Elevator System Case Study[1]

Operational System

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[1] This case study is based upon an M.S. project completed by Cathleen Brown and homework assignments completed by many students.

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1.0 Introduction

This fictional case study assumes the existence of a mythical elevator company, Up and Down Elevator Company, which is considering the development of a new elevator product. [Note, it is most likely that all of the details about elevators in this case study are wrong. The concepts in the case study are the important educational message.] The following description summarizes the market niche that this new product is supposed to develop:

The *Up and Down Elevator Company's* elevator system shall provide vertical transportation, for personnel needs, between two or more floors of a multi-floor office and or residential building. This elevator system shall be a multi-car system installed as a single bank of elevators. The elevator system shall be able to support transportation for at least 10 and no more than 20 stories. The elevator shall be able to provide transportation for 100 to 150 people per floor. This elevator system shall provide vertical transportation in a rapid, safe, reliable, and cost-effective manner.

The Systems Engineering Team that was assembled by Up and Down Elevator Co. has developed an operational concept, external system's diagram, objectives hierarchy, requirements document (ORD), and architectures for each phase of the elevator's life cycle. This document addresses the operational system, the elevator.

2.0 Elevator System Operational Concept

2.1 Vision

The new elevator system being designed by the Up and Down Elevator Company is directed at the major market niche of standard 10 to 20 story office buildings being constructed in the U.S. This product is not to address the low end and high ends of the 10 to 20-story office building market, but the center of this market. Marketing estimates are that 100,000 of these buildings are being constructed each year for the next 10 years. Each such building will require six to twenty elevator cars and associated control systems and maintenance/operations support. This market is envisioned to be very price competitive but requiring that basic thresholds of performance and cost be met.

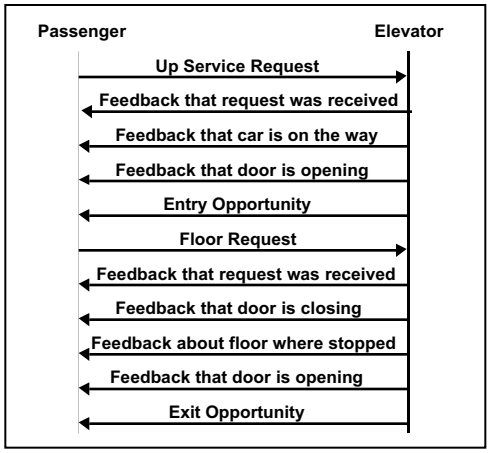
2.2 Mission Requirements

The mission requirement for this new product is to capture 20% of the market of new buildings starting in June 2001. Since Up and Down Elevator Company is not currently one of the major

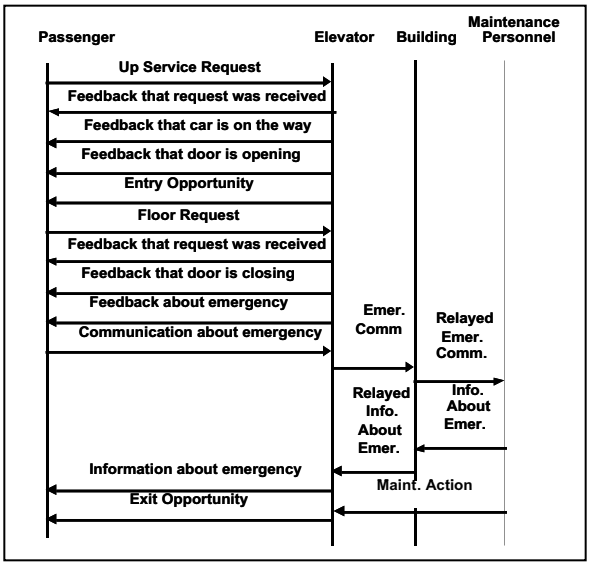
market leaders, this mission requirement will primarily have to be achieved by providing superior operational performance at less operational cost than the products of the major vendors. Our performance and cost goals are to have 20% better performance on a weighted performance index at 80% of the operational cost compared to the current products of the major vendors. The weighted performance index is: 0.3 AWT + 0.3 ATT + 0.2 MTBF + 0.2 MTTR. AWT is a value index that ranges between 0 and 1 for average weight time, ATT is a value index that ranges between 0 and 1 for average transit time, MTBF is a value index that ranges between 0 and 1 for mean time between failure, and MTTR is a value index that ranges between 0 and 1 for mean time to repair.

2.3 Operational Phase Scenarios

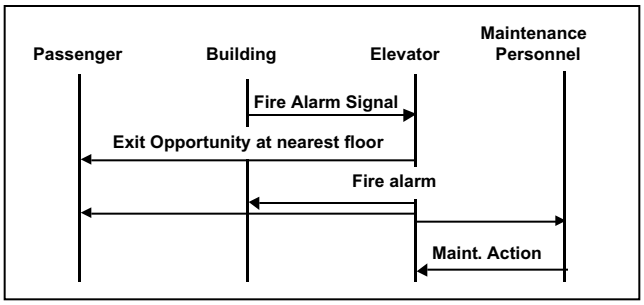
1) Passengers (including mobility, visually and hearing challenged) request up service, receive feedback that their request was accepted, receive input that the elevator car is approaching and then that an entry opportunity is available, enter elevator car, request floor, receive feedback that their request was accepted, receive feedback that door is closing, receive feedback about what floor at which elevator is stopping, receive feedback that an exit opportunity is available, and exit elevator with no physical impediments.



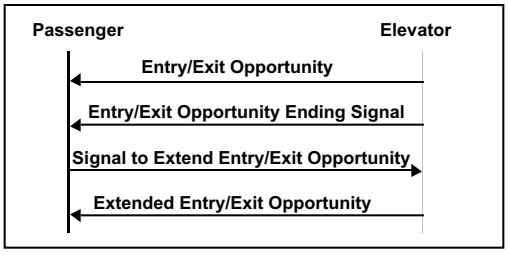
2) Passenger enters elevator car, as described in 1, but finds an emergency situation before an exit opportunity is presented, and notifies the police or health authorities using communication equipment that are part of the elevator. Elevator maintenance personnel create an exit opportunity.



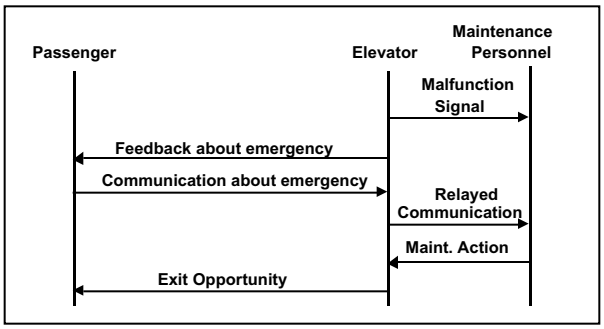
3) Passengers are receiving transportation in the elevator system when a fire breaks out in the building; building alarm system sends signal to elevator system to stop elevator cars stop at the nearest floor, provide exit opportunity, and sound a fire alarm. Passengers leave elevator cars. Elevator cars are reactivated by special access available to maintenance personnel.



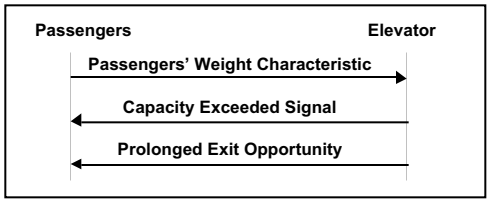
4) Passengers are entering (exiting) an elevator car when doors start to shut; passengers can stop doors from shutting and continue to enter (exit).



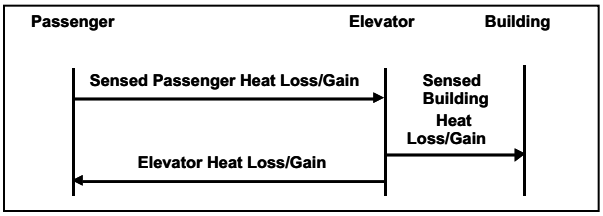
5) Elevator car stops functioning and sends a signal to service. Passengers in the elevator car push an emergency alarm that notifies building personnel to come and help them. Elevator maintenance personnel create an exit opportunity.



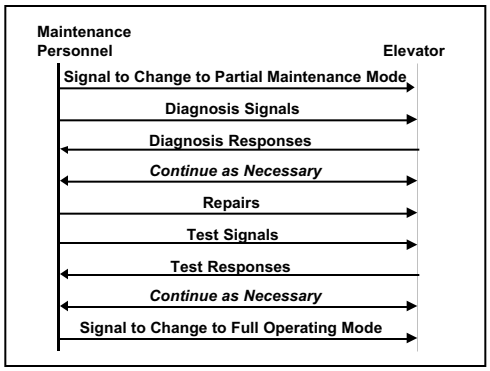
6) Too many passengers enter an elevator car and the weight of passengers in the elevator car exceeds a preset safety limit; the elevator car signals a capacity problem and provides prolonged exit opportunity until some passengers exit the car.



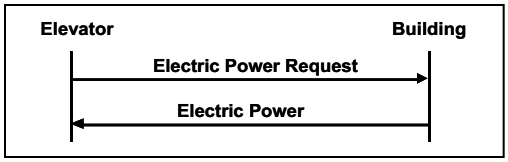
7) Maintain a comfortable environment in the elevator by sensing the temperature in the elevator car that is based upon heat loss/gain of the passengers and the building and then supplying the necessary heat loss/gain to keep the passengers comfortable.



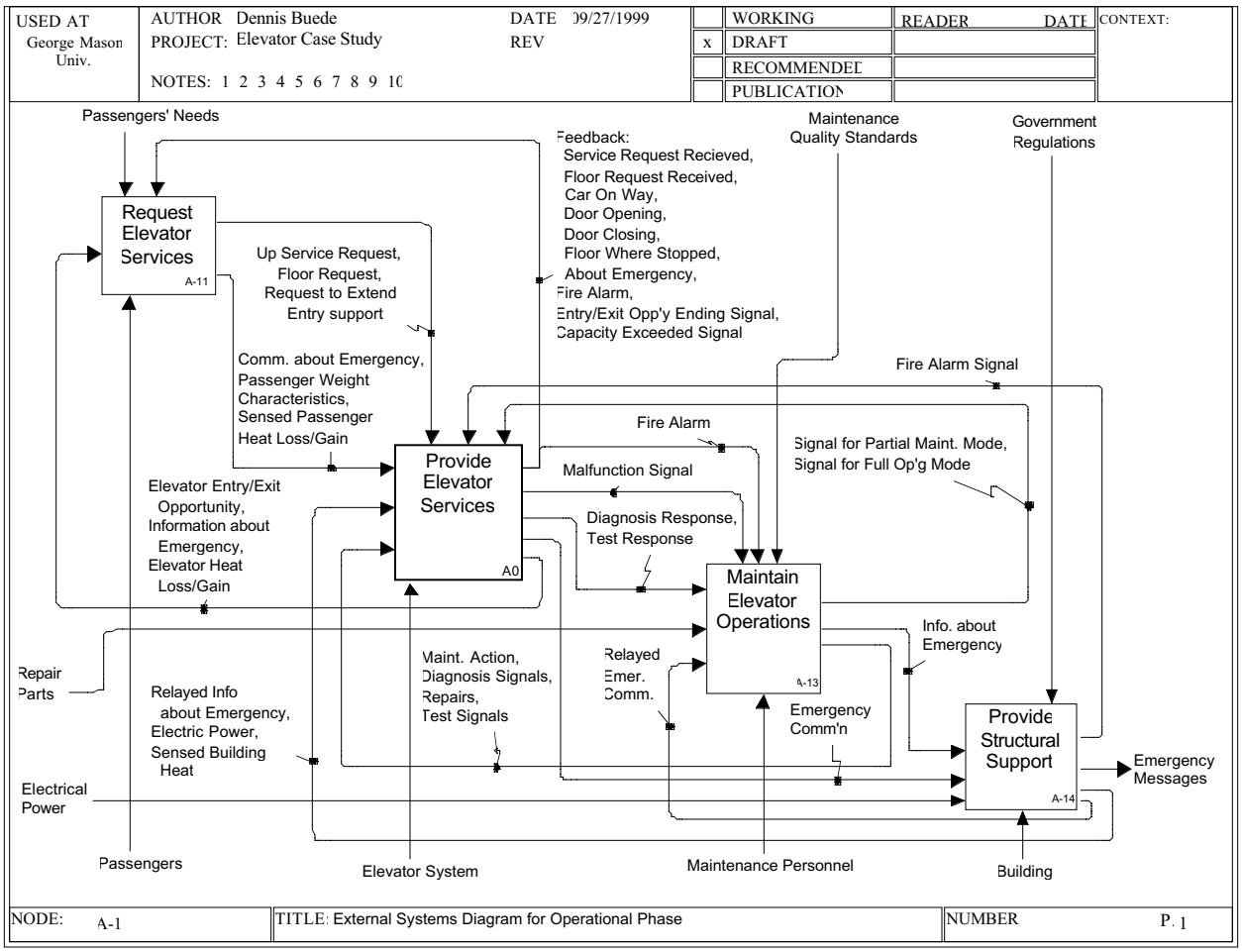
8) A maintenance person needs to repair an individual car; the maintenance person places the elevator system in "partial maintenance" mode so that the other cars can continue to pick up passengers while the car(s) in question is (are) being diagnosed, repaired, and tested. After completion the maintenance person places the elevator system in "full operation" mode.

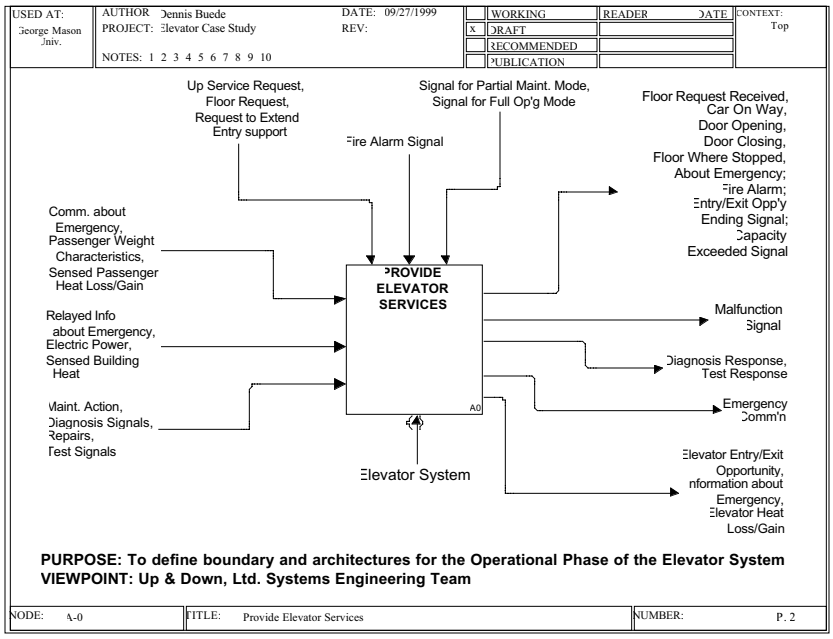


9) Electric power is transferred to the elevator from the building.



3.0 Elevator System External Systems Diagrams for Operational Phase





4.0 Elevator System Originating Requirements Document

4.1 System Overview

The *Up and Down Elevator Company's* elevator system shall provide vertical transportation, for personnel needs, between two or more floors of a multi-floor office and or residential building. This elevator system shall be a multi-car system installed as a single bank of elevators. The elevator system shall be able to support transportation for at least 10 and no more than 20 stories. The elevator shall be able to provide transportation for 100 to 150 people per floor. This elevator system shall provide vertical transportation in a rapid, safe, reliable, and cost-effective manner.

4.2 Applicable Documents

The elevator system shall adhere to industry elevator standards including, at a minimum, the following:

4.2.1 American National Standard Institute (ANSI) Safety Code for Elevators, Dumbwaiters, Escalators and Moving Walks, ANSI A17.1.

4.2.2 American Society of Mechanical Engineers (ASME) A17.1A-91: Safety Code for Elevators and Escalators including all addenda.

4.2.3 ASME A17.1B-92: Safety Code for Elevators and Escalators including all addenda.

4.2.4 ASME A17.2-88: Inspectors' Manual for Elevators and Escalators including all addenda.

4.2.5 ASME A17.2.1-93: Inspectors' Manual for Electronic Elevators.

4.2.6 ASME A17.4-91: Elevator and Escalator Electronic Equipment.

4.2.7 ASME A17.5-91: Guide for Emergency Evacuation of Passengers from Elevators including all addenda.

4.2.8 Construction Specifications Institute (CSI) 14215-90: Electric Elevators-Passenger (Division 14-Conveying Systems).

4.2.9 CSI 14245-90: Hydraulic Elevators-Passenger (Division 14-Conveying Systems).

4.2.10 National Elevator Industry Incorporated (NEII) Vertical Transportation Standards-Standards for Elevators, Escalators and Dumbwaiters.

4.2.11 NEII Elevator Engineering Standard Layouts.

4.2.12 NEII Minimum Passenger Elevator Requirements for the Handicapped.

4.2.13 National Fire Protection Association (NFPA) Fire Protection Handbook (FPH) Section 7-4, Building Transportation Systems (17th ed., 1991).

4.2.14 NFPA LSCH Supplement 4: Extracts from ASME Elevator Code and Handbook.

4.2.15 National Safety Council A10.4-90: Safety Requirements for Personnel Hoists and Employee Elevators.

4.2.16 Underwriters Laboratories (UL) 104-86, UL Standard for Safety Elevator Doors, Locking Devices, and Contacts (8th ed.).

4.2.17 UL Subject 1084-9: Outline of investigation for Hoistway Cables Issue Number 2.

4.3 Operational Phase Requirements.

4.3.1 ***Input/Output Requirements.***

4.3.1.1 Input Requirements.

4.3.1.1.1 *Requirements for inputs from passengers*

4.3.1.1.1.1 The elevator system shall receive 99.99% of communications about emergencies from passengers.

4.3.1.1.1.2 The elevator system shall receive information about total passenger weight in a given car that is 90% correct.

4.3.1.1.1.3 The elevator system shall receive information about the temperature in the elevator car based upon passenger heat loss/gain that is 95% correct.

4.3.1.1.1.4 The elevator system shall receive 99.99% of calls for up and down service from all floors of the building.

4.3.1.1.1.5 The elevator system shall receive 99.99% of passenger activated floor selections in each elevator car.

4.3.1.1.1.6 The elevator system shall receive 99% of signals from the passengers to control operation of the elevator doors.

4.3.1.1.2 *Requirements for inputs from maintenance personnel*

4.3.1.1.2.1 The elevator system shall receive 50% of all routine maintenance actions within 1 hour. The design goal is 80% within 1 hour.

4.3.1.1.2.2 The elevator system shall receive 99.9% of all diagnosis signals.

4.3.1.1.2.3 The elevator system shall receive 50% of all repairs within 2 hours.

4.3.1.1.2.4 The elevator system shall receive 99% of all test signals.

4.3.1.1.2.5 The elevator system shall receive 99.9% of signals for the partial maintenance mode of the elevator cars. These maintenance mode signals include information about the timing, order, velocity and acceleration characteristics of each car.

4.3.1.1.2.6 The elevator system shall receive 99.9% of signals for reconfiguring the full operational mode of the elevator cars. This operational mode signal includes information about the timing, order, velocity and acceleration characteristics of the cars.

4.3.1.1.3 *Requirements for inputs from building housing the elevator*

4.3.1.1.3.1 The elevator system shall receive 99.99% of all relayed information about emergencies.

4.3.1.1.3.2 The elevator system shall receive electric power 99.99% of the time.

4.3.1.1.3.3 The elevator system shall receive information on the temperature in the building that is 90% correct.

4.3.1.1.3.4 The elevator system shall receive 99.999% of all fire alarm signals sounded in the building.

4.3.1.2 Output Requirements.

4.3.1.2.1 *Requirements for outputs to passengers*

4.3.1.2.1.1 Entry/exit opportunities.

4.3.1.2.1.1.1 The elevator system shall open and close automatically 99.99% of the time upon arrival at each selected floor.

4.3.1.2.1.1.2 The elevator system shall have an average wait for service (time interval between elevators) of less than 35 seconds. The design goal is 27 seconds.

4.3.1.2.1.1.3 The elevator system shall provide alternate exit(s) in the event that the primary exit is inoperable.

4.3.1.2.1.1.4 The elevator system shall have an average passenger transit time in the elevator car of no larger than 90 seconds. The design goal is 60 seconds.

4.3.1.2.1.1.5 The elevator system shall come to rest within 0.5 inch of the landing at each floor.

4.3.1.2.1.1.6 The elevator system shall provide service even during periods of maintenance.

4.3.1.2.1.1.7 The elevator system shall provide rates of acceleration and deceleration that are within the standard limits of comfort to passengers.

4.3.1.2.1.2 The elevator system shall provide information about an emergency 99.99% of the time.

4.3.1.2.1.3 The elevator system shall provide air ventilation, heating, and air-conditioning that meets customer expectations 99.99% of the time.

4.3.1.2.1.4 Feedback to the passengers and prospective passengers.

4.3.1.2.1.4.1 The elevator system shall provide indications 99.9% of the time to let a prospective passenger know that he/she has successfully called the elevator.

4.3.1.2.1.4.2 The elevator system shall provide indications 99.9% of the time to let a passenger know that he/she has successfully input a floor request to the elevator.

4.3.1.2.1.4.3 The elevator system shall provide indications 99.9% of the time to let prospective passengers know which floor the elevator is currently servicing and which direction the elevator is heading.

4.3.1.2.1.4.4 The elevator system shall provide indications 99% of the time to let passengers and prospective passengers know that the elevator door is opening.

4.3.1.2.1.4.5 The elevator system shall provide indications 99% of the time to let passengers and prospective passengers know that the elevator door is closing.

4.3.1.2.1.4.6 The elevator system shall provide indications 99.9% of the time to let passengers know at which floor the elevator has stopped.

4.3.1.2.1.4.7 The elevator system shall provide indications 99.99% of the time to let passengers know that their input about an emergency has been received.

4.3.1.2.1.5 The elevator system shall provide fire alarm signals 99.99% of the time that a fire alarm has sounded in the building.

4.3.1.2.1.6 The elevator system shall provide indications 99.9% of the time to passengers and prospective passengers that an entry/exit opportunity is ending.

4.3.1.2.1.7 The elevator system shall provide indications 99.9% of the time to the passengers when the elevator capacity is exceeded.

4.3.1.2.2 *Requirements for outputs to maintenance personnel*

4.3.1.2.2.1 The elevator system shall provide diagnostic responses that are 99% correct based upon the diagnostic signals.

4.3.1.2.2.2 The elevator system shall provide test responses that are 99.9% correct based upon the test signals.

4.3.1.2.2.3 The elevator system shall provide a malfunction signal 99% of the time that a malfunction is detected.

4.3.1.2.3 *Requirements for outputs to the building.* The elevator system shall provide emergency communications 99.99% of the time that a passenger is providing emergency communication signals.

4.3.1.3 External Interface Requirements.

4.3.1.3.1 *Electric Power*. The elevator system shall receive power from the building's main power supply via ANSI standard connections.

4.3.1.3.2 *Emergency Communications Response* The elevator system shall connect to an ANSI standard phone system in the building.

4.3.1.4 Functional Requirements.

4.3.1.4.1 The elevator system shall accept passenger requests and provide feedback..

4.3.1.4.2 The elevator system shall move passengers between floors safely and comfortably.

4.3.1.4.3 The elevator system shall control elevator cars efficiently.

4.3.1.4.4 The elevator system shall enable effective maintenance and servicing.

4.3.2 ***System-wide & Technology Requirements.***

4.3.2.1 Technology Requirements - none

4.3.2.2 Suitability Requirements

4.3.2.2.1 *"Government Regulations".*

4.3.2.2.1.1 The elevator system shall support all relevant fire and safety codes in effect.

4.3.2.2.1.2 The elevator system shall strictly adhere to all Federal, State, and Local government regulations.

4.3.2.2.1.3 The elevator system shall comply with the Americans with Disabilities Act.

4.3.2.2.2 The elevator system shall have an MTBF of greater than 1 year. The design goal is 1.5 years. *Failure* is defined to be a complete inability to carry passengers.

4.3.2.2.3 The elevator system shall have an MTTR of less than 8 hours. The design goal is 4 hours. *Repair* means the system is returned to full operating capacity.

4.3.2.2.4 The elevator system shall operate continuously between the range of 64-80 degrees Fahrenheit.

4.3.2.2.5 The elevator system shall be generic enough to be placed in a range of similar buildings across the United States.

4.3.2.3 Cost Requirement. The elevator system operational costs shall be $1500 per month, or less. The design goal is $1250 per month.

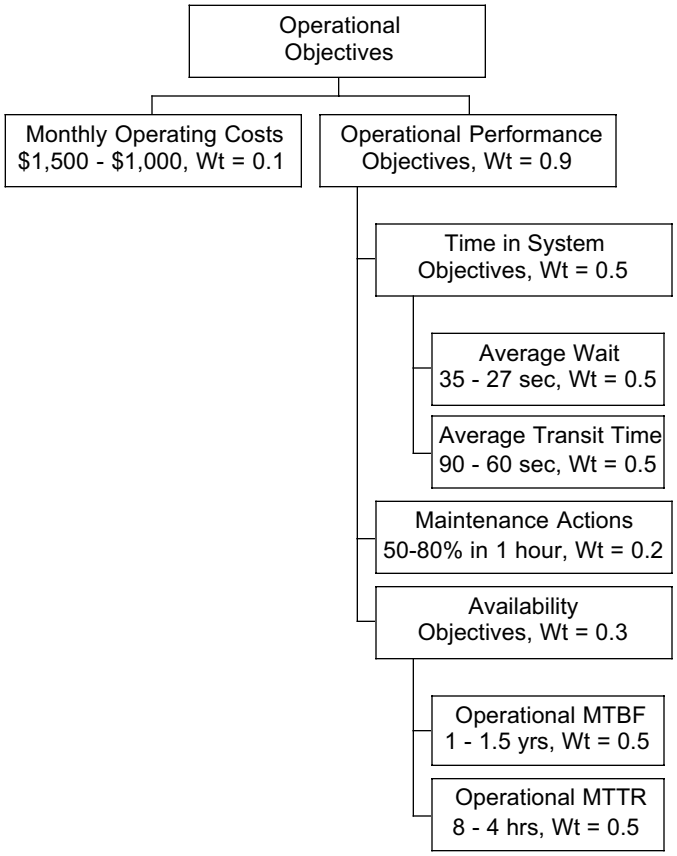
4.3.2.4 Schedule Requirement. The elevator system shall have an expected life of the elevator system of at least twenty-five (25) years.

4.3.3 ***Trade-off Requirements.***

4.3.3.1 Performance Trade-offs. The system shall address the weighted performance scores as defined by the right side of the objectives hierarchy with the relative weights of the performance requirements. The value curves for the performance requirements are to be determined.

4.3.3.2 Cost Trade-offs. The system shall address the weighted cost score as defined by the left side of the objectives hierarchy with the relative weight of the cost requirement. The value curve for the cost requirement is to be determined.

4.3.3.3 Cost-Performance Trade-offs: The system shall achieved the highest weighted score combining the weighted performance and cost as shown in the objectives hierarchy. The relative weights of the cost and performance requirements are 0.1 and 0.9, respectively.



4.3.4 ***System Test Requirements.***

4.3.4.1 Observance Test Requirements.

4.3.4.1.1 The elevator test system shall use instrumented test equipment to collect data to verify requirements 4.3.1.1.1.1 – 4.3.1.1.1.6, 4.3.1.1.2.2, 4.3.1.1.2.4 - 4.3.1.1.2.6, 4.3.1.1.3 – 4.3.1.1.4, 4.3.1.2.1.1.1, 4.3.1.2.1.1.5, 4.3.1.2.1.1.7, 4.3.1.2.1.2 - 4.3.1.2.1.4, 4.3.1.2.1.4.1 - 4.3.5.1.2.1.4.7, 4.3.1.2.5 - 4.3.5.1.2.7, 4.3.1.2.2.1 – 4.3.1.2.2.4, 4.3.1.2.3.1, 4.3.1.3.2, and 4.3.1.3.3.

4.3.4.1.2 The elevator test system shall verify requirement 4.3.1.1.2.1, 4.3.1.1.2.3, 4.3.1.2.1.1.2 - 4.3.1.2.1.1.4, 4.3.1.2.1.1.6, 4.3.1.3.4.1 - 4.3.1.3.4.2, 4.3.1.4.1 - 4.3.1.4.4, 4.3.2.2.1 – 4.3.2.2.4, and 4.3.2.3 - 4.3.2.4 through demonstration.

4.3.4.1.3 The elevator test system shall verify requirements 4.3.1.2.1.1.3, 4.3.1.2.1.1.6, 4.3.1.3.1**,** 4.3.1.3.4.1 - 4.3.1.3.4.2, and 4.3.2.2.5 through inspection.

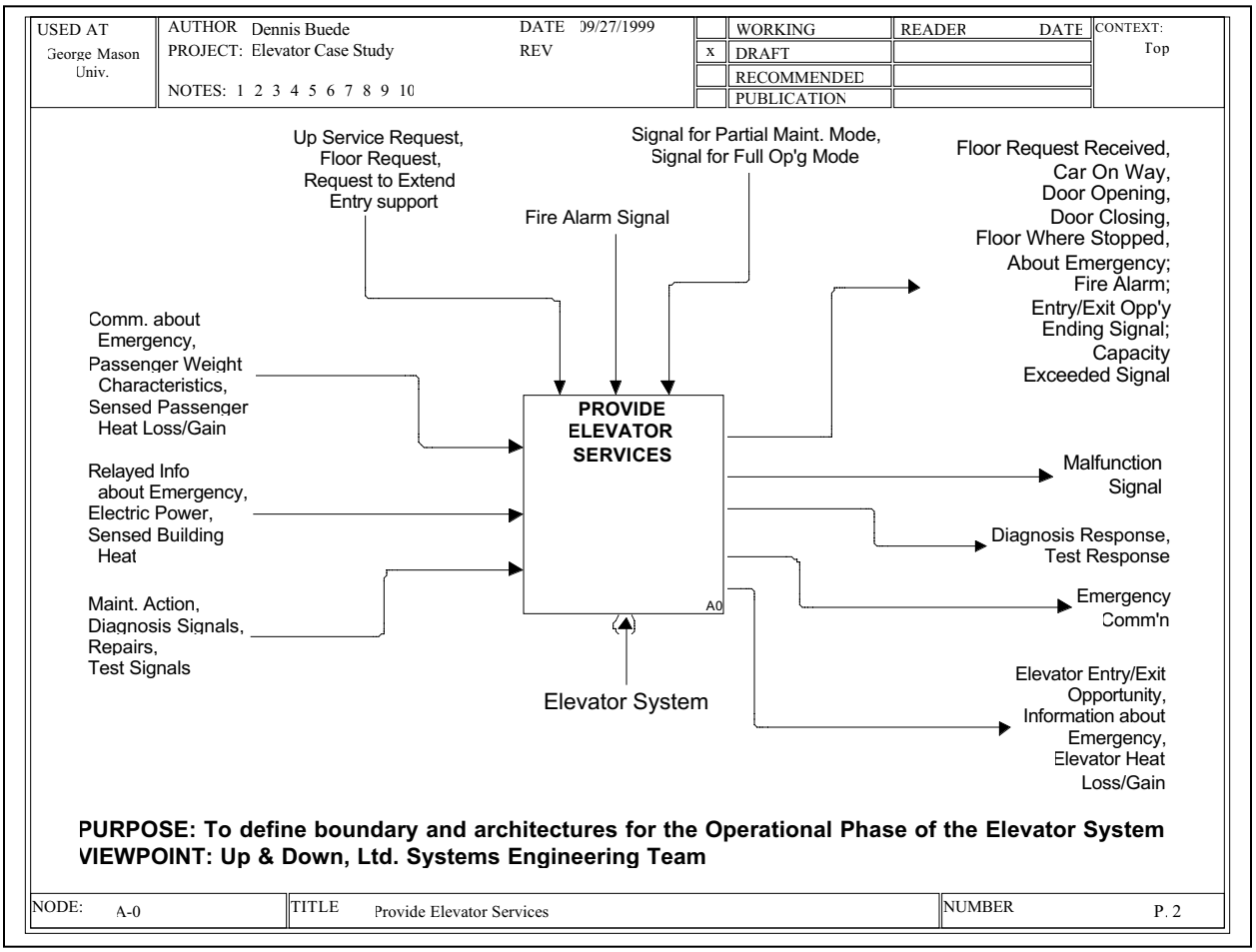
4.3.4.1.4 The elevator test system shall verify requirements 4.3.1.1.2.1, 4.3.1.1.2.3, 4.3.1.2.1.1.2, 4.3.1.2.1.1.4**,** 4.3.2.2.2 - 4.3.2.2.4**,** and 4.3.2.3 – 4.3.2.4 through analysis and simulation.

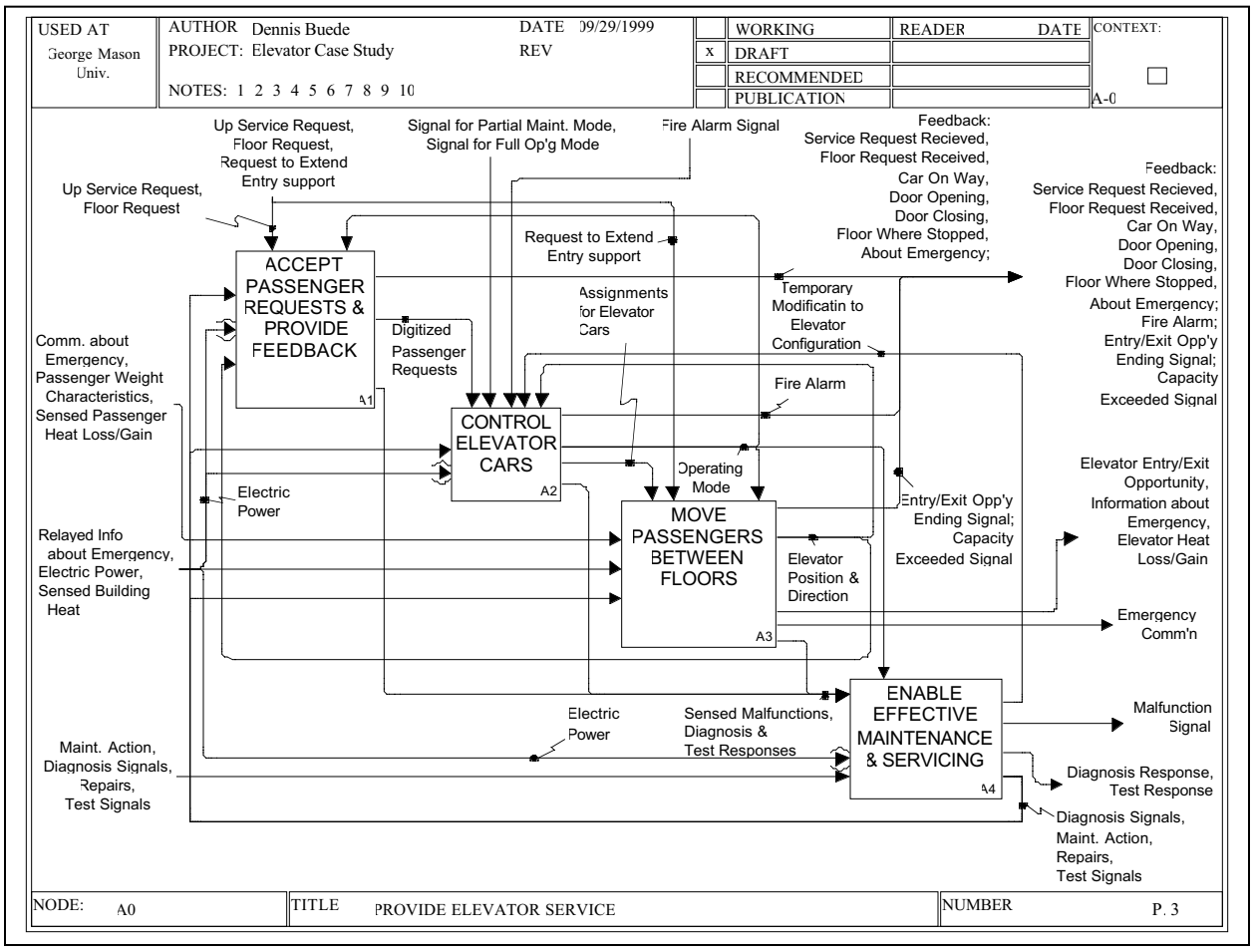
4.3.4.2 Verification Plan. The elevator system verification shall be conducted by demonstration, inspection, instrumented test, and analysis and simulation.

4.3.4.3 Validation Plan. The elevator system validation shall address every scenario in the operational concept for operations and maintenance using demonstration, inspection and analysis and simulation.

4.3.4.4 Acceptance Plan. The elevator system acceptance test shall examine the operation of the pre-production prototypes in test buildings for a 3 month time period.

5.0 Functional Architecture for Operational Phase

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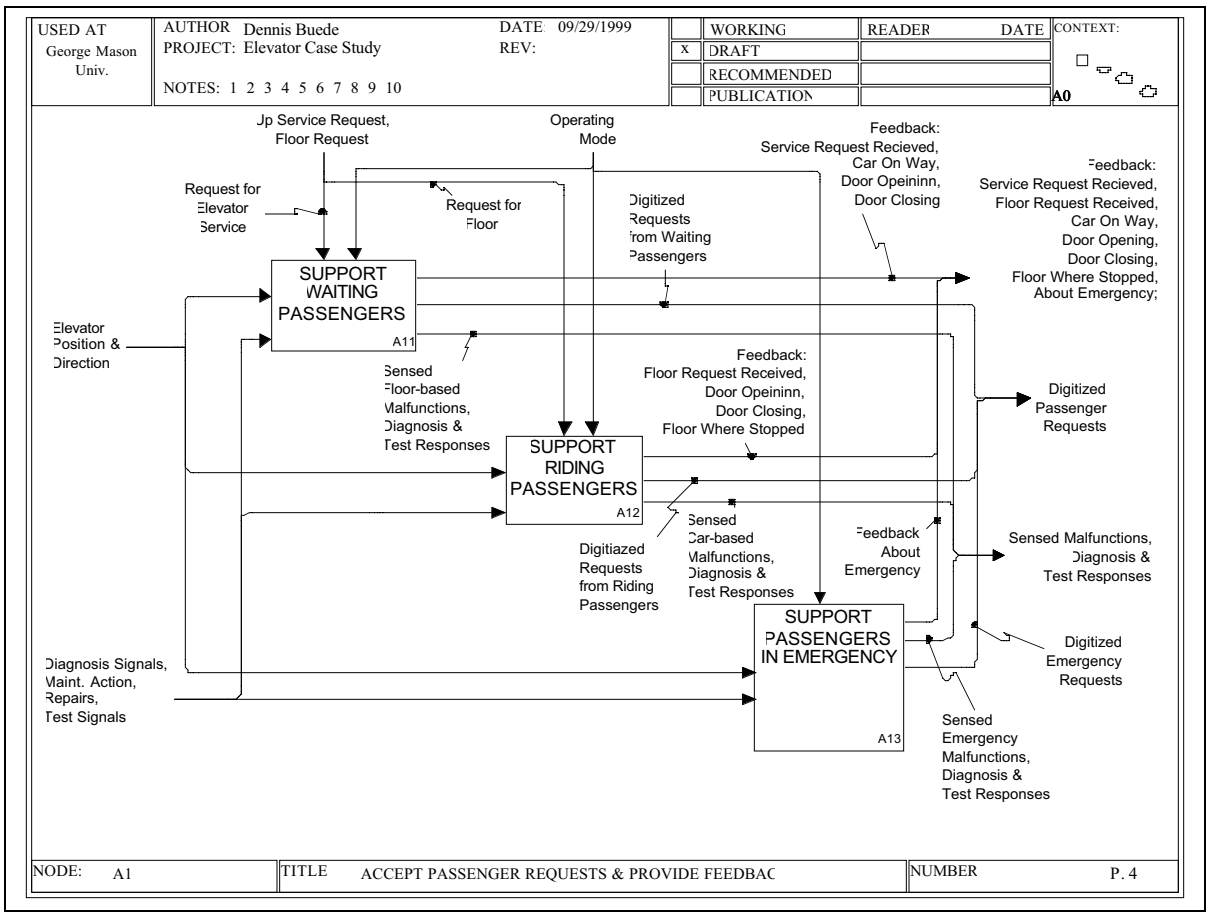
Up Service Request, Floor Request, Request to Extend Entry support
Signal for Partial Maint. Mode, Signal for Full Op'g Mode
Fire Alarm Signal
Feedback: Service Request Recieved, Floor Request Received, Car On Way, Door Opening, Door Closing, Floor Where Stopped, About Emergency;
Up Service Request, Floor Request
Request to Extend Entry support
Feedback: Service Request Recieved, Floor Request Received, Car On Way, Door Opening, Door Closing, Floor Where Stopped, About Emergency; Fire Alarm; Entry/Exit Opp'y Ending Signal; Capacity Exceeded Signal
ACCEPT PASSENGER REQUESTS & PROVIDE FEEDBACK
A1
Assignments for Elevator Cars
Temporary Modificatin to Elevator Configuration
Digitized Passenger Requests
Comm. about Emergency, Passenger Weight Characteristics, Sensed Passenger Heat Loss/Gain
Fire Alarm
CONTROL ELEVATOR CARS
A2
Operating Mode
Electric Power
Entry/Exit Opp'y Ending Signal; Capacity Exceeded Signal
Elevator Entry/Exit Opportunity, Information about Emergency, Elevator Heat Loss/Gain
MOVE PASSENGERS BETWEEN FLOORS
A3
Relayed Info about Emergency, Electric Power, Sensed Building Heat
Elevator Position & Direction
Emergency Comm'n
ENABLE EFFECTIVE MAINTENANCE & SERVICING
A4
Electric Power
Sensed Malfunctions, Diagnosis & Test Responses
Malfunction Signal
Maint. Action, Diagnosis Signals, Repairs, Test Signals
Diagnosis Response, Test Response
Diagnosis Signals, Maint. Action, Repairs, Test Signals
NODE: A0
TITLE PROVIDE ELEVATOR SERVICE
NUMBER P. 3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Jp Service Request, Floor Request
Operating Mode
Feedback: Service Request Recieved, Car On Way, Door Opeininn, Door Closing
Request for Elevator Service
Request for Floor
Digitized Requests from Waiting Passengers
Feedback: Service Request Recieved, Floor Request Received, Car On Way, Door Opening, Door Closing, Floor Where Stopped, About Emergency;
SUPPORT WAITING PASSENGERS
A11
Elevator Position & Direction
Sensed Floor-based Malfunctions, Diagnosis & Test Responses
Feedback: Floor Request Received, Door Opeininn, Door Closing, Floor Where Stopped
Digitized Passenger Requests
SUPPORT RIDING PASSENGERS
A12
Digitiazed Requests from Riding Passengers
Sensed Car-based Malfunctions, Diagnosis & Test Responses
Feedback About Emergency
Sensed Malfunctions, Diagnosis & Test Responses
SUPPORT PASSENGERS IN EMERGENCY
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Digitized Emergency Requests
Diagnosis Signals, Maint. Action, Repairs, Test Signals
Sensed Emergency Malfunctions, Diagnosis & Test Responses
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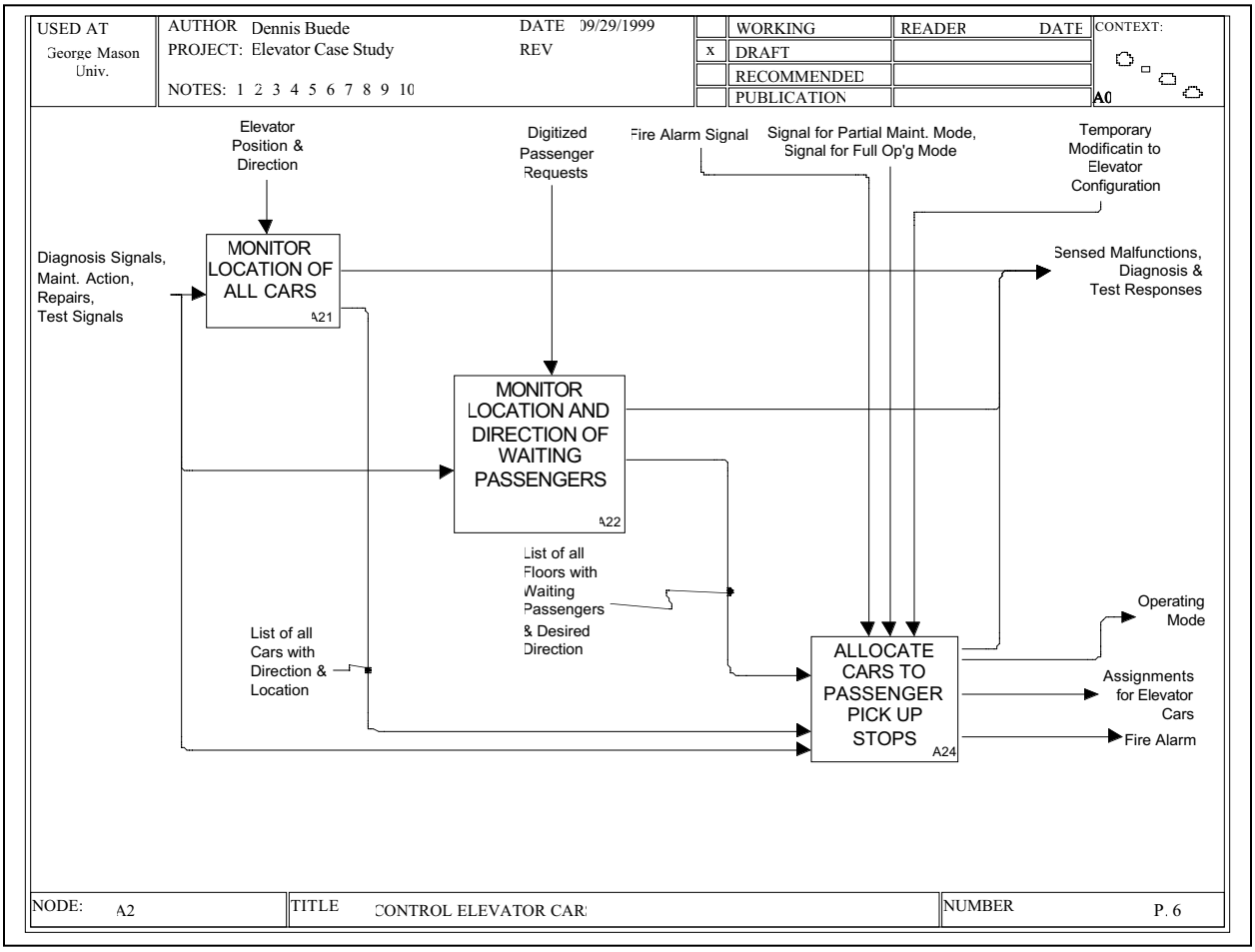
TITLE ACCEPT PASSENGER REQUESTS & PROVIDE FEEDBAC
NUMBER P. 4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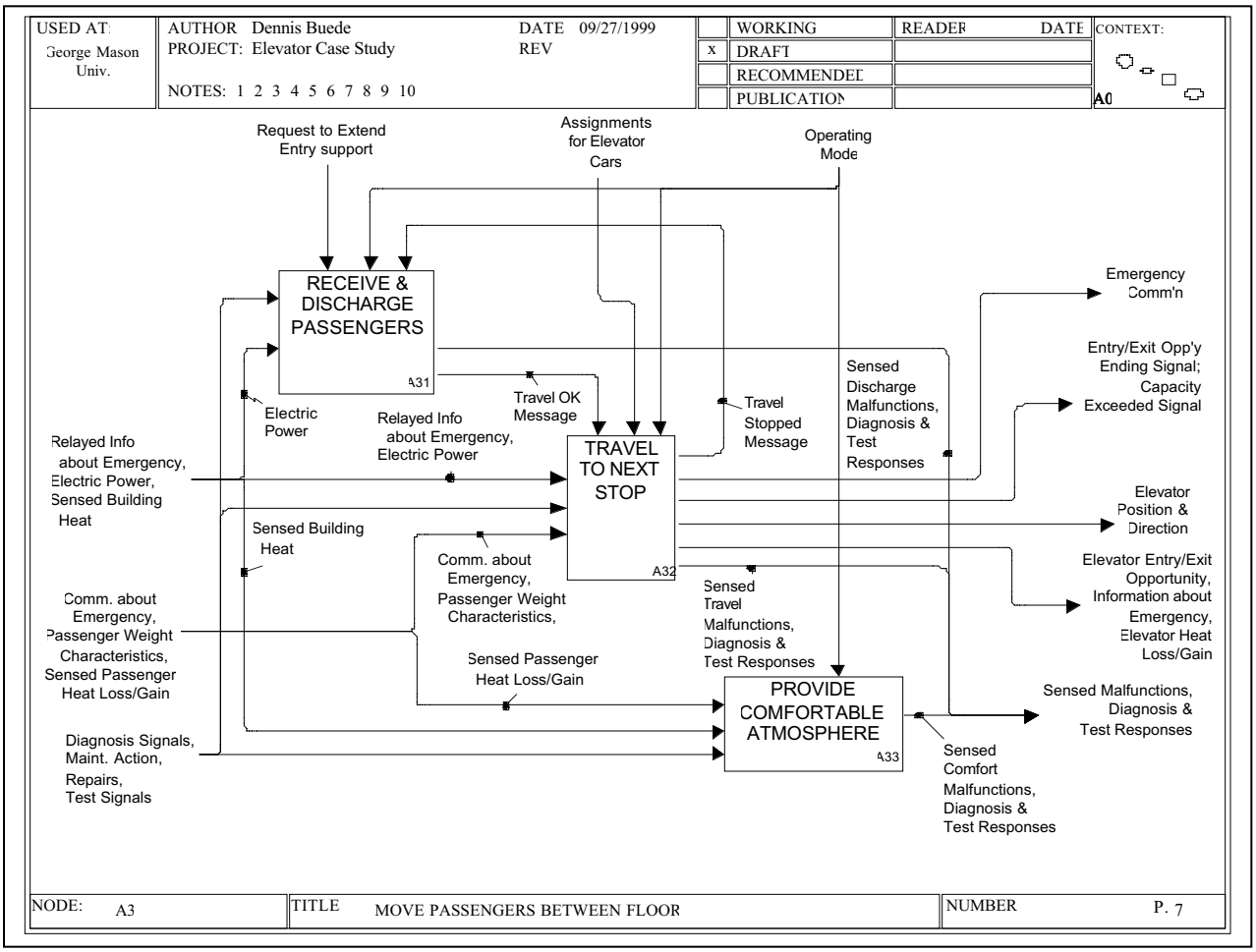
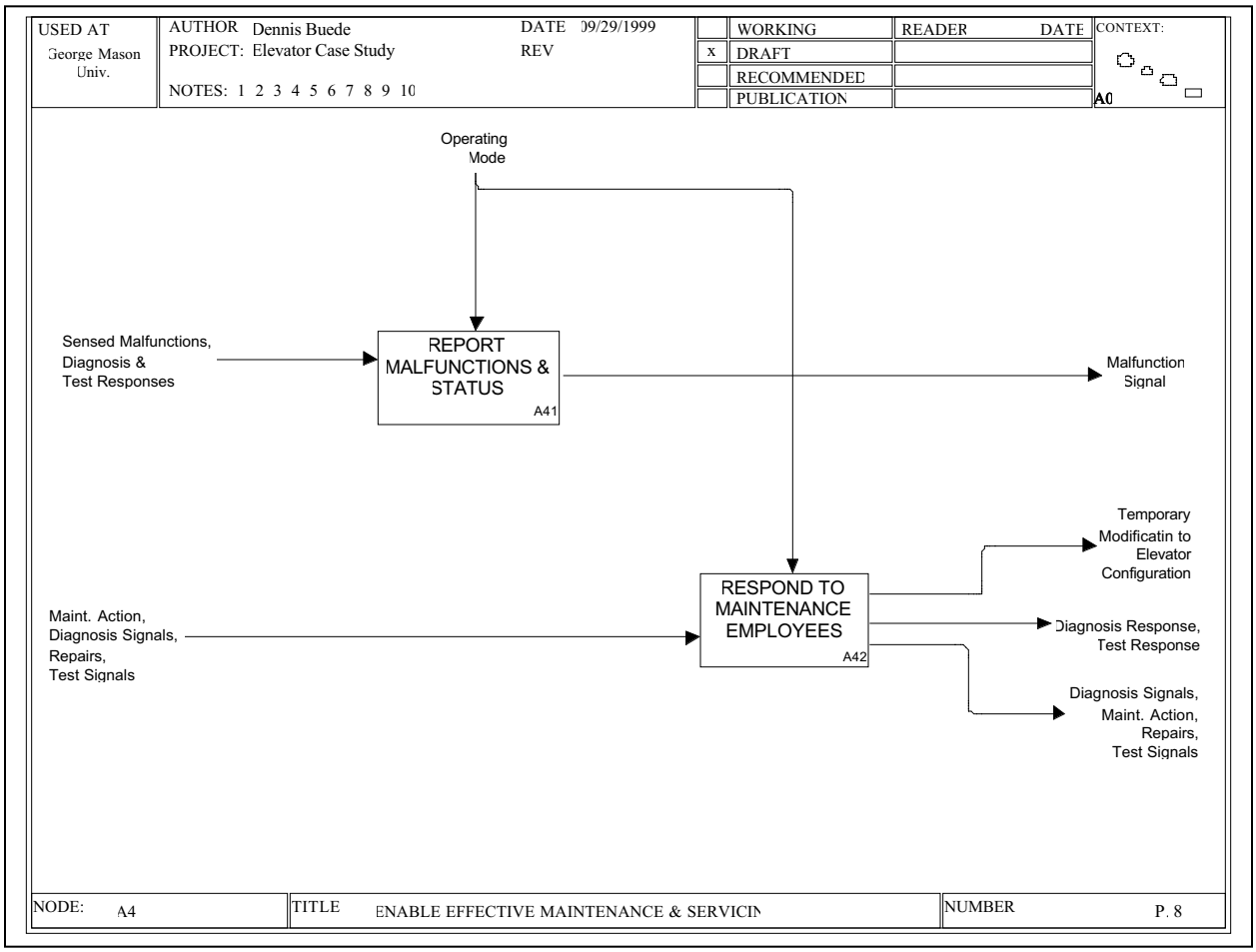
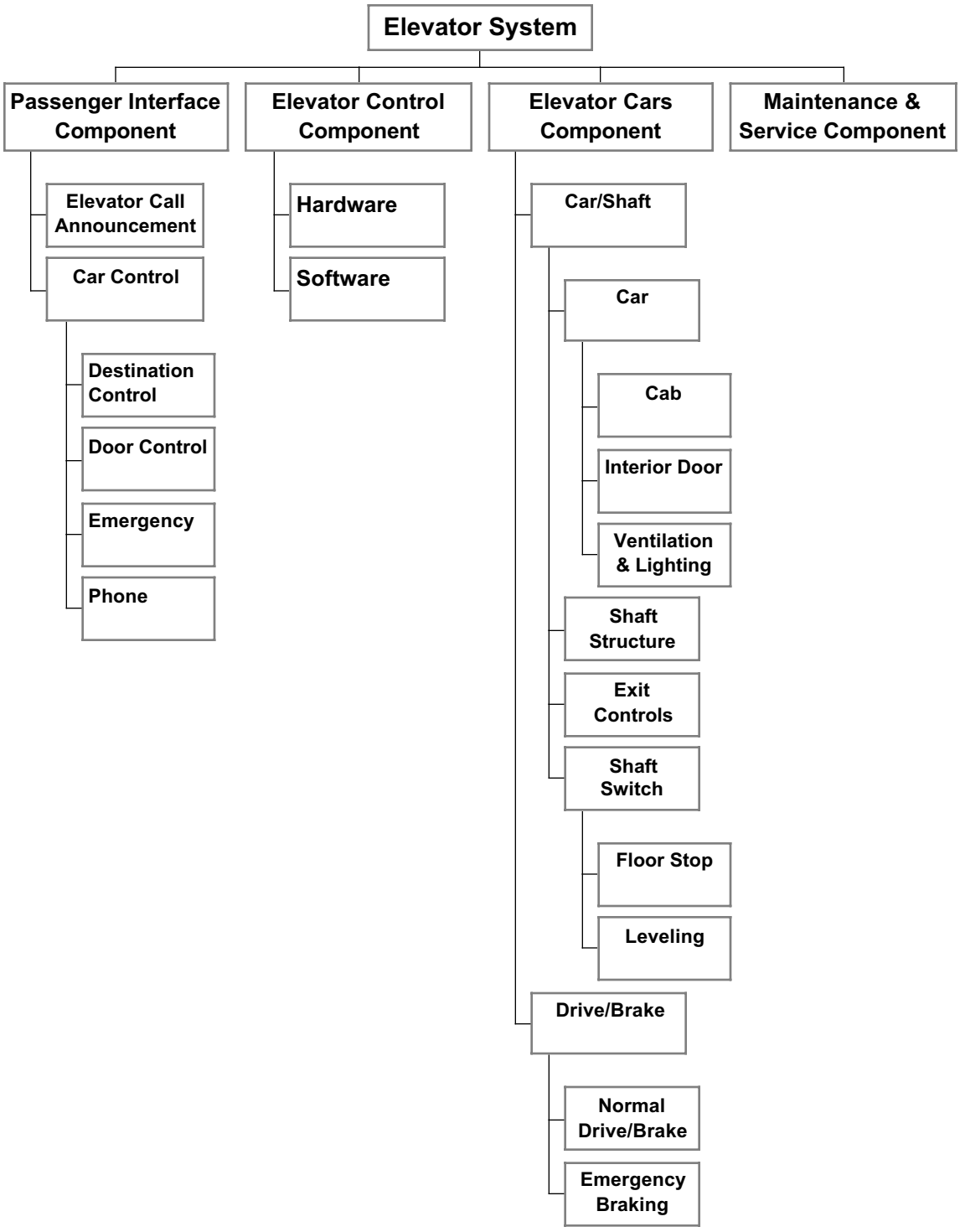
NOTES: 1 2 3 4 5 6 7 8 9 10
DATE 09/29/1999
REV
WORKING
DRAFT
RECOMMENDED
PUBLICATION
READER DATE
CONTEXT:
A0
Elevator Position & Direction
Digitized Passenger Requests
Fire Alarm Signal
Signal for Partial Maint. Mode, Signal for Full Op'g Mode
Temporary Modificatin to Elevator Configuration
Diagnosis Signals, Maint. Action, Repairs, Test Signals
MONITOR LOCATION OF ALL CARS
A21
Sensed Malfunctions, Diagnosis & Test Responses
MONITOR LOCATION AND DIRECTION OF WAITING PASSENGERS
A22
List of all Floors with Waiting Passengers & Desired Direction
List of all Cars with Direction & Location
ALLOCATE CARS TO PASSENGER PICK UP STOPS
A24
Operating Mode
Assignments for Elevator Cars
Fire Alarm
NODE: A2
TITLE CONTROL ELEVATOR CAR
NUMBER P. 6

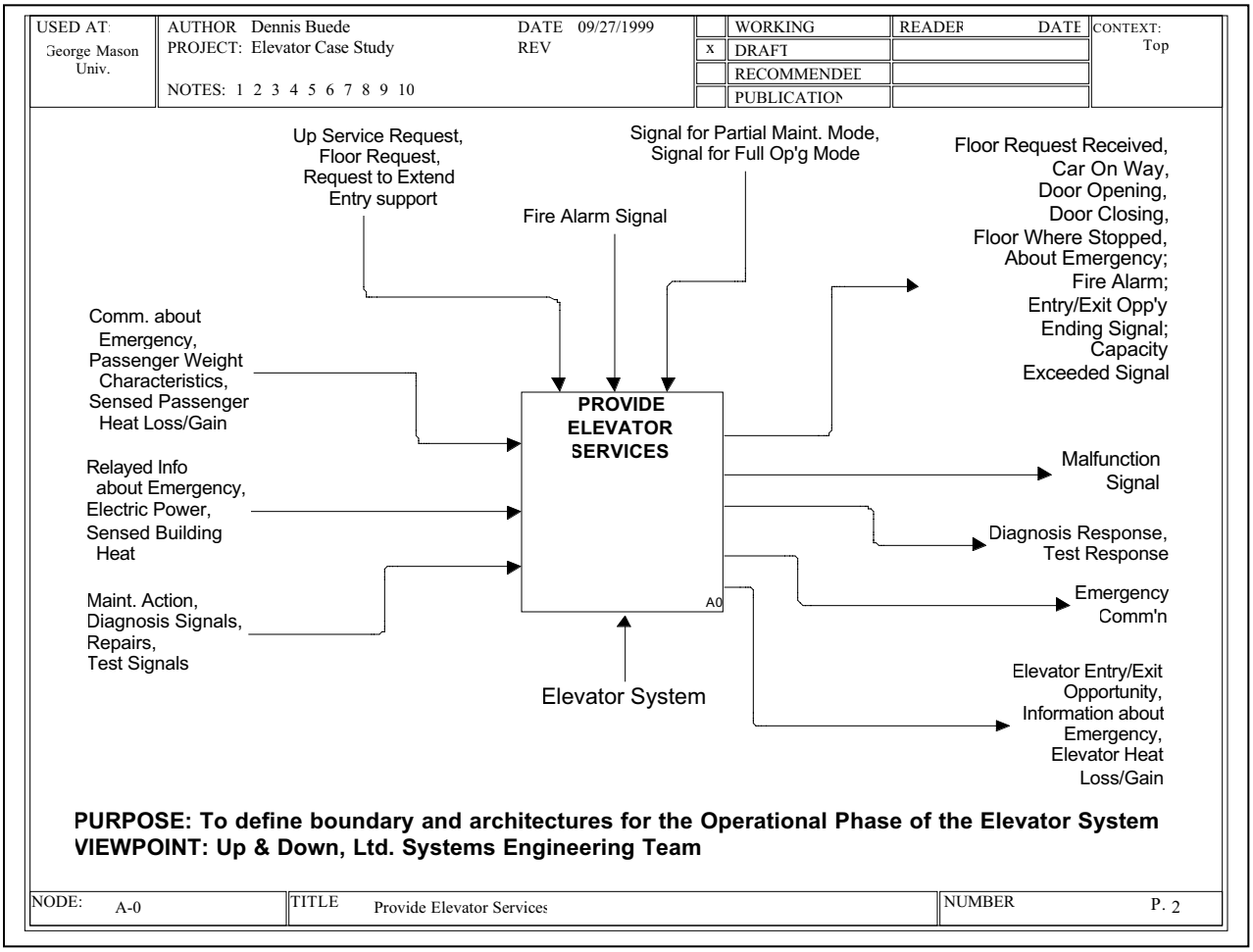

USED AT: George Mason Univ.
AUTHOR Dennis Buede
PROJECT: Elevator Case Study
NOTES: 1 2 3 4 5 6 7 8 9 10
DATE 09/27/1999
REV
WORKING
DRAFT
RECOMMENDEI
PUBLICATION
READER DATE
CONTEXT:
A0
Request to Extend Entry support
Assignments for Elevator Cars
Operating Mode
RECEIVE & DISCHARGE PASSENGERS
A31
TRAVEL TO NEXT STOP
A32
PROVIDE COMFORTABLE ATMOSPHERE
A33
Electric Power
Relayed Info about Emergency, Electric Power
Travel OK Message
Travel Stopped Message
Sensed Discharge Malfunctions, Diagnosis & Test Responses
Emergency Comm'n
Entry/Exit Opp'y Ending Signal; Capacity Exceeded Signal
Relayed Info about Emergency, Electric Power, Sensed Building Heat
Sensed Building Heat
Comm. about Emergency, Passenger Weight Characteristics,
Elevator Position & Direction
Elevator Entry/Exit Opportunity, Information about Emergency, Elevator Heat Loss/Gain
Comm. about Emergency, Passenger Weight Characteristics, Sensed Passenger Heat Loss/Gain
Sensed Passenger Heat Loss/Gain
Sensed Travel Malfunctions, Diagnosis & Test Responses
Sensed Malfunctions, Diagnosis & Test Responses
Diagnosis Signals, Maint. Action, Repairs, Test Signals
Sensed Comfort Malfunctions, Diagnosis & Test Responses
NODE: A3
TITLE MOVE PASSENGERS BETWEEN FLOOR
NUMBER P. 7

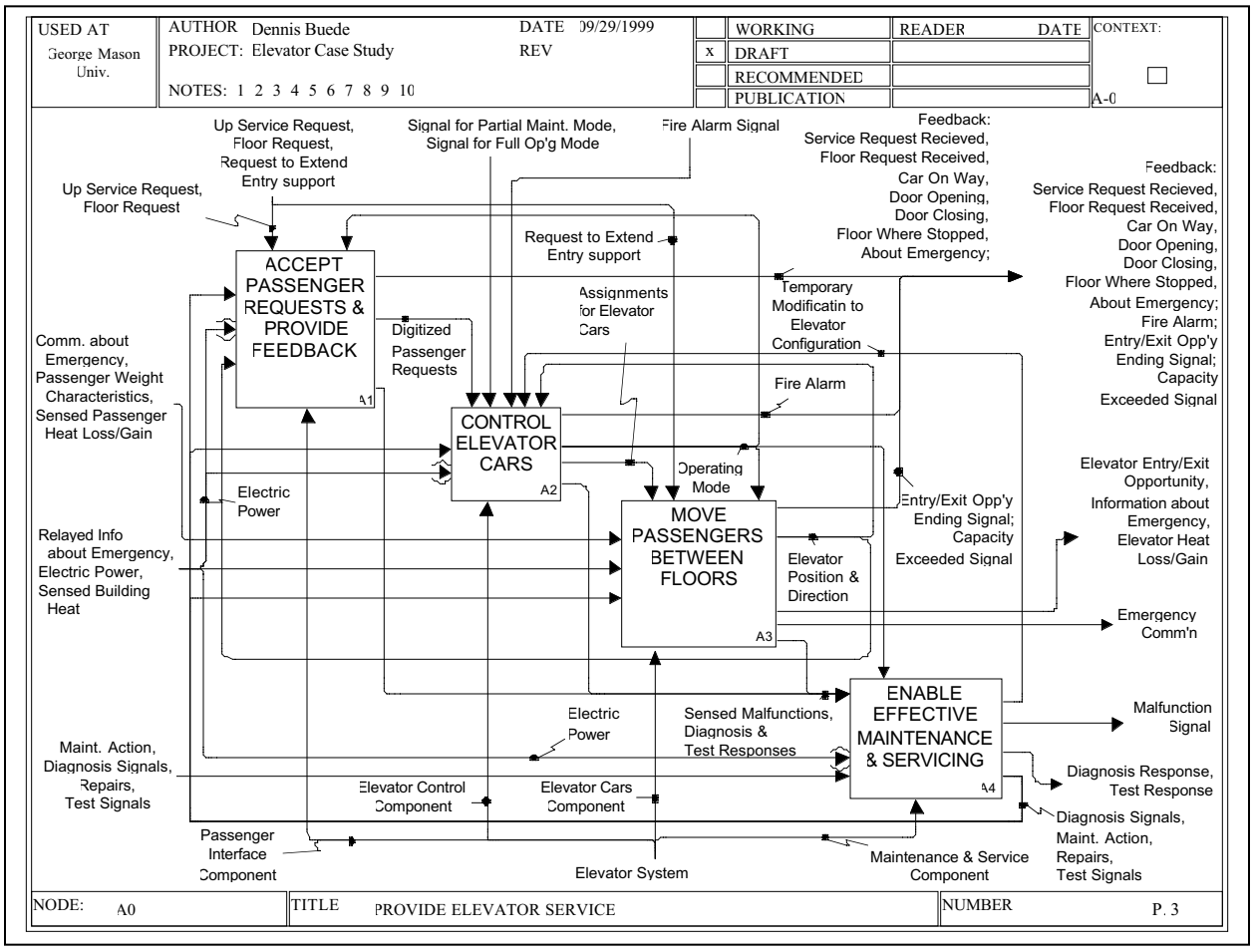


6.0 Physical Architecture for the Operational Phase



7.0 Operational Architecture for the Operational Phase




USED AT
George Mason Univ.
AUTHOR Dennis Buede
PROJECT: Elevator Case Study
NOTES: 1 2 3 4 5 6 7 8 9 10
DATE 09/29/1999
REV
WORKING
DRAFT
RECOMMENDED
PUBLICATION
READER
DATE
CONTEXT:
A-0
Up Service Request, Floor Request, Request to Extend Entry support
Signal for Partial Maint. Mode, Signal for Full Op'g Mode
Fire Alarm Signal
Feedback: Service Request Recieved, Floor Request Received, Car On Way, Door Opening, Door Closing, Floor Where Stopped, About Emergency;
Up Service Request, Floor Request
Request to Extend Entry support
Feedback: Service Request Recieved, Floor Request Received, Car On Way, Door Opening, Door Closing, Floor Where Stopped, About Emergency; Fire Alarm; Entry/Exit Opp'y Ending Signal; Capacity Exceeded Signal
ACCEPT PASSENGER REQUESTS & PROVIDE FEEDBACK
A1
Assignments for Elevator Cars
Temporary Modificatin to Elevator Configuration
Digitized Passenger Requests
Comm. about Emergency, Passenger Weight Characteristics, Sensed Passenger Heat Loss/Gain
Fire Alarm
CONTROL ELEVATOR CARS
A2
Operating Mode
Elevator Entry/Exit Opportunity, Information about Emergency, Elevator Heat Loss/Gain
Electric Power
Entry/Exit Opp'y Ending Signal; Capacity Exceeded Signal
MOVE PASSENGERS BETWEEN FLOORS
A3
Relayed Info about Emergency, Electric Power, Sensed Building Heat
Elevator Position & Direction
Emergency Comm'n
ENABLE EFFECTIVE MAINTENANCE & SERVICING
A4
Malfunction Signal
Electric Power
Sensed Malfunctions, Diagnosis & Test Responses
Maint. Action, Diagnosis Signals, Repairs, Test Signals
Diagnosis Response, Test Response
Elevator Control Component
Elevator Cars Component
Diagnosis Signals, Maint. Action, Repairs, Test Signals
Passenger Interface Component
Elevator System
Maintenance & Service Component
NODE: A0
TITLE PROVIDE ELEVATOR SERVICE
NUMBER P. 3

The following set of FFBDs provide the behavioral model for the operational architecture.