The COSMIC Functional Size Measurement Method
Version 4.0.2

Course Registration ('C-REG') System Case Study

VERSION 2.0.1

August 2018

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1 ABOUT THIS CASE STUDY

1.1 Introduction

This Case Study presents the results of applying the COSMIC v4.0.2 Functional Size Measurement method (ISO/IEC 19761: 2017) to the Course Registration ('C-Reg') software system requirements as described in Chapters 2 - 4.

General information about the software application to be measured:

- Application domain: Business Application
- Application type: PC client interacts with server over an organization's network and the world-wide web.

1.2 How to use this C-Reg case study

This case study aims to be suitable for new users of the COSMIC method who have at least read the 'Introduction to the COSMIC method' document or have received some introductory training in the method, and have ideally read the Measurement Manual [1].

We also assume that the reader is generally familiar with statements of requirements for business application software. The requirements are written as plain text, so no knowledge is needed of any specific system or data analysis method to understand the requirements. To help the reader understand the case, we describe not just C-Reg requirements but also information that would normally be available later when the software design had started (such as menus and screen layouts).

After describing the C-Reg general requirements and context in section 1.3, the requirements and their respective analysis and measurements are dealt with in three Chapters, of concern to:

   2   Registrars and Professors
   3   Registrars and Students
   4   Registrars

We recommend that readers of this case study should try to understand the requirements, analysis and measurement results from Chapter 2 fully before moving on to the requirements of Chapters 3 and 4.

The C-Reg case aims to support the following teaching points on the COSMIC method:

- Determining the various parameters of the Measurement Strategy phase, including establishing a context diagram showing the functional users of the software to be measured.
- Identifying functional processes within the requirements.
- Identifying the objects of interest in requirements.
- How the names of data attributes in requirements may be misleading. They must be analysed carefully to ensure the correct identification of data groups.
- Identifying the data movements of a functional process, including that alternative processing paths may or may not lead to identifying additional data movements.
- The need to recognise that an enquiry functional process may be identical to an 'enquire-before-update', or 'enquire-before-delete' process; such a process should be counted only once per application.
- Identifying the data movements involved in communications between software systems

- The COSMIC rules for ignoring 'Control Commands' and Menu selections and for measuring 'Error/Confirmation messages'.
- Dealing with practical software requirements issues such as the need to check for any data dependencies before deleting an entity from a database.
- How to measure some aspects of Graphical User Interface features.

Note: Comments on the requirements intended to help the reader to understand the case study easily are shown in italics between square brackets.

NOTE

These requirements aim to be easy-to-understand, self-contained (but not complete) and defect-free so that they can be used to teach COSMIC functional size measurement.

(Almost all real-world requirements are incomplete and have ambiguities, etc., so need interpretation and assumptions in order to measure a functional size. These must be documented to trace the application of the measurement rules to the incomplete and ambiguous requirements. Requirements developed iteratively, e.g. using Agile methods, are never 'perfect' until the software is signed off by the user.)

If you are new to functional size measurement, be assured that experienced Measurers use the COSMIC method regularly to measure real-world requirements, even very early in a software project when requirements are evolving, assumptions have to be made about some details and approximate sizing may have to be used. But to get to this stage you need to understand the basic measurement principles and rules. Studying this C-Reg case will help you along this path.

1.3   System Requirements and Context

The system requirements below describe the functionality of the software to be developed by a project that will replace the existing Course Registration System (CRS) with an on-line system ("C-Reg") that allows students and professors access through PC clients.

The current CRS system has been in use since a number of years and lacks the capacity to handle the student and course load projected for the future. In addition, the current system uses outdated mainframe technology, which only supports access through the clerks in the Registration Office. C-Reg will enable all professors and students to access the system, in addition to the clerks in the Registration Office, through PCs connected to the Wylie College computer network and through any personal computer connected through the Internet.

C-Reg will continue to interact with the Course Catalog System which maintains the list of courses and details of the courses that will be offered for the upcoming semester (known as 'Course Offerings'). C-Reg will continue to interact with the student Billing System and the E-mail system – see Figure 1. How the data is loaded and stored in the Course Catalog system is outside the scope of this case study.
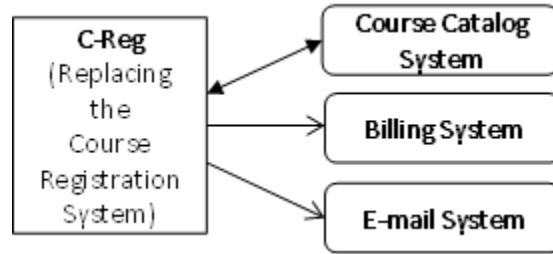
Figure 1 - C-Reg and interacting systems

All human users of C-Reg (i.e. Registrars, Professors and Students) access its functionality via a 'Main Form' menu (see Figure 2a). How the system controls security of access and the functionality available to each type of user is beyond the scope of these requirements.

[Note: in all of the following requirements, where 'he' is written, this can mean 'he' or 'she'. Similarly, 'his' can mean 'his' or 'her'.]

2 REGISTRARS AND PROFESSORS

2.1 Requirements for Registrars and for Professors

This section has two groups of requirements.

2.1.1 Maintain Professor data (by Registrars)

2.1.2 Maintain Course Offering commitments (by any Professor)

2.1.1 Maintain Professor Data

2.1.1.1 Brief Description

This group of requirements allows Registrars to maintain data about any Professor in C-Reg.

Each Professor is identified by a unique identification (or 'ID') in the form [surname, serial number], Example: 'Smith3'. *[For simplicity in the requirements, we assume that when making any enquiries, a Registrar knows the ID of all Professors, and that each Professor knows his own unique ID.]*

C-Reg must enable a Registrar to perform any of the tasks 'Add Professor, 'Modify Professor', 'Delete Professor' or 'Enquire on Professor'.

[We assume C-Reg will be implemented with a menu system, as illustrated in Figure 2. Hence for this group of requirements, a Registrar must first select 'Maintain Professor' from the Main Form as in 2a) and then choose the appropriate sub-option as in 2b).]

(a)   (b)

Figure 2 – a) Main Form and b) Example Sub-options

2.1.1.2 Add a Professor's details

a) When a Registrar wishes to enter data about a new Professor, he selects the sub-option "Add Professor."

b) C-Reg displays a blank formatted screen for entry of Professor data.

c) The Registrar enters the following details for the Professor: ID, name and address, social security number, Department, qualifications and contact details and presses 'Save'. (See Figure 3a) for an example screen showing the entered data.)

d) C-Reg validates the data to ensure the proper formats and checks whether a Professor of that ID already exists. If the entered data are valid, C-Reg creates a record for the new Professor and .

e) Alternatively, if data entered is not valid, C-Reg displays one or more error messages, for example: 'Professor ID unknown', Professor name already exists', "Professor Data Invalid". The Registrar can then change or correct the data, or cancel the operation.

Steps a) to e) may be repeated for each Professor that the Registrar wishes to add to C-Reg.

(a)   (b)

Figure 3 – (a) Add and (b) Enquiry screens

2.1.1.3 Enquire on a Professor's details

a) When a Registrar wishes to enquire on the details of a Professor, he must first select the sub-option 'Enquire on a Professor' as in 2.1.1.2 and enter the Professor ID

b) C-Reg searches for a Professor with the specified ID and displays the Professor's name and address and other details, as in Figure 3(b).

c) Alternatively, if a Professor with the specified ID is not found, C-Reg displays an error message, "Professor Not Found". The Registrar can then type in a different ID or cancel the operation.

2.1.1.4 Modify a Professor's details

a) If a Registrar wishes to modify the details of a Professor, he must first retrieve the Professor details as in 2.1.1.3 'Enquire on a Professor'

b) The Registrar presses 'Modify'.

c) The Registrar may then change one or more of the displayed Professor data items (except the Professor ID). When changes are complete, the Registrar presses "Save" and C-Reg updates the professor data.

d) Alternatively, if data entered is not valid, C-Reg displays an error message, "Professor Data Invalid". The Registrar can then correct the data or cancel the operation.

2.1.1.5 Delete a Professor's details

a) If a Registrar wishes to remove a Professor from C-Reg, he must first retrieve the Professor data as in 2.1.1.3 'Enquire on a Professor'

b) The Registrar presses 'Delete'.

c) C-Reg enquires on the Course Catalog whether the Professor has any Course Offerings that he has committed to teach. The Course Catalog replies to C-Reg with a 'yes/no' indication.

d) If the Professor has no Course Offering teaching commitments, C-Reg displays a message asking the Registrar to confirm the deletion.

e) If the Registrar selects 'yes', the Professor data is deleted from C-Reg.

f) Alternatively, if the Registrar selects 'no', the operation is cancelled.

g) If the Professor is committed to teach any Course Offerings, deletion is not allowed, C-Reg displays an error message and the Registrar must abandon the operation. *[Note: how the Registrar deals with this conflict is outside the scope of this case study.]*

2.1.2 Maintain a Professor's Course Offering commitments

2.1.2.1 Brief Description

The Course Catalog holds the dates, times and locations of all Courses that Wylie College offers to students in the upcoming semester (known as 'Course Offerings').

This group of requirements for the C-Reg system enables a Professor to enquire on Course Offerings that he may wish to teach, and to commit (i.e. add his ID) to teach a Course Offering, or to modify or to delete existing teaching commitments. The Course Catalog holds data on the qualifications needed to teach each Course.

The Course Catalog also holds the 'availability indicator' for each Course Offering. This indicator may have values:

● 'unavailable' (meaning so far no Professor has committed to teach the Course Offering),

● 'available' (meaning a Professor has committed to teach the Course Offering and Students may enrol)

● 'full' (meaning that a Course Offering is 'available' but Students may not enrol as the Course Offering is fully subscribed),

● 'cancelled' (for a Course Offering that was 'available' but has now been cancelled),

● 'closed' (meaning that Professors may no longer change their commitment to, and Students may no longer enrol in this Course Offering (see section 4.1.2 'Close Registration')

2.1.2.2 Enquire on Course Offerings

a) When a Professor wishes to enquire on the courses he may teach, he must first select 'Maintain Course Offerings' from the Main Form and then 'Enquire on Course Offerings (Professor)' from the Sub-Menu.

b) The Professor enters his ID.

c) C-Reg obtains the Professor's qualifications and Department, and sends these to the Course Catalog.

d) C-Reg obtains from the Course Catalog and displays (as shown in Figure 4) the list of Course Offerings for the Professor's Department that he is qualified to teach and that are 'unavailable', i.e. no other Professor has committed to teach the Offering in the upcoming semester. The scheduled month and room for each Course Offering are also shown so that a Professor can select commitments that will not clash on date or location.

e) Alternatively, if there are no Course Offerings that the Professor may commit to teach in the upcoming semester. C-Reg will display an error message. The Professor acknowledges the message and abandons the operation.

Figure 4 – Display resulting from Enquiry requirements 2.1.2.2

2.1.2.3 Create Course Offering commitments

a) When a Professor wishes to enter his first set of teaching commitments, he must first enquire on and display the Course Offerings as in 2.1.2.2, and then select a sub-option "Create Course Offering".

b) The Professor selects the Course Offerings from those displayed in step a) that he will commit to teach for the upcoming semester by adding his ID to the selections.

c) C-Reg returns each selected Course Offering the Professor has committed to teach to the Course Catalog.

d) The Course Catalog checks if the selected Course Offerings conflict on date or location (in case the Professor made a mistake) and returns a message to C-Reg containing:

- *the count of conflicting Course Offerings,*
- *a pair of ID's for each conflict, if any.*
- *(If there are no conflicts, the Course Catalog can then change the status of selected Course Offerings from 'unavailable' to 'available' so that Students may now enroll).). [The reason the count of conflicting Course Offerings must be returned is in case the count is zero. C-Reg interprets this as a confirmation that the committed Course Offerings have been accepted by the Course Catalog.]*

e) If any Course Offerings do conflict on date or location, C-Reg indicates the ID's of the conflicting pairs on the display of Course Offerings, with an error message. The Professor may then resolve the conflict by de-selecting one or more Course Offerings and selecting new ones, or cancelling the operation, in which case any selections will be lost.

f) C-Reg sends the details of any changed Course Offerings back to the Course Catalog as per step c).

Steps c) to f) may be repeated until the Professor is satisfied with the selection or cancels.

2.1.2.4 Modify Course Offering commitments

a) If a Professor wishes to modify any of his teaching commitments, he must first enquire on and display the available Course Offerings for his Department that he may teach and any which he has already committed to teach as in 2.1.2.2 and then select a sub-option "Modify Course to Teach".

b) The Professor then modifies the Course Offerings from those displayed in step a) that he commits to teach for the upcoming semester by adding or removing his ID from the Course Offerings, as necessary.

c) C-Reg returns each modified Course Offering to the Course Catalog. Steps d), e) and f) from 2.1.2.3 are repeated until the Professor is satisfied with this selection by pressing 'Save', or cancels. (The Course Catalog can change the status of selected Course Offerings from 'unavailable' to 'available', or vice versa, according to the Professor's decisions.)

d) C-Reg sends data for each modified Course Offering to all Students via a broadcast e-mail. *(Note: how the e-mail system broadcasts this information is outside the scope of the case study. Students must take action if a Course Offering that was 'available' and that they had enrolled for has now become 'unavailable' – see 3.1.2 below.]*

2.1.2.5 Delete Course Offering commitments

a) If a Professor wishes to delete all of his teaching commitments, he must first enquire on and display the Course Offerings that he has already committed to teach as in 2.1.2.2, and then select a sub-option "Delete Course Offerings".

b) The Professor re-enters his ID.

c) C-Reg displays a message asking the Professor to confirm that he wants to delete all his commitments.

d) If the Professor selects 'yes', C-Reg sends the Course Offering data to the Course Catalog, which changes their status to 'unavailable' (for Students to enroll).

e) Alternatively if the Professor selects 'no', the operation is cancelled.

f) C-Reg sends the ID of each deleted Course Offering to all Students via a broadcast e-mail (as in 2.1.2.4 d)).

2.1.2.6 Alternative Flow

Course Catalog System Unavailable

If C-Reg is unable to communicate with the Course Catalog after three tries, C-Reg will display an error message to the Professor. The Professor acknowledges the error message and the Professor must abandon the operation.

2.2   The Measurement Strategy

> **N.B. The Measurement Strategy parameters are the same for the requirements of Chapters 2, 3 and 4, hence this section is not repeated in the next Chapters 3 and 4.**

2.2.1   Measurement purpose

The purpose is to demonstrate to new users of the COSMIC method how to measure the functional size of the requirements, as stated, of the C-Reg software, which is a typical business application. The requirements are not intended to be complete or suitable for building a real system.

2.2.2   Measurement scope and level of decomposition

The measurement scope is all of the Functional User Requirements (FUR) of the C-Reg system. There is a single software layer for this set of requirements, the application layer.

The requirements do not mention exchanges between the PC client and the web server, i.e. the C-Reg system must be measured 'as a whole', ignoring that physically it has two components.

2.2.3   Functional users

The human functional users of the C-Reg system are clerks in the Registrar's office (referred to as 'Registrars') and Professors (see section 2.1) and the Students (see section 3.1.2).

There are also two other functional users: the Course Catalog system and the Billing System (see section 4.1.2). Figure 4 is a context diagram for the C-Reg system showing all its functional users.
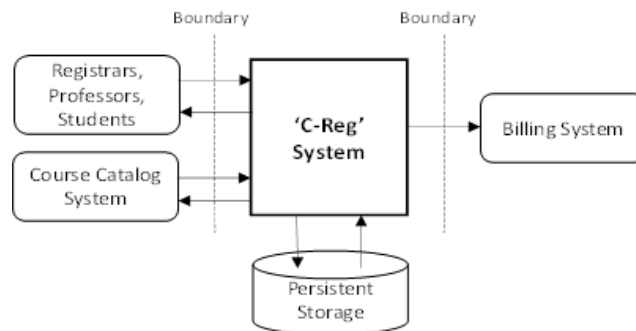
Figure 4 – C-Reg Application Context Diagram

(The E-mail System might also appear to be a functional user, but it is not. See 4.3.)

2.2.4   Level of granularity of the requirements

The functional users of the C-Reg System identified in the requirements are individual humans and software applications.

The requirements in Chapters 2 and 3 sometimes describe clusters of events, such as 'Maintain Professor' Data' but they are all broken down to a level of granularity where single events occur that C-Reg must respond to, such as a Registrar wishing to enquire, add, modify or delete data about a

Professor or to enquire on Professor data. At this level of granularity functional processes and their data movements can be identified, i.e. an exact COSMIC functional size measurement is possible.

2.3 Mapping and Measurement Phases

As for practical reasons this section also contains the measurement result, the Mapping phase is combined with the Measurement phase.

2.3.1 Identifying the functional processes

From the textual descriptions of the requirements, the following triggering event(s) and functional processes are identified as listed in Table 1.

Section	Triggering event	Functional Process
	A Registrar needs to:	
2.1.1.2	add a Professor's details	Add a Professor's details
2.1.1.3	enquire on a Professor's details	Enquire on a Professor's details
2.1.1.4	modify a Professor's details	Modify a Professor's details
2.1.1.5	delete a Professor's details	Delete a Professor's details
	A Professor needs to:	
2.1.2.2	enquire on Course Offerings	Enquire on Course Offerings (Professor)
2.1.2.3	create Course Offering commitments	Create Course Offering commitments
2.1.2.4	modify Course Offering commitments	Modify Course Offering commitments
2.1.2.5	delete Course Offering commitments	Delete Course Offering commitments

Table 1: List of candidate triggering events and candidate functional processes

2.3.2 Identifying the objects of interest

From the requirements in sections 1.3 and 2.1, we can identify the following objects of interest, and the system that holds data about the object of interest.

Source	Object of interest	System storing data about the Object of interest
2.0	Course	Course Catalog
2.0	Course Offering	Course Catalog
2.1.2.3, 2.1.2.4	All conflicting Course Offering selections	(No data is stored about this object of interest but one of its attributes, the count of all conflicting Course Offering selections, is sent in a message from the Course Catalog to C-Reg.)
2.1.1	Professor	C-Reg
2.1.1.2	Errors	(Not stored. We use 'errors' as the name of the object of interest for all error messages output by C-Reg.)

Note: a Registrar is also potentially an object of interest, but the stated requirements do not specify any data describing any Registrar, so an object of interest is not listed for a Registrar.

Below is a list of the objects of interest and their stored data attributes that we know about so far from the requirements.

Course: A standard series of lectures, etc. on a specific subject from the Course Catalog

Key: (Course ID). Other attributes (assumed): Course name, description, Department.

Course offering: A Course that is offered to students during the upcoming Semester

Key: (Course ID, Semester Name). Other attributes: month, room code of the lectures, etc., availability indicator (unavailable, available, full, cancelled, closed), assigned Professor ID, number of students enrolled, maximum number of students that may be enrolled.

Professor: A person who is registered at Wylie College who may deliver a Course Offering for one of his Department's Courses.

Key: (Professor ID).   Other attributes: name, address, date of birth, Social Security Number, qualifications, Department, phone, e-mail

2.3.3 Identifying the data movements of the functional processes

The table below shows the functional processes identified in section 2.3.1, including all their movements of data groups (each of which describes an object of interest identified in section 2.3.2). The requirement numbers in the leftmost column refer to the paragraph numbers in the requirements section 2.1.

(N.B. this layout of the analysis of the functional processes is designed for COSMIC training purposes. It would not be an efficient way of recording the results of real measurements.)

In the following 'Errors' means any of the error messages mentioned in the requirements for the functional process concerned.

Require-ment no.	Process descriptions	Functional user	Sub-process Description	Name of Data Group moved	Object of interest of Data Group moved	Data Move-ment Type	CFP
Maintain Professor Data							
2.1.1.2	Add a Professor	Registrar	Registrar enters details for the Professor	Professor details	Professor	E	1
			C-Reg validates the entered data and checks if the data describe a Professor who already exists	Professor details	Professor	R	1
		Registrar	Registrar selects 'Save' (This step will be omitted from now on in all other processes, except where needed)	Control command		-	-
			C-Reg creates a new Professor	Professor details	Professor	W	1
		Registrar	Display error message	Error Messages	Errors	X	1
						Total	4
2.1.1.3	Enquire on a Professor's details	Registrar	Registrar enters Professor ID	Professor ID	Professor	E	1
			C-Reg retrieves the Professor details	Professor details		R	1
		Registrar	C-Reg displays the Professor details	Professor details	Professor	X	1

		Registrar	Display error message	Error Messages	Errors	X	1
						Total	**4**
2.1.1.4	Modify a Professor's details	Registrar	Registrar modifies the displayed details for the Professor	Professor details	Professor	E	1
			C-Reg validates the details and updates the Professor record	Professor details	Professor	W	1
		Registrar	Display error message	Error Messages	Errors	X	1
						Total	**3**
2.1.1.5	Delete a Professor's details	Registrar	Registrar presses the delete command for the Professor whose details are displayed	Professor ID	Professor	E	1
		Course Catalog	C-Reg asks Course Catalog if Professor has any Course Offering commitments	Professor ID	Professor	X	1
		Course Catalog	Course Catalog replies 'yes' or 'no'	Professor's Course Offering commitment status	Course Offering	E	1
			C-Reg prompts the Registrar to confirm the deletion	Prompt Control Command		-	-
			The Registrar confirms or cancels the deletion	Confirmation Control Command		-	-
			C-Reg deletes the Professor	Professor details	Professor	W	1
		Registrar	Display error messages	Error Messages	Errors	X	1
						Total	5

Require-ment no.	Process descriptions	Functional user	Sub-process Description	Name of Data Group moved	Object of interest of Data Goup moved	Data Move-ment Type	CFP
Maintain Professor's Course Offering commitments							
2.1.2.2	Enquire on Course Offerings (Professor)	Professor	The Professor enters his ID	Professor ID	Professor	E	1
			C-Reg retrieves the Professor's qualifications and Department	Professor qualifications	Professor	R	1
		Course Catalog	C-Reg sends Professor's qualifications and Department to Course Catalog to retrieve eligible and committed Course Offerings	Professor qualifications	Professor	X	1

		Course Catalog	Course Catalog returns the relevant Course Offerings	Course Offering data	Course Offering	E	1
			C-Reg displays the heading showing Wylie College, upcoming Semester and Date	'Application General data. Not counted. See [2] 4.4.1	-	-	-
			C-Reg displays the Professor's Department	Department name	Department	X	1
		Professor	C-Reg displays the returned Course Offerings	Course Offering data	Course Offering	X	1
		Professor	Display error message	Error Messages	Errors	X	1
						Total	7
2.1.2.3	Create Course Offering commitments	Professor	The Professor selects the Course Offerings by entering his ID in each Offering that he wishes to teach	Professor's Course Offering selections	Course Offering	E	1
		Course Catalog	C-Reg sends the Professor's selected Course Offerings to the Course Catalog	Professor's Course Offering selections	Course Offering	X	1
		Course Catalog	C-Reg receives the count of Course Offerings that conflict from the Course Catalog	Count of conflicting courses	All conflicting Course Offering selections	E	1
		Course Catalog	C-Reg receives the ID's of any conflicting pairs of Course Offerings from the Course Catalog	Conflicting Course Offering selections	Course Offering	E	1
		Professor	C-Reg updates the display of Course Offerings with conflicts (if any), or 'Commitments accepted'	Conflicting Course Offering selections	Course Offering	X	1
			Professor repeats the above steps until satisfied with commitments, or cancels			-	-
		Professor	Display error/confirmation message	Error Messages	Errors	X	1
						Total	6
2.1.2.4	Modify Course Offering commitments	Professor	Professor modifies his Course Offering selections by entering or removing his ID	Professor's Course Offering selections	Course Offering	E	1
		Course Catalog	C-Reg sends the Professor's selected Course Offerings to the Course Catalog	Professor's Course Offering selections	Course Offering	X	1
		Course Catalog	C-Reg receives the count of Course Offerings that conflict from the Course Catalog	Count of conflicting courses	All conflicting Course Offering selections	E	1
		Course Catalog	C-Reg receives the ID's of any conflicting pairs of	Rejected Course	Course Offering	E	1

Require-ment no.	Process descriptions	Functional user	Sub-process Description	Name of Data Group moved	Object of interest of Data Goup moved	Data Move-ment Type	CFP
			Course Offerings from Course Catalog	Offering selections			
		Professor	C-Reg updates the display Course Offerings with conflicts (if any), or 'Commitments accepted'	Rejected Course Offering selections	Course Offering	X	1
			Professor repeats the above steps until satisfied with commitments or cancels			-	-
		Student	C- Reg sends an e-mail for broadcast to Students	Modified Course Offering e-mail	Course Offering	X	1
		Professor	Display error message	Error Messages	Errors	X	1
						Total	7
Require-ment no.	Process descriptions	Functional user	Sub-process Description	Name of Data Group moved	Object of interest of Data Goup moved	Data Move-ment Type	CFP
2.1.2.5	Delete Course Offering commitments	Professor	Professor enters his ID and presses delete command	Professor ID	Professor	E	1
			C-Reg prompts the Professor to confirm the deletion	Prompt Control Command		-	-
			The Professor confirms or cancels the deletion	Confirmation Control Command		-	-
		Course Catalog	C-Reg sends ID's of deleted Course Offerings to Course Catalog	Course Offering ID	Course Offering	X	1
		Student	C- Reg sends an e-mail for broadcast to Students	Deleted Course Offering e-mail	Course Offering	X	1
		Professor	Display error message	Error Messages	Errors	X	1
						Total	4

2.4   Questions and Answers

Question re 2.1.1.2 'Add a Professor's details'

Suppose that C-Reg generates a Professor ID rather than, as currently specified, a Registrar must enter a Professor ID in this process. What would be the effect on the analysis of this functional process?

Answer

According to the requirements as stated, there would be the following consequences:

● The Registrar would not need to enter a Professor ID, but an Entry for the other Professor details would still be needed.

- the Create functional process would still need a Read to check whether a Professor of the same name already exists (given the convention that a Professor ID is a combination of his surname and a serial number). If that condition is found, there would be another error message, e.g. 'Professor of this name already exists' but we would still identify only one error/confirmation Exit to account for all such messages.
- Although not stated in the current requirements, logically C-Reg would display the newly-created Professor ID, which would imply one additional Exit.
- As Registrars would not now be maintaining a list of Professor ID's outside C-Reg, they would almost certainly need an additional enquiry functional process to enter a Professor surname and display all ID's that match that name (if any), e.g. 'Smith1', 'Smith2', 'Smith3', etc. This functional process would add 4 CFP to the C-Reg size.

Question 1 re 2.1.1.2 'Add a Professor's details and 2.1.1.4 'Modify' a Professor's details

The requirements do not state how entered Department names are represented and hence how an entered Department can be validated. Suppose the C-Reg system holds a table of valid Department names, and that when entering data for a 'Add' or 'Modify' Professor details there is a requirement to display a drop-down list of valid Department names from which the Registrar must select a valid name. What would be the effect on the analysis of these functional processes?

Answer

There would be no effect on the size of these two functional processes because a Department is not an object of interest for these processes. (No data describing a Department other than its name would be required to be stored by C-Reg.) See [2], section 4.1.7.

An alternative solution for validating entered Department names (rather than holding a table of valid Department names in C-Reg) would be for C-Reg to send an entered name to the Course Catalog for validation. This would require an extra Exit/Entry pair in each of the 'Add' or 'Modify' Professor's details functional processes

Question 2 re 2.1.1.2

Does the answer given above to 'Question 1 re 2.1.1.2' depend on whether the table of names in C-Reg is hard-coded in the software or is stored in a table of names that can be maintained by a System Administrator?

Answer

It makes no difference to the size of the Add and Modify Professor's details functional processes how Department names are stored. Department is not an object of interest for these functional processes, so no Read is needed to access the names.

However, if the Department names are stored in a table that may be maintained by a System Administrator, then 'Department' is an object of interest to the Administrator. Clearly he/she will need functional processes to maintain Department names and these would add to the size of C-Reg.

Question re. 2.4.1

Can one triggering event (Registrar selects the "Maintain Professor" activity from Main Form) trigger more than one functional process (Add, Modify, Delete and Enquire on a Professor)?

Answer

There is no such *triggering event* as 'Maintain Professor' in this case study. In the real world of a Registrar there are events like:

- A new Professor starts work, so his details must be added to C-Reg;
- Something changes for a Professor, e.g. his address, so the data stored about him must be changed;

- A Professor leaves or dies or whatever, so he must be removed from the database;
- A Registrar wants to enquire on a Professor's data.

These events cause functional users to enter data groups into the software, i.e. they are triggering events, leading to the corresponding functional processes (i.e. add, modify, delete and enquire) respectively. 'Maintain Professor' is a <u>group</u> of functional process types. Selection of this group from a menu by a Registrar is a 'Control Command', not measured in COSMIC because it does not move data describing an object of interest– see section 3.5.10 of the Measurement Manual, v4.0.2 [1].

Question re 2.1.2.3 e)

Why doesn't the solution given for requirement 2.1.2.3 e) show all the data movements that allow a professor to change the selection(s) to resolve any conflict that the Course Catalog has found?

Answer

The actions by the Professor following notification of a conflict to de-select one of the conflicting Course Offerings and send his new choices back to the Course Catalog involve the identical data groups that have been moved earlier in the process. Repeating the cycle of requirement 2.1.2.3 e) involves repeated *occurrences* of the same data movements. According to the 'Data movement uniqueness' rule (see [1], section 3.5.7), these data movements should be identified only once.

Cancelling the whole operation is a Control Command and should not be identified.

Question re 2.1.1.5

In the analysis of the requirements 2.1.1.5, 'Delete a Professor', a Registrar enters a delete command, which is identified as an Entry. Why is the delete command identified as an Entry and not as a Control Command? The delete command just says 'delete the Professor whose details are displayed'; it does not convey data about a Professor. This same comment applies to several functional processes.

Answer

The delete command DOES convey data about a specific object of interest, the Professor ID of the already-identified and displayed Professor, so this must be identified as an Entry. It may be that no attribute such as a specific Professor ID must be physically re-entered by the Registrar, but the displayed ID is certainly implied in this command. This is quite different from a 'real' Control Command (as defined in section 3.5.10 of the Measurement Manual v4.0.2 [1]), such as 'page-up' or 'page down'. This same phenomenon occurs in many of the functional processes.

3 REGISTRARS AND STUDENTS

3.1 Requirements for Registrars and for Students

This section has two groups of requirements.

3,1.1 Maintain Student data (by a Registrar)

3.1.2 Maintain Student Schedule items (by any Student)

3.1.1 Maintain Student Data

3.1.1.1 Brief Description

This group of requirements enables a Registrar to maintain data about Students, by first selecting the "Maintain Student" activity from the Main Form.

Each Student is identified by a unique identification (or 'ID'). *[For simplicity in the requirements, we assume that when making any enquiries, a Registrar knows the ID of all Students, and that each Student knows his own ID.]*

3.1.1.2 Add a Student's details

a) When a Registrar wishes to enter data about a new Student, he selects the sub-option "Add Student".

b) C-Reg displays a blank formatted screen for entry of student data.

c) The Registrar enters the following details for the student: name, date of birth, social security number, status, and graduation date.

d) C-Reg validates the data to ensure the proper formats. If the data are valid C-Reg creates a new student record and assigns a unique system-generated ID, which is displayed.

e) Alternatively, if invalid data are entered, C-Reg displays an error message, "Student Data Invalid". The Registrar can then correct the data or cancel the operation.

3.1.1.3 Enquire on a Student's details

a) When a Registrar wishes to enquire on the details of a particular Student he must first select the sub-option "Enquire on a Student" and then enter a Student ID.

b) C-Reg searches for a Student with the specified ID. If the ID is valid C-Reg shows the Student's name, date of birth, status, graduation date.

c) Alternatively, if the Student ID is not found, C-Reg displays an error message, "Student Not Found". The Registrar can then type in a different ID or cancel the operation.

3.1.1.4 Modify a Student's details

a) If a Registrar wishes to modify the details of a Student, he must first retrieve the Student's details as in 3.1.1.3 and then select the sub-option "Modify Student."

b) The Registrar may then modify one or more of the displayed student data items (but not the Student ID). When changes are complete, the Registrar presses "Save."

c) C-Reg validates the data to ensure the proper formats and if correct updates the Student details.

d) Alternatively, if invalid data are entered, C-Reg displays an error message, "Student Data Invalid". The Registrar can then correct the data or cancel the operation.

3.1.1.5 Delete a Student's details

a) If a Registrar wishes to delete the details of a Student, he must first retrieve the Student's details as in 3.1.1.3 and then select the sub-option "Delete Student."
b) C-Reg checks whether the Student has a Student Schedule (see 3.1.2 below).
c) If the Student does not have a Student Schedule, C-Reg displays a message asking the Registrar to confirm the deletion.
d) The Registrar selects "yes" and the student is deleted from C-Reg.
e) Alternatively, if the Student has a Student Schedule, deletion isn't allowed, C-Reg displays an error message and the Registrar must abandon the operation.

3.1.2   Maintain Student Schedule items

3.1.2.1 Brief Description

This group of requirements enables a Student to create his personal 'Student Schedule' for the upcoming semester by enrolling in up to six Course Offerings. Each item in a Student Schedule is uniquely identified by the ID of the Student and the ID of the Course Offering.

The Student can also enquire on, modify or delete Course Offerings in his Schedule, provided the changes are made before course registration is closed (see 4.1.2 Close Registration).

As already stated, the Course Catalog holds the Course Offerings for the upcoming semester. It also holds any 'Prerequisite' for each Course Offering. For any Course 'X', a Pre-requisite is any one other Course 'Y' for which a Student must have achieved satisfactory examination results before he may enroll for Course 'X'.

The C-Reg system holds for each current Student:

● his 'Schedule' of up to six Course Offerings (known as 'Student Schedule items') that he wishes to attend for the upcoming semester;
● his results for successfully-completed examinations for each Course in previous semesters.

3.1.2.2 Enquire on Course Offerings (Student)

a) When a Student wishes to enquire on Course Offerings, he must first select 'Maintain Student Schedule' from the Main Form and then 'Enquire on Course Offerings (Student)' from the Sub-menu.
b) The Student enters his ID.
c) C-Reg retrieves the details of all Course Offerings (date/time and location, and their availability status) from the Course Catalog as well as the ID of a pre-requisite Course (if any) for each Course Offering.
d) C-Reg displays these Course Offering details and the entered Student ID.

3.1.2.3 Create a Student Schedule

a) When a Student wishes to create his Schedule by selecting Course Offerings for the first time, he must first retrieve the Course Offerings as in 3.1.2.2 and then select the sub-option "Create Student Schedule".
b) The Student selects at most six available Course Offerings from the displayed list for his Schedule. Once the selections are complete, the Student selects "Submit", which results in his ID and the selections being entered *[The Student must manually check there are no conflicts on date/time of his selected Course Offerings. C-Reg will only accept selection of a Course Offering that has the status 'available'.]*

c) C-Reg checks whether the Student has achieved the necessary pre-requisite for each Course Offering that the Student has selected for enrollment. If the check is OK, C-Reg accepts each selected Course Offering as an item in the Student's Schedule, with the status "enrolled".

d) Alternatively, if C-Reg determines that the Student has not satisfied the necessary pre-requisite for a particular selected Course, an error message is displayed.

e) The Student can then either select an alternative Course Offering and submit his selection again, or cancel the whole operation (in which case no Schedule is saved).

f) C-Reg stores the Student Schedule items if all prerequisites have been satisfied.

g) C-Reg sends the ID's of the added Course Offerings to the Course Catalog so that the latter can update the number of Students enrolled for each Course Offering.

3.1.2.4 Modify a Student Schedule

a) If a Student wishes to modify the Course Offerings in his Schedule, he must first retrieve the Course Offerings as in 3.1.2.2 and then select "Modify Student Schedule".

b) C-Reg retrieves the Student's current Schedule items, both 'enrolled' and 'selected' (see 3.1.2.6 below) and adds this status to each of the displayed Course Offerings that are 'available'.

c) The Student adds and/or deletes Course Offerings to/from the selections in his current Schedule. When his new selections are complete, the Student selects "Submit" *[Subject to the same limitations as in 3.1.2.3 b).]*.

d) C-Reg checks whether the Student has achieved the necessary prerequisite for each Course Offering that the Student has now selected for enrollment. If the check is OK, C-Reg then updates the selected Course Offering in the Schedule, with the status "enrolled".

e) Alternatively, if C-Reg determines that the Student has not satisfied the necessary prerequisite for a particular selected course, an error message is displayed.

f) The Student can either select an alternative Course Offering and submit his selection again, or cancel the whole operation (in which case the modified Schedule is not saved, i.e. the original Schedule is unchanged).

g) C-Reg stores the Student Schedule items.

h) C-Reg sends the ID's of the modified Course Offerings, if any, to the Course Catalog so that the latter can update the number of Students enrolled for each Course Offering.

3.1.2.5 Delete a Student Schedule

a) If a Student wishes to delete his Schedule, he must first select 'Maintain Student Schedule' from the Main Form and then select the sub-option "Delete Schedule".

b) The Student enters his ID.

c) C-Reg retrieves and displays his Student Schedule items (his list of enrolled and/or selected Course Offerings).

d) C-Reg prompts the Student to verify the deletion; the Student verifies the deletion.

e) C-Reg deletes the Schedule items and issues a confirmation message.

f) C-Reg sends the ID's of the deleted Course Offerings to the Course Catalog so that the latter can update the number of students enrolled for each course.

g) C-Reg issues an error message in case the Student's Schedule is not found.

3.1.2.6 Alternative Flows

a) Save the Student Schedule items

At any point during the 'Add' or 'Modify' processes, the Student may choose to save his Schedule items by pressing "Save". Selected Course Offerings that were not previously marked as 'enrolled' are marked as 'selected' Schedule items and are saved on C-Reg and the operation ceases, In this case the ID of any Course Offerings of status 'selected' are not sent to the Course Catalog.

b) Course Catalog System Unavailable

If C-Reg is unable to communicate with the Course Catalog after three tries, C-Reg will display an error message to the Student. The Student acknowledges the error message and the Student must abandon the operation.

3.2 Mapping and Measurement Phases

> **For the Measurement Strategy parameters, see section 2.2.**

3.2.1 Identifying the functional processes

From the textual descriptions of the requirements, the following triggering event(s) and functional processes are identified as listed in Table 2.

Section	Triggering event	Functional Process
	A Registrar needs to:	
3.1.1.2	add a Student's details	Add a Student's details
3.1.1.3	enquire on a Student's details	Enquire on a Student's details
3.1.1.4	modify a Student's details	Modify a Student's details
3.1.1.5	delete a Student's details	Delete a Student's details
	A Student needs to:	
3.1.2.2	enquire on Course Offerings	Enquire on Course Offerings (Student)
3.1.2.3	create a Student Schedule	Create a Student Schedule
3.1.2.4	modify a Student Schedule	Modify a Schedule
3.1.2.5	delete a Student Schedule	Delete a Student Schedule

Table 2: List of candidate triggering events and candidate functional processes

3.2.2 Identifying the objects of interest

This list of objects of interest in 3.2.2 must now be extended to include the fact that we are told in 3.1 2 1 that C-Reg holds past examination results for each Student for each Course. *[The requirements do not specify how these past examination results are loaded for each student.]*

Source	Object of interest	System storing data about the Object of interest
2.0	Course	Course Catalog
2.0	Course Offering	Course Catalog
2.1.1	Professor	C-Reg
2.1.2.4 d)	Student	C-Reg
2.1.2.4 d)	Student Schedule item	C-Reg
3.1.2.1	Student/Course	C-Reg

3.1.1.2	Errors	(Not stored. We use 'errors' as the name of the object of interest for all error messages output by C-Reg.)

The list of the objects of interest and their stored data attributes that we know about so far from the requirements is also now extended as below.

Course: A standard series of lectures, etc. on a specific subject from the Course Catalog
Key: (Course ID). Other attributes (assumed): Course name, description, Department.
Course offering: A Course that is offered to students during the upcoming Semester
Key: (Course ID, Semester ID). Other attributes: dates, locations of the lectures, etc., availability indicator (unavailable, available, full, cancelled, closed), pre-requisite Course ID, assigned Professor ID, number of students enrolled, maximum number of students that may be enrolled.
Professor: A person who is registered at Wylie College who may deliver a Course Offering for one of his Department's Courses.
Key: (Professor ID). Other attributes: name, address, date of birth, Social Security Number, qualifications, Department, phone, e-mail address
Student: A person who is registered at Wylie College who may enrol in a Course Offering.
Key: (Student ID). Other attributes: name, date of birth, social security number, graduation date, e-mail address.
Student Schedule item: A record for each Student for each of his selected or enrolled Course-Offerings
Key: (Student ID, Course Offering ID). Oher attributes: status (enrolled or selected)
Student/Course: A record for each Student of his examination results for previously-attended Courses
Key: (Student ID, Course ID, Semester ID). Other attributes (assumed): Examination grade.

3.2.3 Identifying the data movements of the functional processes

The table below shows the functional processes identified in section 3.2.1, including all their movements of data groups (each of which describes an object of interest identified in section 3.2.2). The requirement numbers in the leftmost column refer to the paragraph numbers in the requirements section 3.1.

In the following 'Errors' means any of the error messages mentioned in the requirements for the functional process concerned.

Require-ment no.	Process descriptions	Functional user	Sub-process Description	Name of Data Group moved	Object of interest of Data Group moved	Data Move-ment Type	CFP
Maintain Student Data							
3.1.1.2	Add a Student's details	Registrar	Registrar enters Student details	Student details	Student	E	1
			C-Reg creates a new Student record	Student details	Student	W	1
		Registrar	C-Reg displays the generated Student ID	Student ID	Student	X	1
		Registrar	Display error message	Error Messages	Errors	X	1
						Total	**4**
3.1.1.3	Enquire on a Student's details	Registrar	Registrar enters Student ID	Student ID	Student	E	1
			C-Reg obtains the Student details	Student details	Student	R	1
		Registrar	C-Reg displays the Student details	Student details	Student	X	1
		Registrar	Display error message	Error Messages	Errors	X	1
						Total	**4**
3.1.1.4	Modify a Student's details	Registrar	Registrar modifies the displayed Student details	Student details	Student	E	1
			C-Reg stores the modified details	Student details	Student	W	1
		Registrar	Display error message	Error Messages	Errors	X	1
						Total	**3**
3.1.1.5	Delete a Student's details	Registrar	Registrar enters the delete command for the selected Student	Student ID	Student	E	1
			C-Reg checks if the Student has a Student Schedule	Student Schedule item	Student Schedule item	R	1
			C-Reg prompts the Registrar to confirm the deletion	Prompt Control Command		-	-
			The Registrar confirms the deletion	Confirmation Control Command		-	-
			C-Reg deletes the Student details	Student details	Student	W	1
		Registrar	Display error message	Error Messages	Errors	X	1
						Total	**4**

Require-ment no.	Process descriptions	Functional user	Sub-process Description	Name of Data Group moved	Object of interest of Data Group moved	Data Move-ment Type	CFP
Maintain Student Schedule items							
3.1.2.2	Enquire on Course Offerings (Student)	Student	Student enters his ID and 'Enquire on courses' command	Student ID	Student	E	1
		Course Catalog	C-Reg asks Course Catalog for Course Offerings	Course Offering request	Course Offering	X	1
		Course Catalog	C-Reg receives Course Offering details, incl. pre-requisite Course ID	Requested Course Offerings	Course Offering	E	1
		Student	C-Reg displays Course Offering details, incl. any pre-requisite Course ID	Requested Course Offerings	Course Offering	X	1
		Student	C-Reg displays Student ID	Student ID	Student	X	1
		Student	Display error message	Error Messages	Errors	X	1
							6
3.1.2.3	Create a Student Schedule	Student	Student selects 'Create Schedule' and his ID is entered	Student ID	Student	E	1
		Student	Student selects up to 6 Course Offerings	Student's selected Course Offerings	Student Schedule item	E	1
			C-Reg checks if the Student satisfies pre-requisites of selected Course Offerings	Student previous exam results	Student/ Course	R	1
		Course Catalog	Validated Course Offering ID's are sent to the Course Catalog so that it can maintain the count of Students for each Course Offering	Course offering ID	Course Offering	X	1
		'Submit'	Student's Schedule items are marked 'enrolled' and made persistent on C-Reg	Student Schedule item details	Student Schedule item	W	1
		"Save"	Student's Schedule items are marked 'selected' and made persistent on C-Reg	Student Schedule item details		(Same as for Submit)	-
		Student	Display error message	Error Messages	Errors	X	1
							6
3.1.2.4	Modify a Student Schedule	Student	Student selects 'Modify Course Offerings' and his ID is entered	Student ID	Student	E	1

			C-Reg retrieves Student's Schedule items	Student Schedule item details	Student Schedule item	R	1
		Student	C-Reg adds the item statuses (enrolled or selected) to the displayed Course Offerings	Student Schedule item details	Student Schedule item	X	1
		Student	Student modifies his displayed Course Offering selections	Modified Student Schedule item details	Student Schedule item	E	1
			C-Reg checks if the Student satisfies pre-requisites of modified Course Offerings	Student previous exam results	Student/ Course	R	1
	"Submit"		C-Reg marks Student Schedule items as 'enrolled' and makes them persistent	Student Schedule item	Student Schedule item	W	1
3.1.2.6 a)	"Save"		C-Reg marks Student Schedule items as 'selected' and makes them persistent	Student Schedule item		(Same as for Submit)	-
		Course Catalog	C-Reg sends modified Course Offering ID's to the Course Catalog	Course Offering changes	Course Offering	X	1
		Student	Display error message	Error Messages	Errors	X	1
							8
3.1.2.5	Delete a Student Schedule	Student	The Student selects the 'Delete Schedule' command and his ID is entered	Student	Student	E	1
			C-Reg retrieves the Student's Schedule items	Student Schedule Item details	Student Schedule item	R	1
		Student	C-Reg displays the Student's Schedule items	Student Schedule Item details	Student Schedule item	X	1
			C-Reg prompts the Student to verify the deletion	Control Command		-	-
			The Student confirms the deletion	Control Command		-	-
			C-Reg deletes the Student Schedule items	Student Schedule item details	Student Schedule item	W	1
		Course Catalog	C-Reg sends the deleted Course Offering ID's to the Course Catalog	Course Offering deletions	Course Offering	X	1
		Student	Display error message	Error Messages	Errors	X	1
							6

3.3 Questions and Answers

Question re. 3.3.1

The functional process "Delete a Student's details" has a requirement: "C-Reg prompts a Registrar to verify the deletion". Confirmations like this appear in other functional processes like Delete a Professor. Why are these 'confirmation prompts' not identified as data movements?

Answer

In the Business Application Guideline [2], the rule is given in 4.4.1 that clicking 'OK' to confirm some entered data should be ignored as it is a Control Command. The command does not move data describing an object of interest.

Question re 3.1.2.3 and 3.1.2.4

The requirements for these two functional processes ('Create' and 'Modify' a Student Schedule) do not specify that the Student must enter his ID at the start of the process, but the analysis shows an Entry is identified for the Student ID. Why?

Answer

The requirements state that these two functional processes can only be started after executing an 'Enquire on Course Offerings (Student)' process. The output of this latter process will show the Student ID which he entered, as well as the retrieved Course Offerings. This display will become the data entry screen for the 'Create' or 'Modify' a student Schedule functional processes if they are selected.

When the Student has made his Course Offering selections, he presses 'Submit' (or 'Save') and the data on the screen crosses the boundary from the Student functional user to enter the 'Create' or 'Modify' functional process. Therefore we must identify an Entry for the input of the Student ID. The Student may not need to physically re-enter his ID, but the 'Create' and 'Modify' functional processes need this Student ID from their input screen.

Question re. 3.1.2.3

The requirement 3.1.2.3 "Create a Student Schedule" states that the Student 'submits' his Schedule Items and later that C-Reg 'saves' the Schedule. The alternative flow requirement 3.1.2.6 states that the student may 'save' a Schedule without submitting it. This appears to indicate that there are as many as three Writes. How does the 'data movement uniqueness' rule apply here?

Answer

The 'Submit' is the final action of entering data that is measured as one Entry. After the Student presses 'Submit', his Student Schedule is made persistent (i.e. stored) by C-Reg with the status 'enrolled' for each Course Offering. The action by a Student to 'save' his Student Schedule, is the same data movement, but with the status 'selected'. The data group moved - 'Student Schedule item' - is the same type, regardless of the value of the 'status' data attribute. There is only one Write data movement needed to satisfy all these requirements.

Question re. 3.1.2.4

In section 3.1.2.4, 'Modify Course Offerings in a Student Schedule', after the current Course Offerings have been displayed and the Student presses 'Modify Course Offerings', C-Reg retrieves the current Student Schedule items and adds their status (enrolled or selected) to the displayed Course Offerings. The Student can now modify his selection. Why is an Exit identified for this update of the displayed Course Offerings?

Answer

At the start of the process 'Modify Course Offerings in a Student Schedule', the screen displayed for data input shows the available Course Offerings. When C-Reg retrieves a Student Schedule item and adds its status (enrolled or selected) to the displayed Course Offering, C-Reg is now displaying a Student Schedule item in place of a Course Offering, i.e. it is displaying a different data group. (The display is now showing the list of Course Offerings that are not of interest to the Student interspersed with those that are of interest, i.e. with Student Schedule items. So the display now has two Exits.)

Question re. 3.1.2

Why is 'Student Schedule' not listed as an object of interest?

Answer

 'Student Schedule' is a name we give for convenience to a collection of up to six Student Schedule items. There is no data stored or moved that describes the 'Student Schedule' collection; data are stored only about the individual Student Schedule items. 'Student Schedule' is therefore not an object 'of interest'.

Question re 3.2.2

'Department' is shown as an attribute of both the objects of interest 'Professor' and 'Course Offering'. How can this be true?

Answer

The meaning of this attribute is different for each object of interest.

The meaning of the attribute of Professor that is named 'Department' is 'the Department to which the Professor belongs'

The meaning of the attribute of Course Offering that is named 'Department' is 'the Department which provides this Course Offering'.

These two attributes should therefore really be named differently. A good convention for naming attributes is to form the name from the object of interest that the attribute describes, followed by a name that distinguishes the attribute; these two are joined by an underscore '_'. For these two attributes, the names could be:

Professor_Department

Course Offering_Department

In practice as in this case study, attributes are usually listed in statements of requirements, and on displays and in report headings, with short, simple names whose meanings are clear in the context.

Measurers must be aware of these practices if objects of interest and data groups are to be distinguished correctly. See [2] section 4.2.1 'Warning on misleading attribute names'.

4 REGISTRARS

4.1   Requirements for the Registrars

This section has two groups of requirements:

4.1.1   Registrar Management Information

4.1.2   Close Registration

4.1.1   Registrar Management Information

4.1.1.1 Brief Description

This group of requirements enables a Registrar to monitor progress in course registrations by a report and an Enquiry, and to close registration, i.e. prevent further registrations.

4.1.1.2 Monitor Course Offering Enrollment progress

a) When a Registrar wishes to check progress on Course Offering enrollment, he selects the menu sub-option 'Monitor Course Offering Enrollment'.

b) C-Reg requests from the Course Catalog and receives all Course Offerings including their current status, the name of the Department that 'owns' the Course, the number of students enrolled, and the maximum number of students that may be enrolled.

c) C-Reg sorts the received Course Offerings by Department name and produces a report (see Figure 5) showing, at the displayed date:

- For each Department (by name), a list of Course Offerings, each with its status; the actual number of Students enrolled; the maximum number that may be enrolled; and the 'enrollment percentage' (= actual/maximum)

- For each Department, the actual number of Students enrolled; the maximum number that may be enrolled; and the average enrollment percentage for all the Department's Course Offerings

- For the whole of Wylie College, the actual number of Students enrolled; the maximum number that may be enrolled; and the average enrollment percentage for all Course Offerings.

```
Wylie College. Fall Semester                              5/11/2015

Registrar's Enrolment Monitoring Report

Department: Biology
Course Offering       Status      # Enrolled   Max #    % Enrolment
Biochemistry          Full            50         50          100
Botany                Available       44         50          88
Cell Theory           Cancelled       0          25          0
(etc.)
(etc.)
Department Summary                    349        395         88.4


Department: Modern Languages
Course Offering       Status      # Enrolled   Max #    % Enrolment
Chinese I             Available       38         40          95
Chinese II            Full            40         40          100
French I              Available       27
(etc.)
Department

Wylie College Summary               5,097       5350        95.2
```

Figure 5. – Three sections from an example report resulting from requirement 4.1.1.2

4.1.1.3 Monitor Student Schedule Enrollment progress

a) When a Registrar wishes to check progress on Student Schedule enrollment, he selects the menu sub-option 'Monitor Student Schedules'.

b) C-Reg retrieves the Student Schedule items for each Student and the names of all Students that have not enrolled for or selected any Course Offerings.

c) C-Reg displays, at the report's date:

- the name of every Student that has not enrolled for or selected any Course Offerings i.e. has no Student Schedule items

- the overall percentage of enrollments in Student Schedules (= total actual enrollments in Schedules as a percentage of the maximum possible number of enrollments in a Schedule, where the latter is six per Student) for Wylie College.

4.1.2 Close Registration

4.1.2.1 Brief Description

This requirement allows a Registrar to close the registration processes, by changing the status of each Course Offering (i.e. the value of its availability indicator field) from 'available' or 'full', to 'cancelled' or 'closed'. As close registration processing cannot be performed if a registration is in progress, the Registrar announces in advance the closing date to people concerned. *[This announcement is not part of the scope of the measurement.]* Course Offerings that do not have enough students are cancelled. C-Reg deals with the consequences of course closure or cancellation for billing Students and for their Schedules.

4.1.2.2 Close Registration

a) When a Registrar wishes to close all registration processes, he selects the menu sub-option "Close Registration".

b) C-Reg obtains the Course Offerings from the Course Catalog that are 'available' or 'full'.

c) C-Reg performs the following processing:
   - For each Course Offering that has less than 3 students enrolled, C-Reg sets the Course Offering status to 'cancelled'.
   - For all other Course Offerings, C-Reg sets the status to 'closed'.

d) C-Reg returns the Course Offering data to the Course Catalog so that it can update Course Offering statuses in its files.

e) For each combination of enrolled Student and closed Course Offering, C-Reg sends the Student ID and the Course Offering ID to the Billing System.

f) C-Reg prepares and issues e-mails announcing cancelled Course Offering(s) to be sent to each affected Student via the E-mail System. The E-mail system requires a message to have three fields: To (e-mail address), Subject (header), Message (body). The e-mail address must conform to normal internet standards; the header and body may be unstructured text.

> An example message could be:
> To: John.Doe@wyliemail.com, Subject: 'Notice of course cancellations',
> Message:
> 'Dear John Doe, I regret to inform you that due to insufficient numbers the following courses in which you enrolled have been cancelled: Asian History III, Korean for Beginners.
> Please make an appointment to visit my office to discuss your options.
> (Signed) Dr Mary Shelley, Registrar.'

g) C-Reg updates Student Schedule items where necessary.

4.2   Mapping and Measurement Phases

> **For the Measurement Strategy parameters, see section 2.2.**

4.2.1   Identifying the functional processes

There are two functional processes triggered by a Registrar's need to monitor progress in enrollments in Course Offerings and per Student in their Schedules.

There is one functional process triggered by the need for a Registrar to close registration.

4.2.2   Identifying the objects of interest

The two 'Management Information' processes produce data describing the objects of interest shown in the table below.

Note: no data is stored *about* a 'Department' or *about* 'Wylie College'. But they are "*things in the world of the functional user that are identified in the Functional User Requirements, about which the software is required to process .... data*" (as per the definition of an object of interest). 'Department' and 'Wylie

College' are therefore objects of interest for the C-Reg output which includes some derived, transient data describing them.

Source	Object of interest	System storing data about the Object of interest
4.1.1.2 c)	Course Offering	Course Catalog
4.1.1.2 c)	Department	No data is stored about this object of interest in C-Reg. Transient data about Department is output by C-Reg.
4.1.1.2 c) and 4.1.1.3 c)	Wylie College	No data is stored about this object of interest in C-Reg. Transient data about Department is output by C-Reg.
4.1.1.3 b	Student Schedule item	C-Reg
4.1.1.3 b)	Student	C-Reg

The list of the objects of interest and their data attributes from the requirements of section 4.1 is as below.

Course Offering: A Course that is offered to students during the upcoming Semester

Key: (Course ID, Semester Name). Other attributes: month, room code of the lectures, etc., availability indicator (unavailable, available, full, cancelled, closed), assigned Professor ID, number of students enrolled, maximum number of students that may be enrolled.

Department: A part of Wylie College with specific research and teaching responsibilities.

Key: (Department name). Other (derived) attributes: the actual number of Students enrolled; the maximum number that may be enrolled; and the average enrollment percentage for all the Department's Course Offerings, all at the date shown.

Student: A person who is registered at Wylie College who may enrol in a Course Offering.

Key: (Student ID). Other attributes: name, date of birth, social security number, status, graduation date and e-mail address.

Student Schedule item: A record for each Student for each of his selected or enrolled Course-Offerings

Key: (Student ID, Course Offering ID). Oher attributes: status (enrolled or selected)

Wylie College: A teaching college that sponsors the C-Reg system.

Key: (Wylie College name). Other (derived) attributes: the actual number of Students enrolled; the maximum number that may be enrolled and the average enrollment percentage for all Course Offerings; the overall percentage of enrollments in Student Schedules and the overall percentage of selections in Student Schedules, all at the date shown.

The 'Close Registration' process does not introduce any new objects of interest. The list of objects of interest relevant to this process is therefore the same as in section 4.2.2.

4.2.3 Identifying the data movements of the functional processes

The table below shows the functional processes identified in section 4.2.1, including all their movements of data groups (each of which describes an object of interest identified in section 4.2.2). The requirement numbers in the leftmost column refer to the paragraph numbers in the requirements section 4.1.

In the following 'Messages' means any of the 'Error/confirmation messages' mentioned in the requirements for the functional process concerned.

Require-ment no.	Process descriptions	Functional user	Sub-process Description	Name of Data Group moved	Object of interest of Data Group moved	Data Move-ment Type	CFP
Registrar Management Information							
4.1.1.2	Monitor Course Offering Enrolment progress	Registrar	Registrar selects 'Monitor Course Offering Enrolment progress'	Course Offering Enrolment Data request	Course Offering	E	1
		Course Catalog	C-Reg requests Course Catalog to send Course Offering data	Course Offering Data request	Course Offering	X	1
		Course Catalog	C-Reg receives Course Offering data	Course Offering Data	Course Offering	E	1
		Registrar	C-Reg outputs Department name, the number of Students enrolled, etc., and the average percentage enrolment for all Course Offerings that it 'owns'	Department data	Department	X	1
		Registrar	C-Reg outputs number of Students enrolled, etc for each Course Offering the Department 'owns'	Departmental Course Offering Enrolment Data	Course Offering	X	1
		Registrar	C-Reg outputs , the number of Students enrolled, etc., and the av. % enrolment in Course Offerings for Wylie College	Wylie College Course Offering Enrolment data	Wylie College	X	1
						Total	6
4.1.1.3	Monitor Student Schedule Enrolment progress	Registrar	Registrar selects 'Monitor Student Schedule Enrolment progress'	Student Schedule Enrolment progress request	Student Schedule item	E	1
			C-Reg retrieves Student details	Student details	Student	R	1
			C-Reg retrieves Student Schedule items	Student Schedule item data	Student Schedule item	R	1

		Registrar	C-Reg displays names of Students with no enrolled or selected Course Offerings	Student name	Student	X	1
		Registrar	C-Reg displays the overall % of enrolments in Student Schedules for Wylie College	Wylie College Student Schedule enrolment data	Wylie College	X	1
						Total	**5**
Close Registration							
4.1.2.2	Close Registration	Registrar	The Registrar selects sub-option "Close registration"	Date closed	Course Offering	E	1
		Course Catalog	C-Reg requests Course Offering data (with number of students enrolled, etc.) from the Course Catalog	Course Offering Data request	Course Offering	X	1
		Course Catalog	Course Offering data received	Course Offering Data	Course Offering	E	1
			C-Reg checks that at least three students enrolled. If <3, it sets Course Offering status to 'cancelled'	(Data manipulation)		-	-
		Course Catalog	C-Reg sends updated statuses of Course Offerings to the Course Catalog	Course Offering statuses	Course Offering	X	1
			C-Reg retrieves the Student Schedule items for the Students enrolled for each Course Offering	Student Schedule item data	Student Schedule item	R	1
		Billing System	C-Reg sends data to the Billing System for each Student enrolled for each Course Offering that has not been cancelled	Student Schedule item data	Student Schedule item	X	1
			C-Reg retrieves Student name and e-mail address	Student details	Student	R	1
		Student	C-Reg sends info on each cancelled Schedule item to each Student in the form of an e-mail	Student e-mail address.	Student	X	1
		Student		Cancelled Student Schedule item message	Student Schedule item	X	1
			C-Reg updates Student Schedule items for cancelled Course Offerings	Student Schedule item data	Student Schedule item	W	1
						Total	**10**

4.3   Questions and Answers

Question 1 re. 4.1.2

In the 'Close Registration' functional process, the requirement 4.1.2.2 e) states: 'For each closed Course Offering and enrolled Student combination, C-Reg sends the Student ID and the Course Offering ID to the Billing System.

The size of this requirement has been given as one Exit in the analysis of 4.1.2. The object of interest of the data group moved is 'a Student Schedule item' and its unique identifier (or key) is [Student ID, Course Offering ID]. The requirements do not specify any other data attributes. The data group will occur once for every combination of Course Offering ID and enrolled Student ID, so this is one data group moved in one Exit.

In practice, if the Billing System is to produce an invoice for the Student, it will need more than just a Student ID; it will also need his name and address. The Billing System could, of course, access the C-Reg system to get that data.

However, suppose as an alternative to the requirement 4.1.2.2 e), that C-Reg is required to send the Student name and address, as well as the Student ID and Course Offering ID to the Billing System, how would that affect the size of this function process?

Answer

The output would now be two Exits. Why is the size greater?

The [Student ID, Course Offering ID] data group that is output resulting from requirement 4.1.2 occurs once for every combination of Course Offering ID and enrolled Student ID.

A Student's name and address are two data attributes of the 'Student' object of interest (This is fixed quite independently of whether the Student is enrolled or not in any Course Offerings). The Student ID, name and address attributes form a data group that occurs once for each 'Student'.

This difference in the frequency of occurrence tells us that C-Reg must output two different data groups to meet this requirement, i.e. there would be two Exits to the Billing System. (See Chapter 2 of the 'Guideline for sizing Business Application Software', v1.2, [2].

Question 2 re. 4.1.2

Why is the message sent by C-Reg about cancelled Course Offerings to the E-mail System for onward transmission to affected Students measured as two Exits when the E-mail system requires only three fields? These three fields could be interpreted as attributes of one object of interest 'E-mail'

Answer

C-Reg assembles an e-mail message to meet the formatting standards of the E-mail system. These specify that any message must have three fields, namely 'To' (a standard e-mail address), 'Subject' (header text), 'Message' (body text). From the viewpoint of the E-mail system, these are clearly three attributes of the one object of interest 'E-mail' (so it would process the message as one Entry).

However, the E-mail System is NOT the functional user of the C-Reg system for this requirement. The functional user (the 'intended recipient' of the data) is the Student identified in the 'To' field of the e-mail. This should be clear from the requirements which state that the e-mail message must include the Student's e-mail address and name ('John Doe' in the example).

This Functional User Requirement has two components: a) the information required by the Student, and b) the format of the transmitted information must comply with the standard of the E-mail System.

C-Reg, which assembles the message, outputs the Student e-mail address and name (attributes of the Student object of interest) and the list of one or more cancelled Course Offerings, as per the example in Question 1 above. From C-Reg's point of view it is outputting data describing two objects of interest (Student and Course Offering), hence it is outputting two Exits.

If the information output by C-Reg in this process were in the form of a printed report rather than a series of e-mails, then following COSMIC rules we would expect to count two Exits. The format of the output (report or e-mail) should not influence our analysis of the data movements of the software being measured which is based on the number of data group types that are output.

Question 3 re 4.1.2

In the 'Close Registration' functional process, C-Reg outputs a 'Enrolled Student/Course Offering' data group to the Billing System and a 'Cancelled Student Schedule item message' data group to the Student in the e-mail. These two data groups each describe the same object of interest – a Student Schedule item - i.e. a Student/Course Offering combination. The only difference is that one data group is for enrolled Students, the other is for Students whose Course offering has been cancelled; this is a difference of the value of the status attribute.

As the output to the Billing System and to the E-mail System describe the same object of interest, why identify two Exits?

Answer

The data groups required to be output to the Billing System and to the Student in the e-mail are not identical. The data group output to the Student contains information in text form (that C-Reg generates) that does not occur in the output to the Billing System. Further, the Billing System and the Student are two different functional users.

These two differences – of data groups and of receiving functional users – satisfy the conditions of the 'Data Uniqueness and possible exceptions' rule b), section 3.5.7 of the Measurement Manual [1], so that we must identify two different Exits.

5

5   C-REG SUMMARY FUNCTIONAL SIZE MEASUREMENT

No	Functional Process	CFP
1	Add a Professor	4
2	Enquire on a Professor	4
3	Modify a Professor	3
4	Delete a Professor	5
5	Enquire on Course Offerings (Professor)	7
6	Create Course Offering commitments	6
7	Modify Course Offering commitments	7
8	Delete Course Offering commitments	4
9	Add a Student's details	4
10	Enquire on a Student's details	4
11	Modify a Student's details	3
12	Delete a Student's details	4
13	Enquire on Course Offerings (Student)	6
14	Create a Student Schedule	6
15	Modify a Student Schedule	8
16	Delete a Student Schedule	6
17	Monitor Course Offering Enrolment progress	6
18	Monitor Student Schedule Enrolment progress	5
19	Close Registration	10
	Total size	**102**

Table 3: List of the functional processes and their sizes

Important

The above measurement results are based on the information available at the Requirements level. It is feasible that more information is added at the Specifications level which would add further data groups; this would most certainly impact the functional size. It is also plausible that the detailed specifications lead to additional functional processes and/or the addition of sub-processes. Again, this could lead to changes to the functional size in order to take into account these additions.

6 REFERENCES

All COSMIC documents are available for free download from www.cosmic-sizing.org.

[1] 'The COSMIC Functional Size Measurement Method v4.0.2: Measurement Manual. (The COSMIC Implementation Guide for ISO/IEC 19761:2017)' December 2017.
[2] 'Guideline for Sizing Business Application Software', v1.3, May 2017

APPENDIX

A.1   Version Control

Date	Reviewers (s)	Modifications / Additions
2003	IBM	The original version of this case study was documented in the Rational Unified Process (RUP Version 2003.06.00.65) document as an example of a Web site Project. The case study was reproduced with permission from IBM.
Most recent update of version 1: 2008-02-23	Many reviewers	The first version of this case study was published on 26th August 2004, copyright of the École de Technologie Supérieure, Montréal, Canada. This version went through several successive updates, the final one dated 23rd February 2008, all of which were published on www.cosmicon.com.
Version 2.0 December 2015	Arlan Lesterhuis, Alain Abran, Charles Symons Other members of the COSMIC Measurement Practices Committee Metrics specialists from Capgemini UK	Updated to comply with v4.0.1 of the COSMIC method, and partly re-written to simplify the requirements to make the whole document easier to understand by eliminating ambiguities. Some requirements have been removed from earlier versions and some new requirements added (in Chapter 4) to introduce new teaching points. The document has been re-structured so that each of the main Chapters 2, 3 and 4 contain the requirements followed by the analysis. These can be handed out separately for teaching purpose Copyright of the case has been transferred from ETS to COSMIC.
Version 2.0.1 April 2018	Arlan Lesterhuis, Alain Abran, Charles Symons Bruce Reynolds, Francisco Valdes Souto, Metrics specialists from Capgemini UK	Updated to comply with v4.0.2 of the COSMIC method. No substantive changes. Font changed from 10 to 11 pt.

A.2   Change requests, Comments, Questions

Where the reader believes there is a defect in the text, a need for clarification, or that some text needs enhancing, please send an email to: mpc-chair@cosmic-sizing.org. You can use the forum on cosmic-sizing.org/forums to post your questions and receive answers from our world-wide community. The quality of any answers will depend on the knowledge and experience of the community member that writes the answer; the MPC cannot guarantee the correctness. Commercial organizations exist that can provide training and consultancy or tool support for the method. Please consult the www.cosmic-sizing.org web-site for further detail.