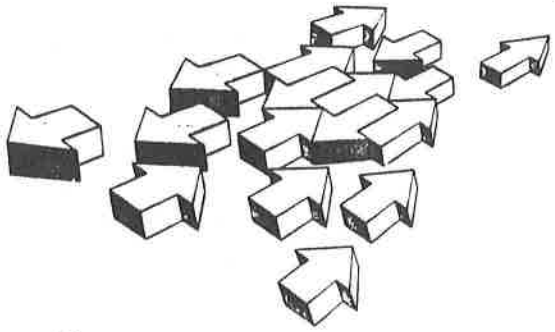

Case Study Problem Statement: Habitat Control Center (HCC)

HCC-1.0 INTRODUCTION

A Habitat Control Center (HCC) is to contain 48 living quarters and a software system, named Sealed Environment Monitor (SEM), which is to act as a monitor of all the living quarters for the habitat personnel in the HCC[1].

HCC-2.0 SEALED ENVIRONMENT MONITOR (SEM)

The SEM shall monitor all *occupied* living quarters. There shall be a total of 48 living quarters, each of which may, or may not, be occupied at any one time.

HCC-2.1 MONITORED DATA

For each occupied living quarter, the SEM shall obtain, once per minute, the following data:

- Current air pressure (pounds per square inch)
- Current temperature (degrees Fahrenheit)
- Current oxygen level (as a percentage).

This information shall be obtained from three sensors that are located inside each living quarter. There shall be one sensor per environmental condition.

[1] It is important to note that the authors do not have access to actual alarms and sensors, consequently the interfaces are emulated in the software.

HCC-2.2 ALARM CONDITIONS

For each of the items in Paragraph HCC-2.1, the SEM shall immediately react to the following situations as indicated:

- For a changed value that represents a deviation of >= 1% but <2% from the nominal values found in the database, the appropriate window in the panel shall be lit.
- For a changed value that represents a deviation of >= 2% but less than 3% from the nominal values found in the database, the appropriate window in the panel shall be lit and flash at a rate of two times per second.
- For a changed value that represents a deviation of >= 3% from the nominal values found in the database, the appropriate window in the panel shall be lit and flash at a rate of four times per second. Additionally, an audible alarm shall be sounded.

There shall be only one audible alarm.

HCC-3.0 ANNUNCIATOR PANEL

The annunciator panel is located in the control center of the sealed habitat. The panel of annunciators shall consist of 48 annunciators, arranged in six rows (A–F) of eight annunciators in each row (numbered 1–8, respectively). Additionally, each annunciator shall be mapped to a unique living quarter by the location in the annunciator panel. For example, annunciator C-5 corresponds to living quarter C-5. Figure HCC-1 depicts the envisioned panel display.

Each annunciator in the panel shall be composed of three parts: an air pressure warning window, an oxygen warning window, and a temperature warning window. Each window shall be identified by an appropriate legend. Figure HCC-2 depicts a typical annunciator display that is composed of three windows, one for each environmental condition.

HCC-4.0 NOMINAL VALUES

All nominal values shall be found in the database. There shall be an option for an Operator to redefine the values of the environmental conditions maintained in the database. The Operator shall be able to redefine all three environmental nominal values to be used for all living quarters and apply this change to SEM processing.

HCC-5.0 ALARMS

The audible alarm-sounding and window-flashing features shall be only turned *on* by the SEM. The SEM shall continue to turn on these warning indicators as long as the alarm condition continues to exist. The warning indicators shall only be turned *off* by the Operator.

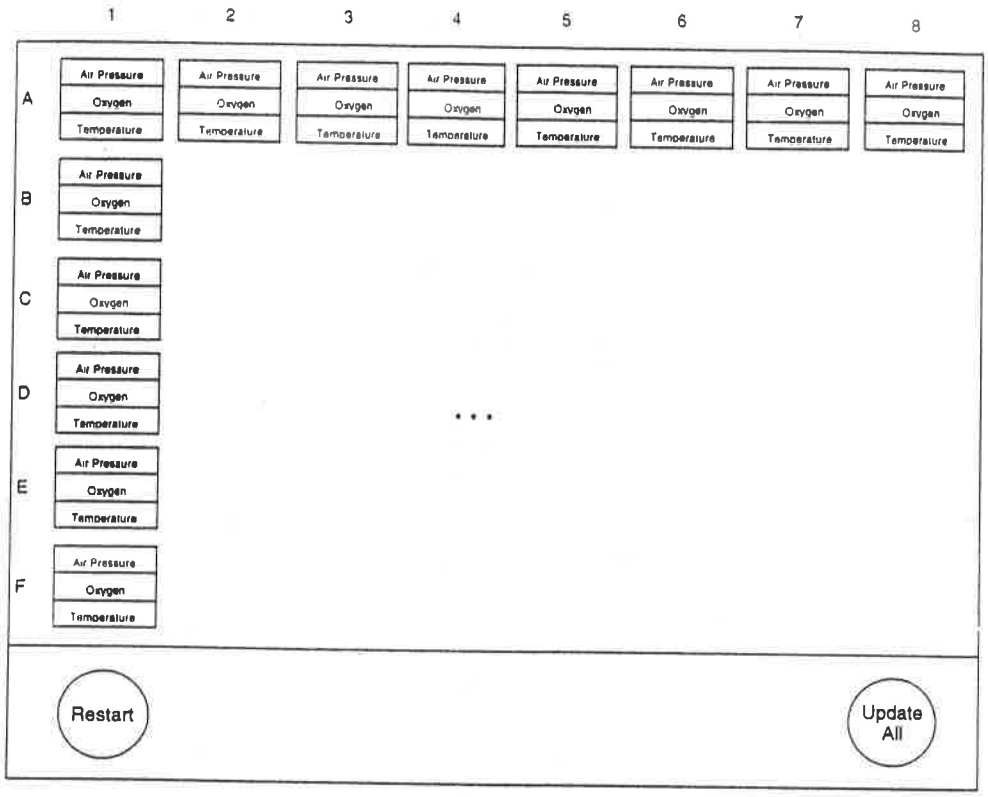

Figure HCC-1. Panel Display

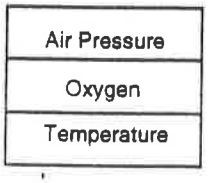

Figure HCC-2. Annunciator Display

Shall statement

Entry #	Para #*	HCC Requirements Traceability Matrix	Type
1	2.0	The SEM shall monitor all occupied living quarters.	
2	2.0	There shall be a total of 48 living quarters.	
3	2.1	Air Pressure, Temperature, and Oxygen % shall be obtained once per minute.	
4	2.1	There shall be three sensors in each living quarter.	
5	2.1	There shall be one sensor for each environmental condition.	
6	2.2	A current value representing a deviation >= 1% but <2% from the nominal value shall cause the window in the panel to be lit.	
7	2.2	A current value representing a deviation >= 2% but < 3% from the nominal value shall cause the window in the panel to be lit and flash two times per second.	
8	2.2	A current value representing a deviation >= 3% from the nominal value shall cause the window in the panel to be lit and flash four times per second and sound an audible alarm.	
9	2.2	There shall be one audible alarm.	
10	3.0	The panel shall accommodate 48 annunciators arranged in six rows.	
11	3.0	Each annunciator shall be mapped to a unique living quarter.	
12	3.0	Each annunciator shall accommodate three windows.	
13	3.0	Each window shall be identified with an appropriate legend.	
14	4.0	All nominal values shall be found in the database.	
15	4.0	The Operator shall be capable of redefining the nominal values in the database.	
16	4.0	The Operator shall be capable of redefining all three nominal values in the database to be used for all living quarters.	
17	4.0	The Operator shall be able to redefine the nominal value for a specific living quarter.	
18	5.0	Only the software shall turn on the audible alarm.	
19	5.0	Only the software shall flash a window.	
20	5.0	The software shall continue to turn on the warning indicators as long as the alarm condition exists.	
21	5.0	The Operator shall turn the audible alarm off.	
22	5.0	The Operator shall turn the window off.	
23	3.0	Each environmental condition will be represented by a different color.	
24	3.0	All windows for the same environmental condition will be the same color.	
25	—	Because the Operator can reset the nominal values in the DB, he/she needs to be able to reset the SEM to operate on those new values.	
26	—	The SEM does not need to monitor unoccupied living quarters, so the Operator can set living quarters to occupied/unoccupied to enable the SEM to operate more efficiently.	

*The paragraph number represents the paragraph number from the Case Study Problem Statement section with the prefix "HCC-" omitted.

Figure 1-3. Initial Habitat Control Center (HCC) RTM

Use Case 16: Operator_Updates_Nominal_Values_In_DB

Overview:

This Use Case enables the Operator to change the nominal values of all three environmental conditions in the database. These updated values are the nominal values against which the values detected by the sensors are compared to reflect percent deviation.

Preconditions:

1. There are no alarms currently active.
2. SEM_Desktop_View is displayed.
3. The database is accessible.

Scenario:

Action	Software Reaction
1. Operator clicks on the Update All button on the SEM_Desktop_View.	1. Update_All_View pop-up appears.
2. Disable the alarm.	2. Alarm disabled.
3. Enter Air Pressure value.	3. Air Pressure field is updated.
4. Enter Oxygen value.	4. Oxygen field is updated.
5. Enter Temperature value.	5. Temperature field is updated.
6. Operator clicks on the OK button.	6. The Update_All_View pop-up is destroyed, the DB is updated, and the Operator is returned to the SEM_Desktop_View.
7. Operator clicks on the Cancel button.	7. The Update_All_View is destroyed and monitoring continues. The database is not updated.
8. Enable alarm.	8. Alarm is enabled.

Scenario Notes:

Items 3, 4, and 5 may be done in any order. Additionally the Operator does not have to update all three values. This Use Case *permits* the modification of all three values. *but* the Operator may choose to update one, two, or all three. Steps 6 and 7 are mutually exclusive. Step 8 happens regardless of whether 6 or 7 was selected.

Post Conditions:

1. The nominal Air Pressure value is updated in the DB (if OK button was selected).
2. The nominal Oxygen value is updated in the DB(if OK button was selected).
3. The nominal Temperature value is updated in the DB(if OK button was selected).
4. The Operator is returned to the Desktop.
5. The alarm is enabled.

Exceptions:

1. The DB cannot be accessed.

Use Cases Utilized:

None

Required GUI:

1. SEM_Desktop_View
2. Update_All_View pop-up

Timing Constraints:

None

Figure 2-5. Example Scenario: Use Case 16

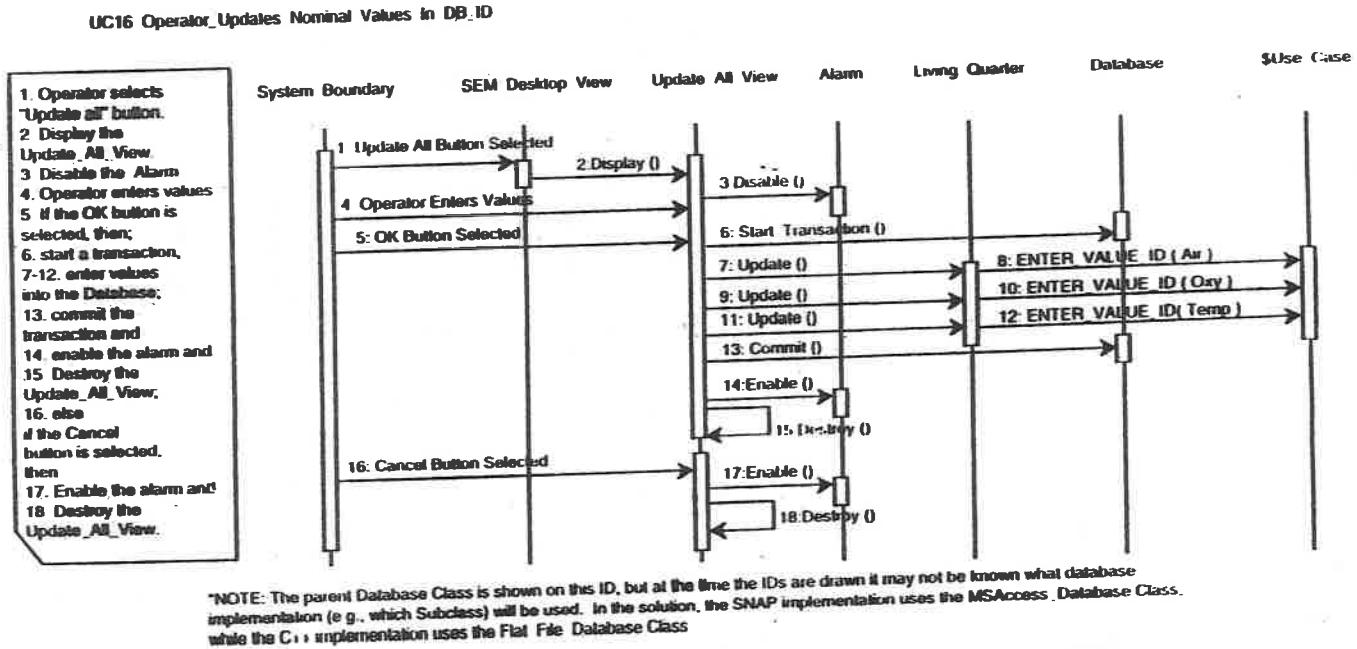

Figure 6-6. Interaction Diagram : UC16 Operator Updates Nominal Values In DB

RTM

1 2 3 4

58

Entry #	Para #*	System Specification Text	Type	Build	Use Case Name	Class	Method	Category
1	2.0	The SEM shall monitor all occupied living quarters.	SW	B1	UC1 SW Monitors Living Quarters			Living Quarter CAT
2	2.0	There shall be a total of 48 living quarters.	HW	B1	n/a			
3	2.1	Air Pressure, Temperature, and Oxygen % shall be obtained once per minute.	SW, P	B1	UC3 Timer Triggers Living Quarter Sensor Timer Triggers LQ Air Pressure Sensor Timer_Triggers LQ Temperature Sensor Timer Triggers LQ Oxygen Sensor			Living Quarter CAT
4	2.1	There shall be three sensors in each living quarter.	HW	B1	n/a			
5	2.1	There shall be one sensor for each environmental condition.	HW	B1	n/a			
6	2.2	A current value representing a deviation >= 1% but <2% from the nominal value shall cause the window in the panel to be lit.	SW	B2	UC6 SW Lights Window			Panel CAT
7	2.2	A current value representing a deviation >= 2% but < 3% from the nominal value shall cause the window in the panel to be lit and flash two times per second.	SW	B2	UC7 SW Flashes Window 2X			Panel CAT
8	2.2	A current value representing a deviation >= 3% from the nominal value shall cause the window in the panel to be lit and flash four times per second and sound an audible alarm.	SW	B2, B3	UC8_SW Flashes Window 4X			Panel CAT
9	2.2	There shall be one audible alarm.	HW	B3	n/a			
10	3.0	The panel shall accommodate 48 annunciators arranged in six rows.	SW	B1	UC10_SW Displays Panel			Panel CAT
11	3.0	Each annunciator shall be mapped to a unique living quarter.	HW	B1	n/a			
12	3.0	Each annunciator shall accommodate three windows.	SW	B1	UC12 SW Displays Annunciator			Panel CAT
13	3.0	Each window shall be identified with an appropriate legend.	SW	B1	UC13 SW Displays Window			Panel CAT

13	3.0	Each window shall be identified with an appropriate legend.	SW	B1	UC				
14	4.0	All nominal values shall be found in the database.	SW	B1	n/a				
15	4.0	The Operator shall be capable of redefining the nominal values in the database.	SW	B4	Duplicate (#16)				
16	4.0	The Operator shall be capable of redefining all three nominal values in the database to be used for all living quarters.	SW	B4	UC_16_Operator_Updates_Environmental_Condition_Nominal_Values_In_DB			DB CAT	
17	4.0	The Operator shall be able to redefine the nominal value for a specific living quarter.	SW	B4	UC17_Operator_Updates_Living_Quarter_Nominal_Value			DB CAT	
18	5.0	Only the software shall turn on the audible alarm.	SW	B3		Alarm	Sound	Alarm_CAT	
19	5.0	Only the software shall flash a window.	SW	B2	Duplicate (# 7 and #8)				
20	5.0	The software shall continue to turn on the warning indicators as long as the alarm condition exists.	SW	B2, B3	Duplicate (#18 and #19)				
21	5.0	The Operator shall turn the audible alarm off.	SW	B3		Alarm	Silence	Alarm CAT	
22	5.0	The Operator shall turn the window off.	SW	B2	UC22_Operator_Turns_Off_Window			Panel_CAT	
23	3.0	Each environmental condition will be represented in a different color.							
23	3.0	All windows for the same environmental condition will be the same color							
25	—	Because the Operator can reset the nominal values in the DB, he/she needs to be able to reset the SEM to operate on those new values.	SW, DR	B4	UC23 Operator Resets SEM			Process CAT	
26	—	The SEM does not need to monitor unoccupied living quarters, so the Operator can set living quarters to occupied/unoccupied to enable the SEM to operate more efficiently.	SW, DR,	B4	UC24_Operator_Sets_Living_Quarter_State			Living Quarter CAT	

*The paragraph number represents the paragraph number from the Case Study Problem Statement section, with the "HCC-" prefix omitted.

Figure 2-10. HCC RTM with Category Allocation Completed

Class Listing By Category

Category	Child Category	Class	Static Diagram
Alarm_CAT			**SCD**
		Alarm	Alarm_CAT_CCD, IF_CAT_CCD, Operator_CAT_CCD, Living_Quarter_CAT_CCD
DB_CAT			**SCD**
		Database	DB_CAT_CCD, Living_Quarter_CAT_CCD, Operator_CAT_CCD
Environmental_Condition_CAT			**SCD**
		Environmental_Condition	Environmental_Condition_CAT_CCD, Panel_CAT_CCD
		Air_Pressure_Environmental_Condition	Environmental_Condition_CAT_CCD, Sensor_CAT_CCD
		Oxygen_Environmental_Condition	Environmental_Condition_CAT_CCD, Sensor_CAT_CCD
		Temperature_Environmental_Condition	Environmental_Condition_CAT_CCD, Sensor_CAT_CCD
IF_CAT			**SCD**
		Alarm_IF	IF_CAT_CCD, Alarm_CAT_CCD
		Sensor_IF	IF_CAT_CCD, Sensor_CAT_CCD
Interim_CAT			
Living_Quarter_CAT			**SCD**
		Deviation	Living_Quarter_CAT_CCD, Alarm_CAT_CCD, Panel_CAT_CCD
		Hall	Living_Quarter_CAT_CCD
		Living_Quarter	Living_Quarter_CAT_CCD, Environmental_Condition_CAT_CCD, DB_CAT_CCD, Panel_CAT_CCD, Sensor_CAT_CCD, Timer_CAT_CCD
		Room	Living_Quarter_CAT_CCD
Operator_CAT			**SCD**
		Operator	Operator_CAT_CCD, Alarm_CAT_CCD, Panel_CAT_CCD, Operator_CAT_CCD, View_CAT_CCD
Panel_CAT			**SCD**

Panel_CAT		
		SCD
	Annunciator	Panel_CAT_CCD, Living_Quarter_CAT_CCD
	Panel	Panel_CAT_CCD,
	Window	Panel_CAT_CCD, Environmental_Condition_CAT_CCD, Living_Quarter_CAT_CCD
Process_CAT		
Reusable_CAT		
Sensor_CAT		
		SCD
	Air_Pressure_Sensor	Sensor_CAT_CCD, Living_Quarter_CAT_CCD, Environmental_Condition_CAT_CCD
	Oxygen_Sensor	Sensor_CAT_CCD, Living_Quarter_CAT_CCD, Environmental_Condition_CAT_CCD
	Sensor	Sensor_CAT_CCD, IF_CAT_CCD, Living_Quarter_CAT_CCD
	Temperature_Sensor	Sensor_CAT_CCD, Living_Quarter_CAT_CCD, Environmental_Condition_CAT_CCD
Timer_CAT		
		SCD
	Timer	Timer_CAT_CCD, Living_Quarter_CAT_CCD
View_CAT		
		SCD
	Annunciator_View	View_CAT_CCD, Panel_CAT_CCD
	Hall_View	View_CAT_CCD, Living_Quarter_CAT_CCD, Operator_CAT_CCD
	Panel_View	View_CAT_CCD, Panel_CAT_CCD, Operator_CAT_CCD
	SEM_Desktop_View	View_CAT_CCD, Operator_CAT_CCD
	Update_All_View	Panel_CAT_CCD, Living_Quarter_CAT_CCD, Operator_CAT_CCD
	Window_View	View_CAT_CCD, Panel_CAT_CCD, Operator_CAT_CCD
	Window_Pop_Up_View	View_CAT_CCD, Operator_CAT_CCD, Panel_CAT_CCD

Figure 5-17. Project Classes Reported by Category