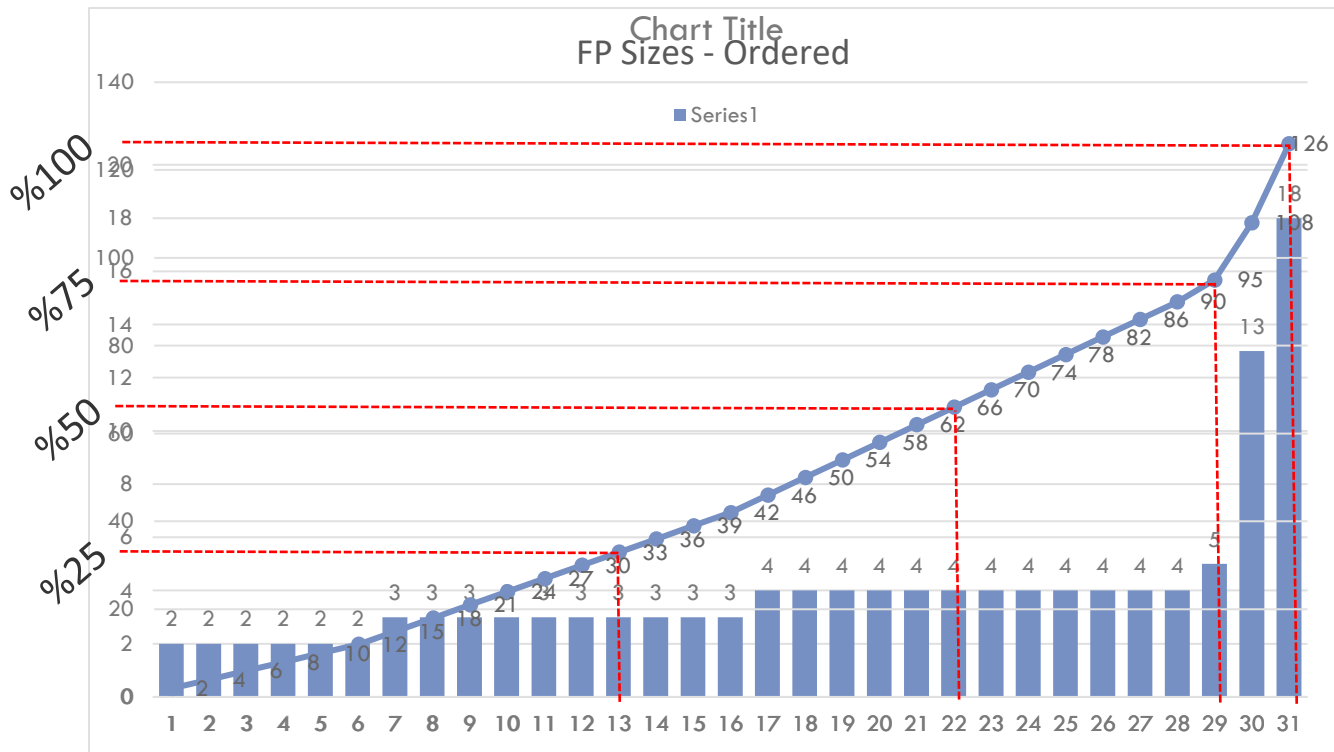
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Total Size: 126

- When 4 Equal Size Bands are selected:
 - Each band should contribute %25 of the total size -> $126 / 4 = 31,5$

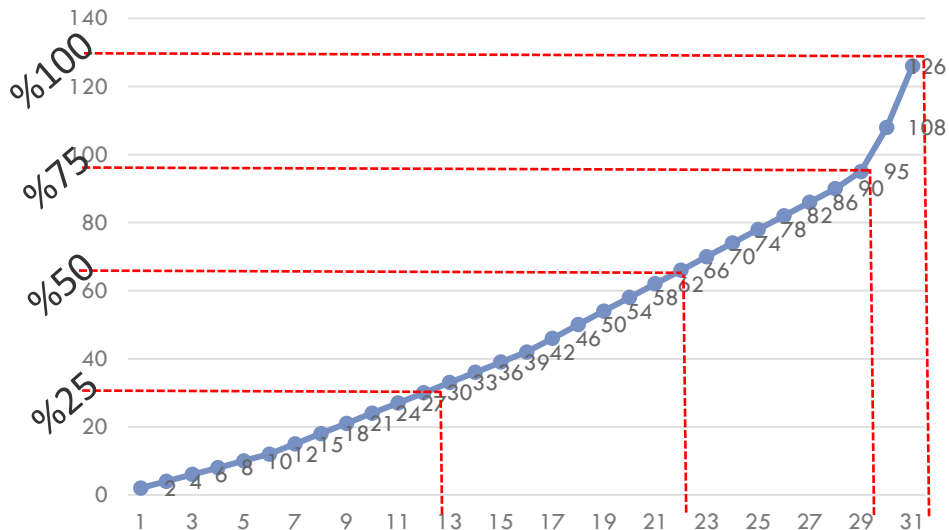
4- Equal Size Band EXAMPLE – Resto-Sys

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4- Equal Size Band EXAMPLE – Resto-Sys

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Average sizes per class.

- $\frac{30}{13} = 2.3$
- $\frac{(62-30)}{(22-13)} = \frac{28}{9} = 3.1$
- $\frac{(95-62)}{(29-22)} = \frac{33}{7} = 4.7$
- $\frac{(126-95)}{(31-29)} = \frac{31}{2} = 15.5$

4- Equal Size Band EXAMPLE – Resto-Sys

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Average sizes per class.

- $\frac{30}{13} = 2.3$
- $\frac{(62-30)}{(22-13)} = \frac{28}{9} = 3.1$
- $\frac{(95-62)}{(29-22)} = \frac{33}{7} = 4.7$
- $\frac{(126-95)}{(31-29)} = \frac{31}{2} = 15.5$

Band	Average size of a Functional Process	% of total Functional Size	% of total number of Functional Processes
Small	2.3	25%	42%
Medium	3.1	25%	29%
Large	4.7	25%	23%
Very Large	15.5	25%	6%

4- Exercise: Equal Size Band

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Steps:

1. Assign a size class (Judgement)
2. Use respective scaling factor for that class size.

Band	Average size of a Functional Process	% of total Functional Size	% of total number of Functional Processes
Small	2.3	25%	42%
Medium	3.1	25%	29%
Large	4.7	25%	23%
Very Large	15.5	25%	6%

Example:

5 Small

2 Medium

0 Large

1 Very large

5 Small 5 x 2.3

2 Medium 2 x 3.1

0 Large 0 x 4.7

1 Very large 5 x 15.5

Approximate size = ~33 CFP

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5. **Average size of use cases**
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7. Functional Size Measurement Patterns

5- Average size of Use Cases

- ✦ A Use Case (UC) may be refined into one to several Functional Processes (FP)
 - ✦ **Local calibration** might determine that a (locally-defined) UC comprises, on average, 3.5 functional processes, each FP of an average size = 8.0 CFP
 - ✦ In that case, the average size of a UC, according to this local definition, is $3.5_{\text{FP/UC}} \times 8.0_{\text{CFP/FP}} = 28$ CFP per Use Case
- ✦ To approximate the project size, apply this average on the number of Use Cases

5- Average Use Case Size

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Example of a use case with:

- 6 functional processes on average for a use case (Std Deviation: ?? FP)
- each functional process on average size = 8 CFP
 - Std Deviation: ?? CFP [range + or - 1 Std CFP]
- Hence the average size of a use case = ? = $8 \times 6 = 48$ CFP per use case.

For a new project with 12 use cases = ?

- software size would be $12 \times 48 = 576$ CFP.

Note: The uncertainty on this approximate size will be greater:

- the scale factor 48 is the product of 2 scale factors (8 & 6) which are themselves estimated.

5- Average Use Case EXAMPLE – Resto-Sys

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Use Case	Functional Process		Use Case Size
FUR1	FP1	5	5
FUR2	FP2	18	31
	FP3	13	
FUR3	FP4	4	4
FUR4	FP5	4	16
	FP6	4	
	FP7	3	
	FP8	2	
	FP9	3	
FUR5	FP10	4	16
	FP11	4	
	FP12	3	
	FP13	2	
	FP14	3	
FUR6	FP15	4	13
	FP16	4	
	FP17	3	
	FP18	2	
FUR7	FP19	3	19
	FP20	4	
	FP21	4	
	FP22	3	
	FP23	2	
	FP24	3	
	FUR8	FP25	
FP26		4	
FP27		3	
FP28		2	
FP29		3	
FUR9	FP30	4	6

Total size = 126 CFP

- 9 Use Cases
- Average Use Case size = ?
- $126/9 = 14$ CFP per Use Case
- Std Deviation: ?? CFP

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6. **Early & Rapid sizing**
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6- Early & Rapid technique (1 of 2)

Type	Level	Ranges / COSMIC Equivalent	min CFP	most likely	max CFP
Functional Process	Small	1 - 5 Data movements	2.0	3.9	5.0
	Medium	5 - 8 Data movements	5.0	6.9	8.0
	Large	8 - 14 Data movements	8.0	10.5	14.0
	Very large	14+ Data movements	14.0	23.7	30.0
Typical process	Small	CRUD (Small/Medium processes) CRUD + List (Small processes)	15.6	20.4	27.6
	Medium	CRUD (Medium/Large processes) CRUD + List (Medium processes) CRUD + List + Report (Small processes)	27.6	32.3	42.0
	Large	CRUD (Large processes) CRUD + List (Medium/Large processes) CRUD + List + Report (Medium processes)	42.0	48.5	63.0
General process	Small	6 -10 Generic FP's	20.0	60.0	110.0
	Medium	10 - 15 Generic FP's	40.0	95.0	160.0
	Large	15 - 20 Generic FP's	60.0	130.0	220.0
Macro process	Small	2 - 4 Generic GP's	120.0	285.0	520.0
	Medium	4 - 6 Generic GP's	240.0	475.0	780.0
	Large	6 - 10 Generic GP's	360.0	760.0	1,300

i.e. per business object

i.e. Module

i.e. App.

6- Early & Rapid technique (2 of 2)

Similar to fixed size classification:

- By analyzing the functional processes already measured, get an idea of the number of FPs and the size per business object
 - Do we have a CRUD (3, 4 or 5 functional processes) or a report (one functional process)?
 - Examples:
 - Only one primary data group of a small CRUD → Use 15.6 CFP.
 - A report most often uses more than one data group → 6.9 CFP.

Note:

- ✓ For a CRUD, the expression is often 'manage <business object>', while for a report the expression is simply 'list or report on <business object>'.

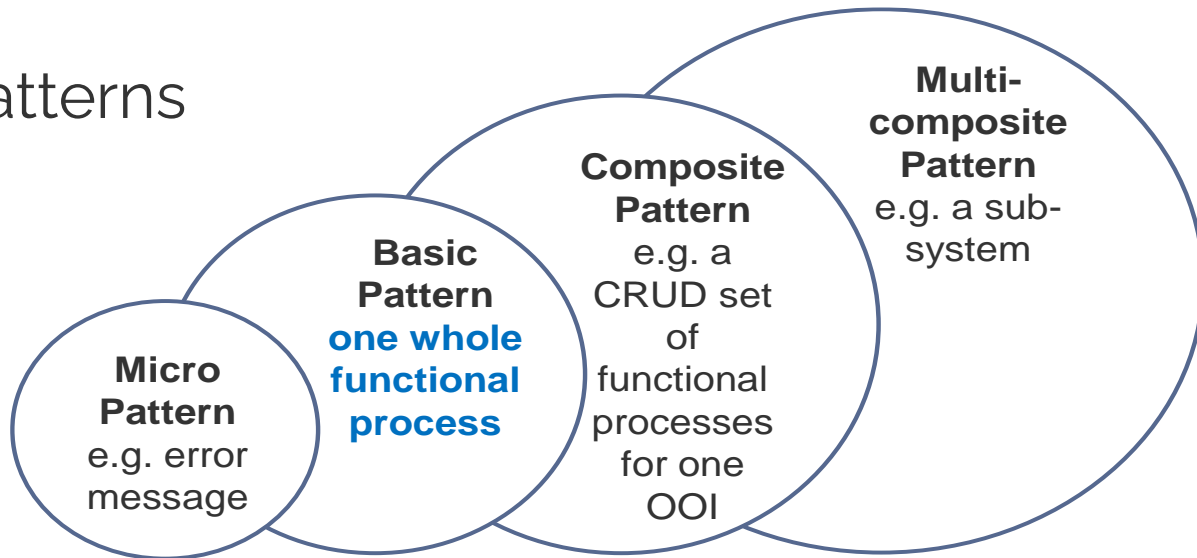
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7. **Functional Size Patterns**

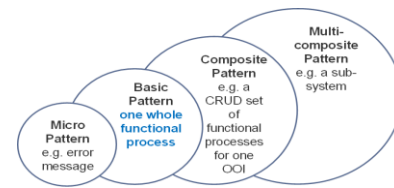
Functional Size Measurement Patterns

42 Observations of measurers:

- some patterns of measurement results recur repeatedly.
- Four types of patterns



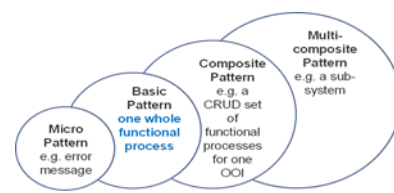
Functional Size Patterns



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- **Micro FSM patterns:** A fragment of a functional process, involving one or several data groups.
Example: displaying an error message.
- **Basic FSM patterns:** A complete single COSMIC functional process.
- **Composite FSM pattern:** A set of basic FSM patterns having a high level functional meaning together.
Example: The CRUDL (Create, Retrieve, Update, Delete, List) set of FPs to maintain data .
- **Multi-composite FSM pattern:** A set of composite and basic patterns having functional relationships among them.
 - In business application software, a multi-composite FSM pattern could represent a whole module, or component of a distributed application or even a whole application.
 - In embedded/real-time systems, it could be the set of back-end subsystem functionalities for a family of devices.

Functional Size Patterns



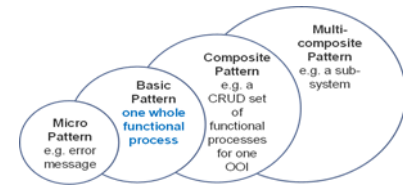
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Example for **Micro FSM** pattern:

- Display simple error messages.

Functional Process	Data Group	Data Movements	Functional Size (in CFP)
<Functional process>	Error message	X	1
		Total:	1

Functional Size Patterns

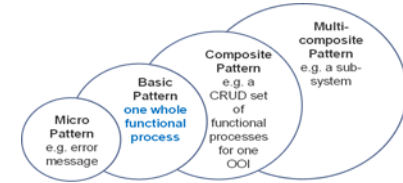


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Example of a Composite pattern:

- CRUDL with 3 Data Groups

Functional Process	Data Group	Data Movements	Functional Size (in CFP)	Remark
Create <First DG>	<First DG>	ERW	3	Create new occurrence
	<Second DG>	RX	2	Read and display list
	<Third DG>	RX	2	Read and display list
	Error message	X	1	Subtotal: 8 CFP
Retrieve <First DG>	<First DG>	ERX	3	Select, read and display existing occurrence
	<Second DG>	RX	2	Must read its ID to display its name
	<Third DG>	RX	2	Same as above
	Error message	X	1	Subtotal: 8 CFP
		Total:	36	For this FSM pattern



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Example for a Basic Pattern:

- Create 1 data group

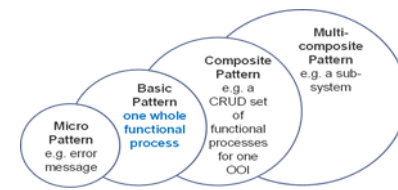
Functional Process	Data Group	Data Movements	Functional Size (in CFP)	Remark
Create <data group>	<data group>	ERW	3	Creates a new occurrence
	Error message	X	1	
Total:			4	

Functional Size Measurement Patterns

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Update <First DG>	<First DG>	ERW	3	Update existing occurrence
	<Second DG>	RX	2	Read and display list
	<Third DG>	RX	2	Read and display list
	Error message	X	1	Subtotal: 8 CFP
Delete a <First DG>	<First DG>	ERW	3	Delete an occurrence, read it first, no other DG required
	Message	X	1	Subtotal: 4 CFP
List <First DG>	<First DG>	RX	2	Read and display list
	Filter	E	1	Search filter applicable to all DGs
	<Second DG>	RX	2	Read/display list (filter)
	<Third DG>	RX	2	Same as above
	Error message	X	1	Subtotal: 8 CFP

Functional Size Patterns



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Example of a Multi-Composite pattern:

- A Module with 3 Data Groups

FSM Pattern	Category	Functional Size (in CFP)	Remark
CRUDL-3DG	Composite	36	Ex. for "Customer"
CRUDL-1DG	Composite	20	Ex. for "Sales Rep"
CRUDL-1DG	Composite	20	Ex. for "Customer category"
CRUD-2DG	Composite	22	Ex. for "Account aging parameters"
CRUD-3DG	Composite	26	Ex. for "Invoicing parameters"
CRUD-3DG	Composite	26	Ex. for "Cash receipt (C/R) parameters"
Transaction-7DG	Basic	12	Ex. for "Enter manual invoices"
Transaction-6DG	Basic	10	Ex. for "Enter a manual cash receipt"
Transaction-8DG	Basic	14	Ex. for "Enter adjustment on Invoice or C/R"
Report-3DG	Basic	7	Ex. for "Report on customer sales"
Report-4DG	Basic	9	Ex. for "Customer aging report"
Report-5DG	Basic	11	Ex. for "Customer statement of account"
Milestone-2DG	Basic	10	Ex. for "End of month A/R processing"
	Total:	223	For this FSM pattern

Patterns EXAMPLE – Resto – Sys

49 ■ Basic Pattern: “Logon”

Functional Process	Data Group	Data Movements	Functional Size (in CFP)	Remark
Logon For <data group>	<data group>	EXR	3	Checks credentials and opens a session for the user
	Error message	X	1	
Total:			4	

Composite pattern in RestoSys

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“Manage” =

➤ Add, View, Modify, Delete, List : CRUDL

Functional Process	Data Group	Data Movements	Functional Size (in CFP)	Remark
Add <DG>	<First DG>	ERW	3	Create new occurrence
	Error message	X	1	Subtotal: 4 CFP
View <DG>	<First DG>	ERX	2	Select, read and display existing occurrence
				Subtotal: 2 CFP
Modify <DG>	<First DG>	EW	2	Update existing occurrence
	Error message	X	1	Subtotal: 3 CFP
Delete a <DG>	<First DG>	EW	2	Delete an occurrence, read it first, no other DG required
	Message	X	1	Subtotal: 3 CFP
View List of <DG>	<First DG>	ERX	3	Read and display list
	Error message	X	1	Subtotal: 4 CFP
		Total:	16	For this FSM pattern



QUESTIONS?

Early or Rapid COSMIC Functional Size Measurement

Group Exercise

52 Which technique used in which context?

Table 1: Quality rating of an individual functional process

Rating	Functional Process Quality Level	Quality of the functional process definition
(a)	Completely defined	The functional process and its data movements are completely defined
(b)	Partially Documented	The functional process is partially documented: not in sufficient detail to identify all the data movements
(c)	Identified	The functional process is listed but no details are given of its data movements
(d)	Counted	A count of the functional processes is given, but there are no more details
(e)	Implied (a 'known unknown'), not mentioned or missing (an 'unknown unknown')	The functional process is implied in the actual requirements but is not explicitly mentioned, or is missing

Info Sources Quality		Functional Process Average	Use Case Average	Fixed Size Bands	Equal Size Bands	Functional Patterns
A	Complete					
B	Partial					
C	Identified					
D	Counted					
E	Implied					