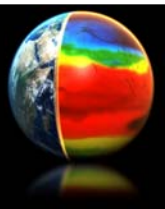

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UNSW
Planning Sustainable Infrastructure
Week 3: 24th March 2009

Dr. Ken Doust

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WS Atkins

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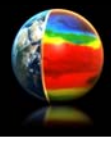
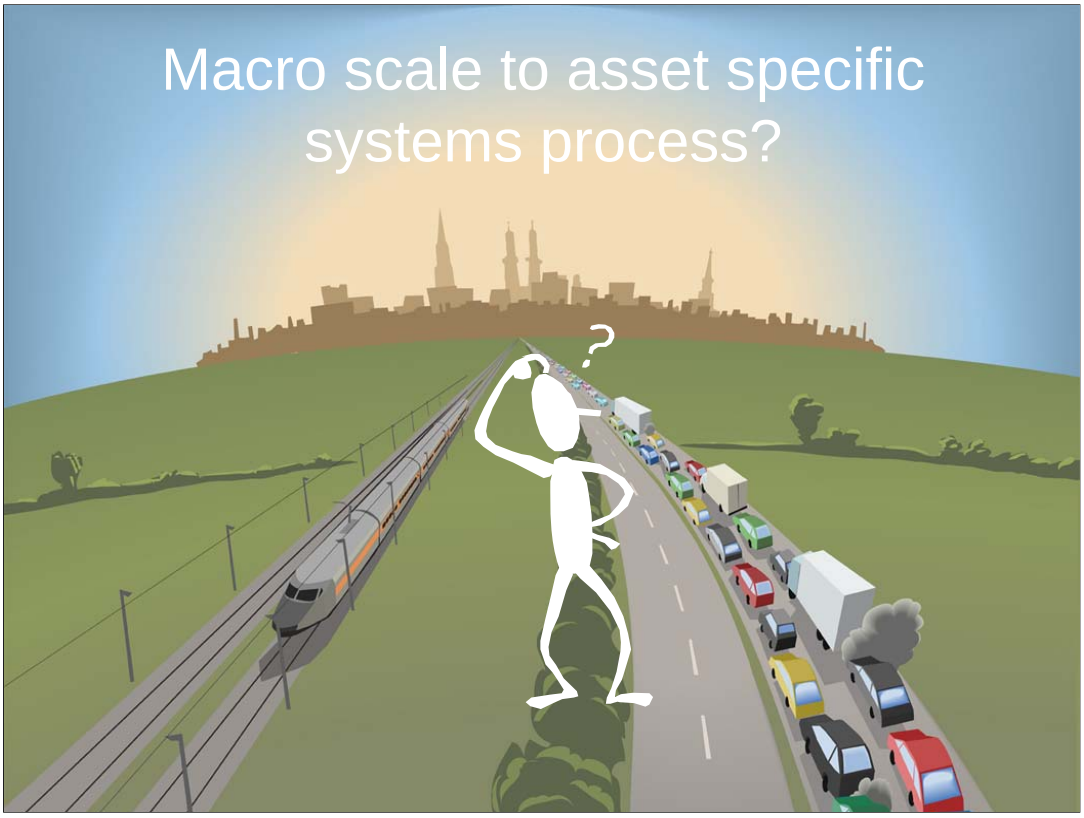
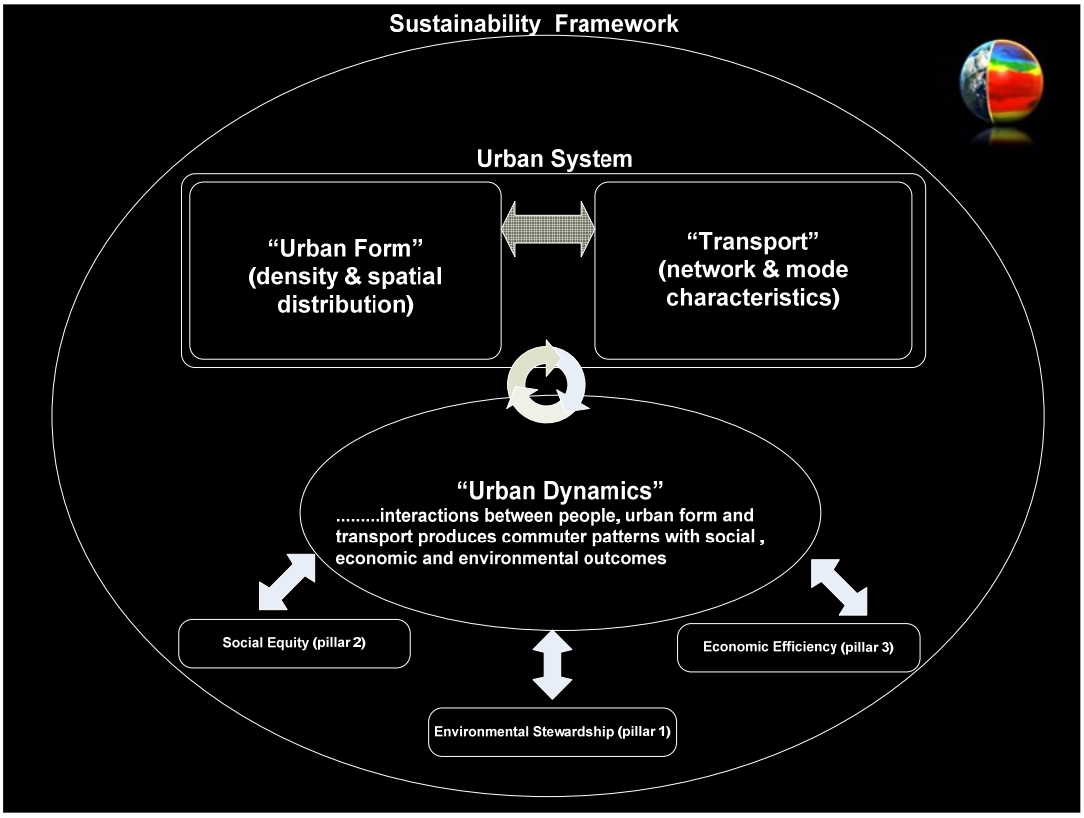
INTRODUCTION - Transport 2: Systems thinking techniques in planning from macro scale to asset specific scale

- Macro scale to asset specific systems process
- Case study system and subsystems
- Systems Engineering Management Plan





Identifying option characteristics



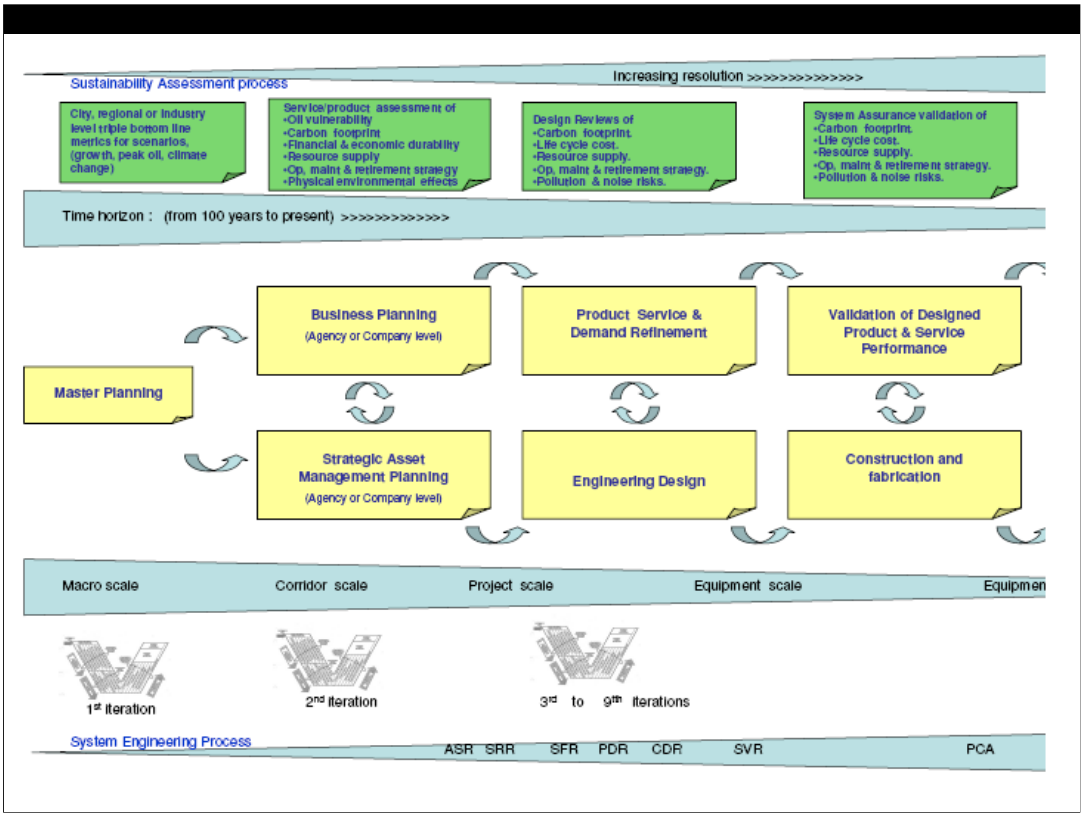
In a new approach to sustainability analysis , a sustainability framework is formulated to bring not only the three pillars of sustainability together, but also a holistic consideration of the urban system, the urban dynamics and the resulting sustainability performance.

Figure summarises this framework, showing the interconnection between the urban system elements, the urban dynamics and identifying the three pillars of sustainability. This framework lays out the frame points for ensuring that the systems elements and interactions that drive the sustainability performance of the city are visible and measured.

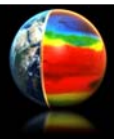
The "Urban System" is the physical aspect of the framework, consisting of the "Urban Form" and "Transport" elements which define the structural configuration of the city. Interaction between these two elements shows their interdependencies. "Urban Form" is characterised by density and spatial distribution of land-use. "Transport" on the other hand is characterised by the transport network spatial layout and the specific mode characteristics.

The system function is to provide for the needs of the community (including industry). Response by the community to the "Urban System" produces interactions – the selection of location of residence and workplace, industry and travel patterns, and so on. These interactions are collectively known as "Urban Dynamics". It is an iterative process as indicated by the circular arrow having feedback effect between each element.

The resulting "Urban Dynamics" outcomes generate the sustainability performance in terms of the three pillars included as elements in Figure 2. Each pillar has a feedback to the "Urban Dynamics" and consequently the "Urban System". This is indicated by the double headed arrows in the figure.

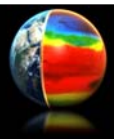

Sustainability Assessment process
Increasing resolution >>>>>>>>>>>>>>
City, regional or industry level triple bottom line metrics for scenarios, (growth, peak oil, climate change)
Service/product assessment of
•Oil vulnerability
•Carbon footprint
•Financial & economic durability
•Resource supply
•Op, maint & retirement strategy
•Physical environmental effects
Design Reviews of
•Carbon footprint.
•Life cycle cost.
•Resource supply.
•Op, maint & retirement strategy.
•Pollution & noise risks.
System Assurance validation of
•Carbon footprint.
•Life cycle cost.
•Resource supply.
•Op, maint & retirement strategy.
•Pollution & noise risks.
Time horizon : (from 100 years to present) >>>>>>>>>>>>>
Master Planning
Business Planning
(Agency or Company level)
Product Service & Demand Refinement
Validation of Designed Product & Service Performance
Strategic Asset Management Planning
(Agency or Company level)
Engineering Design
Construction and fabrication
Macro scale
Corridor scale
Project scale
Equipment scale
Equipmen
1st iteration
2nd iteration
3rd to 9th iterations
System Engineering Process
ASR SRR SFR PDR CDR SVR PCA

Systems Engineering Process



- The system engineering process drives the balanced development of system products and processes

Systems Engineering Process



- transforms needs and requirements into a set of system product and process descriptions,
- input for the next level of development.
- applied sequentially, one level at a time,
- adding additional detail and definition with each level of development.

The Systems Engineering Process (SEP) is a comprehensive, iterative and recursive problem solving process, applied sequentially top-down by integrated teams. It transforms needs and requirements into a set of system product and process descriptions, generate information for decision makers, and provides input for the next level of development. The process is applied sequentially, one level at a time, adding additional detail and definition with each level of development. As shown by Figure 3-1, the process includes: inputs and outputs; requirements analysis; functional analysis and allocation; requirements loop; synthesis; design loop; verification; and system analysis and control.

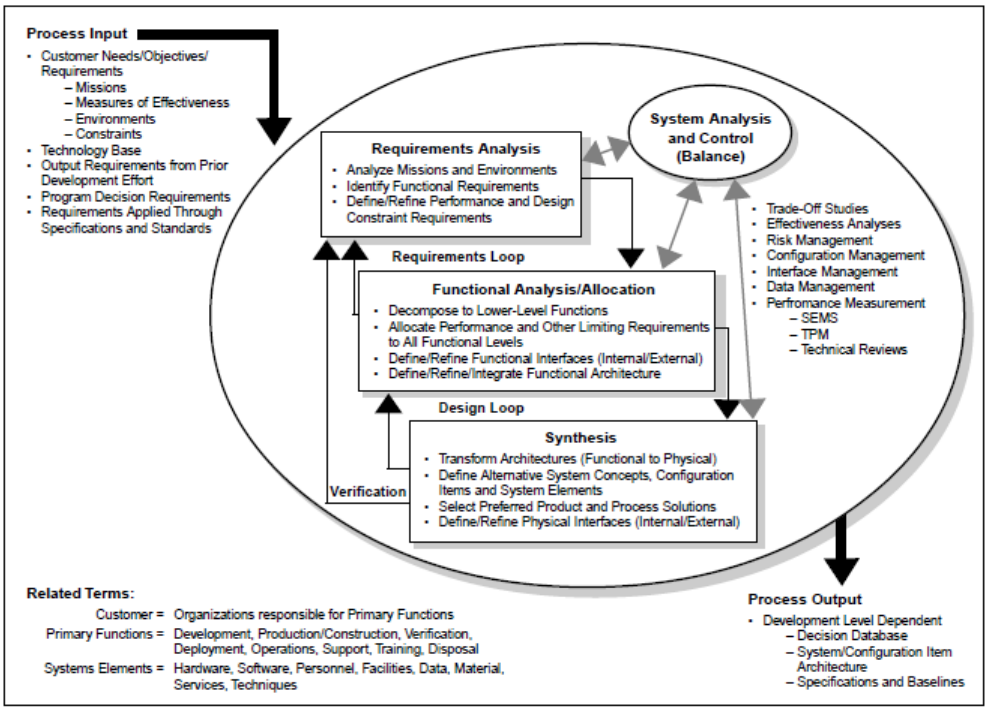


Figure 3-1. The Systems Engineering Process

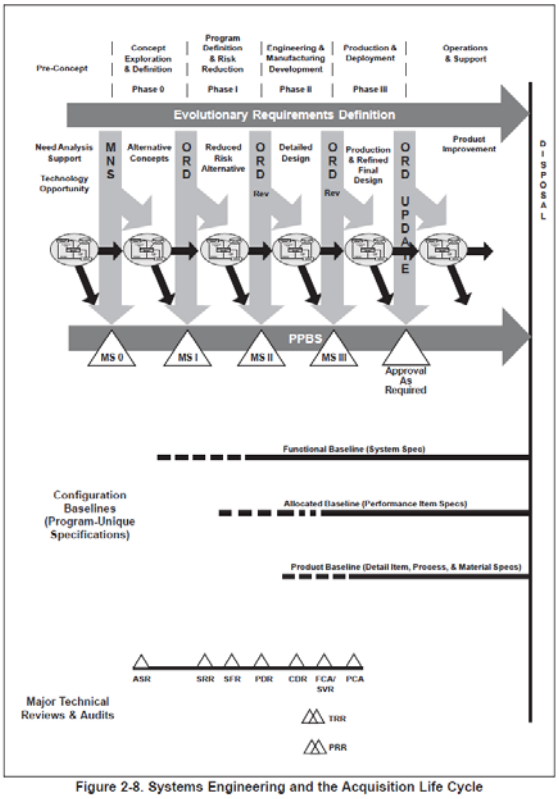
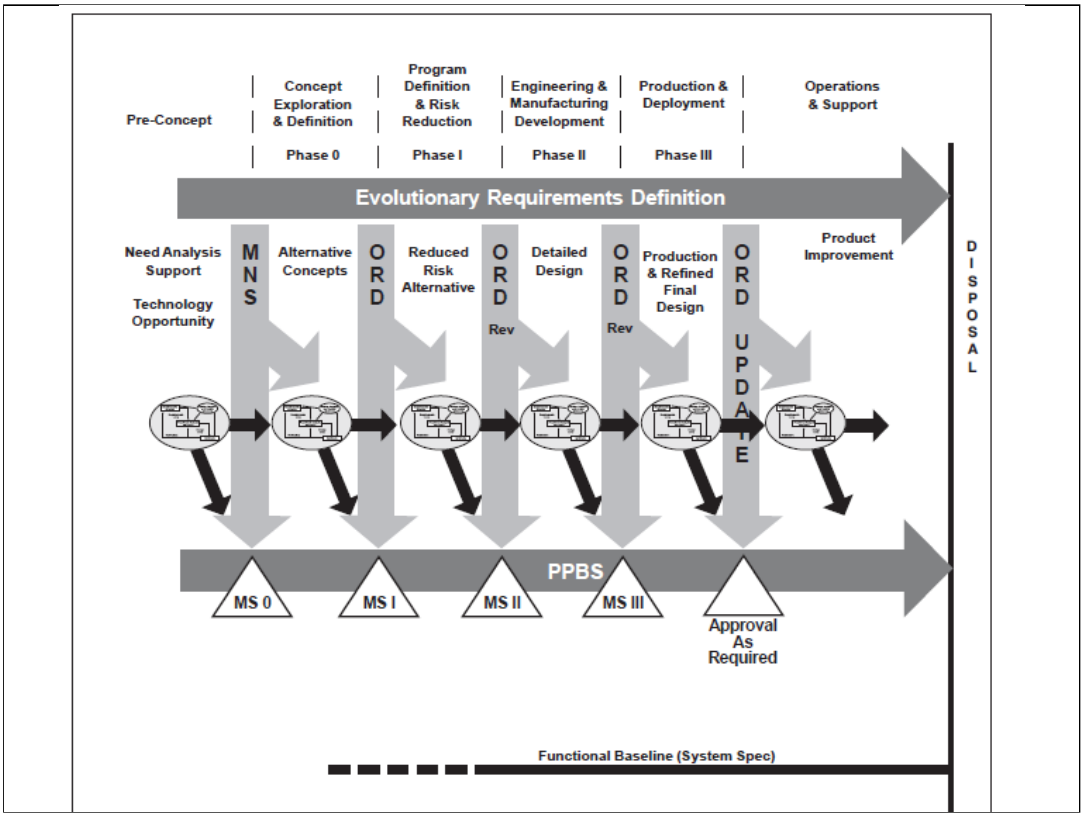


Figure 2-8. Systems Engineering and the Acquisition Life Cycle


Pre-Concept
Concept Exploration & Definition
Program Definition & Risk Reduction
Engineering & Manufacturing Development
Production & Deployment
Operations & Support
Phase 0
Phase I
Phase II
Phase III
Evolutionary Requirements Definition
Need Analysis Support
Technology Opportunity
MNS
Alternative Concepts
ORD
Reduced Risk Alternative
ORD Rev
Detailed Design
ORD Rev
Production & Refined Final Design
ORD UPDATE
Product Improvement
DISPOSAL
PPBS
MS 0
MS I
MS II
MS III
Approval As Required
Functional Baseline (System Spec)

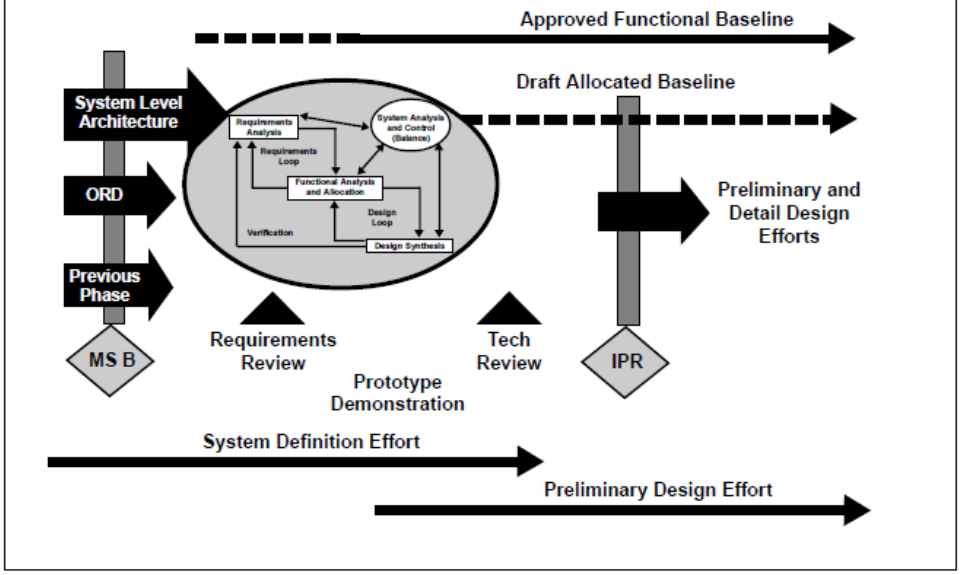


Figure 2-4. System Development and Demonstration (System Integration Stage)

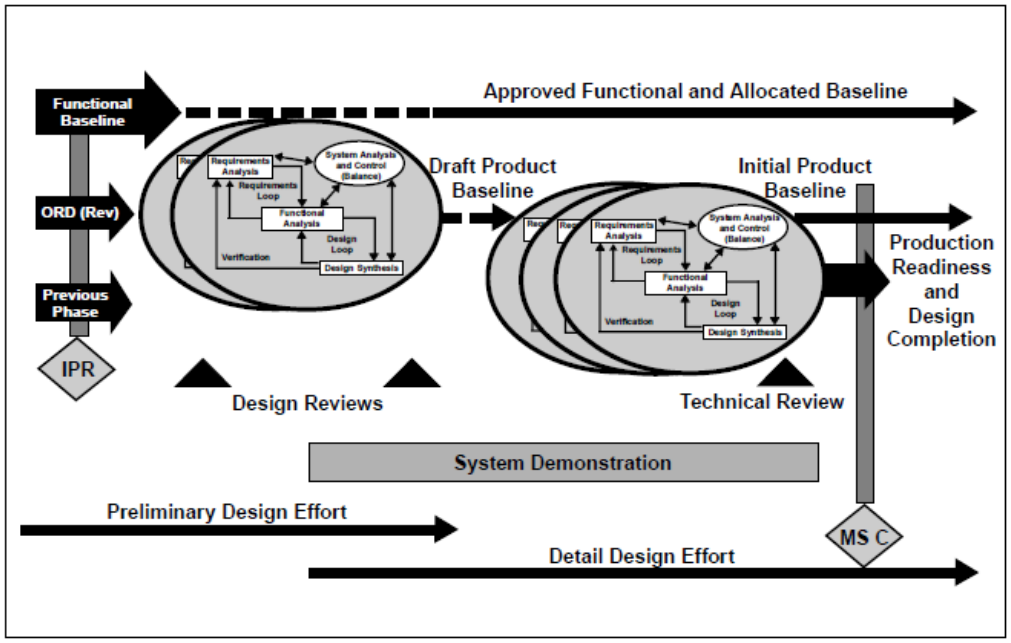


Figure 2-5. System Development and Demonstration
(System Demonstration Stage)

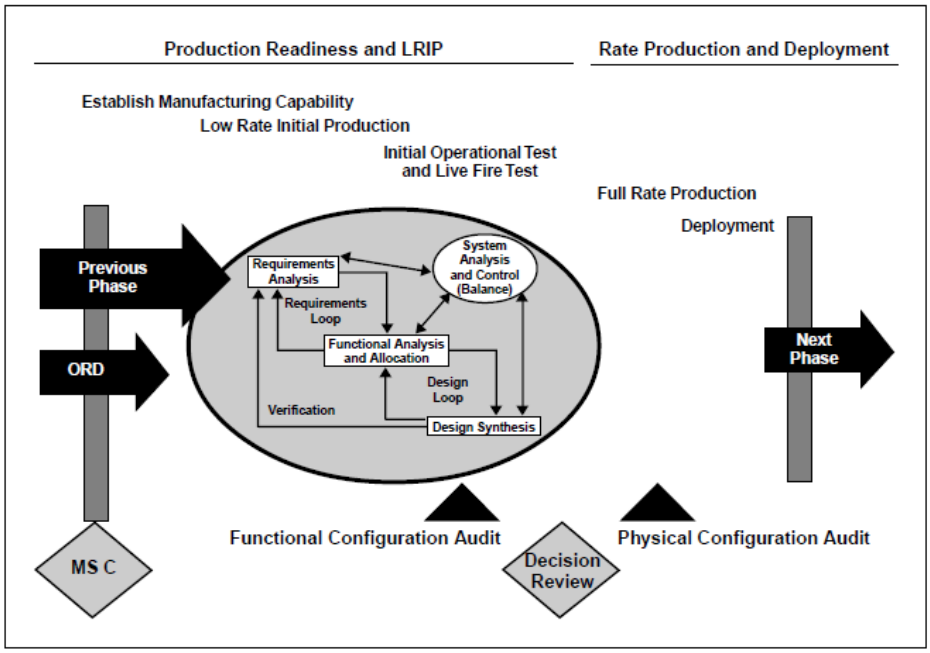


Figure 2-6. Production and Deployment

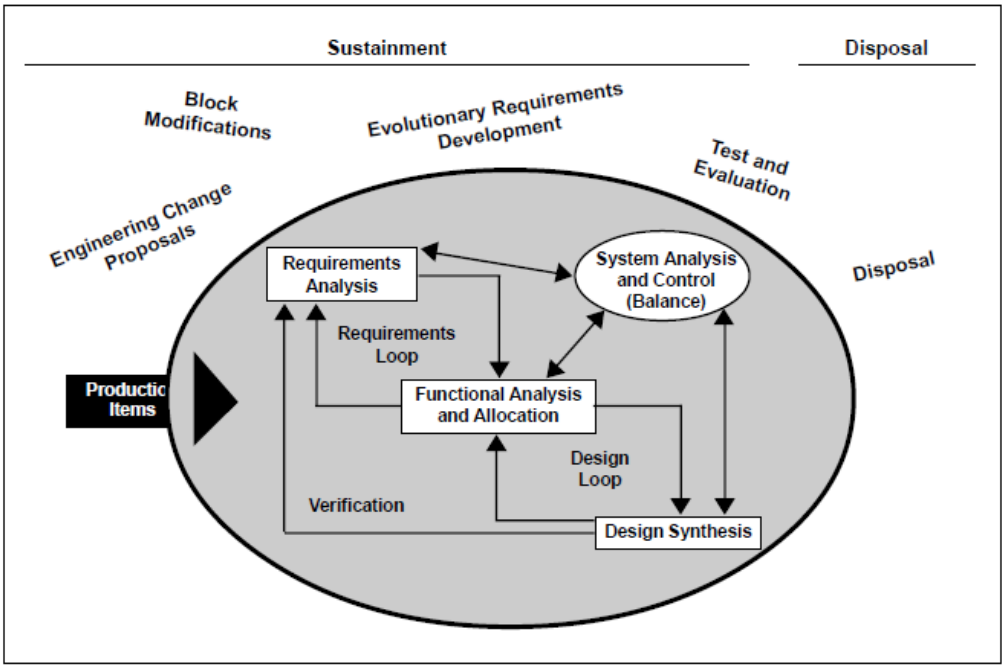
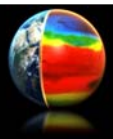


Figure 2-7. Sustainment and Disposal

Systems Engineering Process

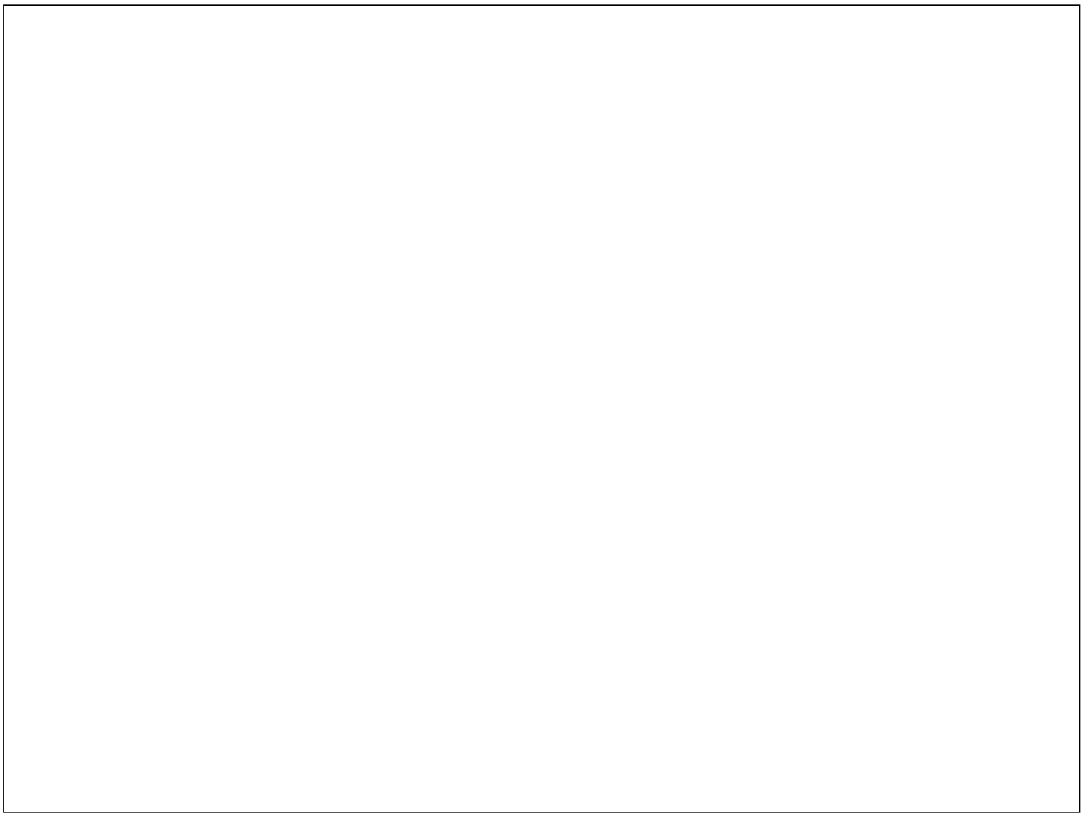


- Tailor the process to the level of maturity of the system
- Ensure that the system has achieved the levels of maturity expected prior to progressing into succeeding phases.

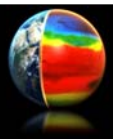
The system acquisition life cycle process is a model used to guide the program manager through the process of maturing technology based systems and readying them for production and deployment to users.

• The acquisition process model is intended to be flexible and to accommodate systems and technologies of varying maturities. Systems dependent on immature technologies will take longer to develop and produce, while those that employ mature technologies can proceed through the process relatively quickly.

• The system engineering effort is integrated into the systems acquisition process such that the activities associated with systems engineering Systems Engineering Fundamentals (development of documentation, technical reviews, configuration management, etc.) support and strengthen the acquisition process. The challenge for the engineering manager is to ensure that engineering activities are conducted at appropriate points in the process to ensure that the system has, in fact, achieved the levels

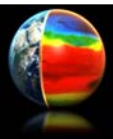


Corridor scale



- The system is the infrastructure and fleet chosen to deliver the product

Corridor Scale



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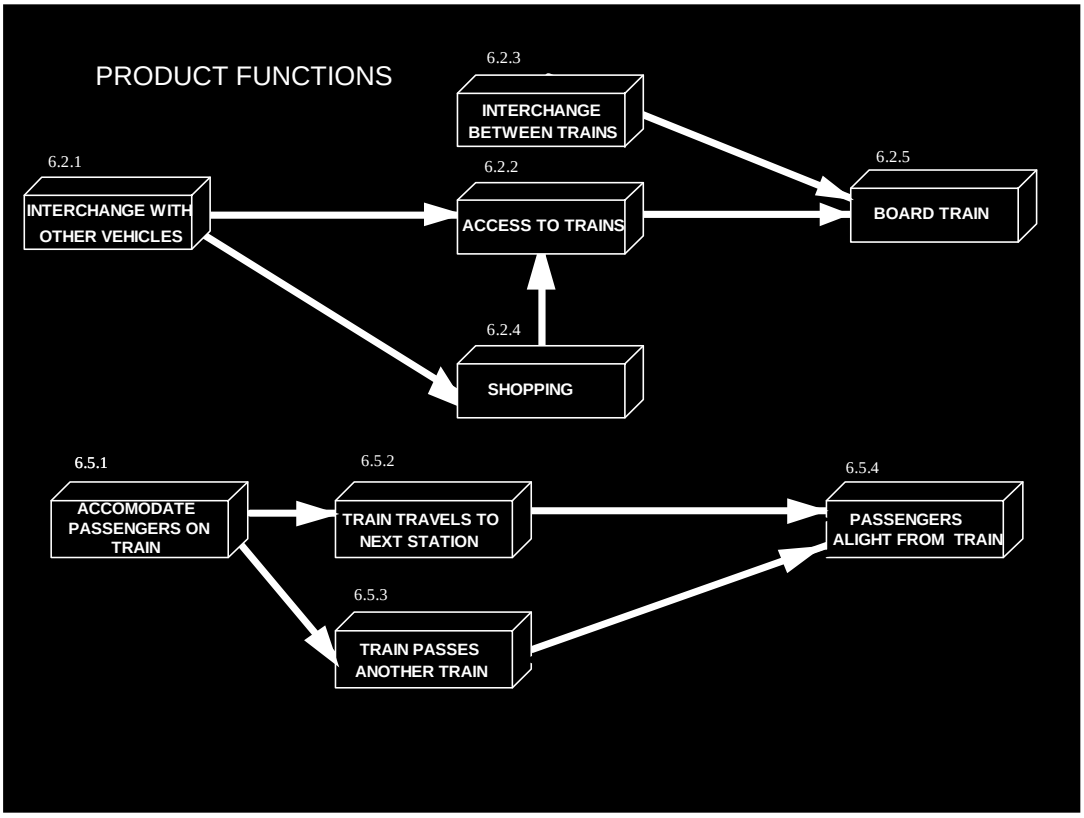
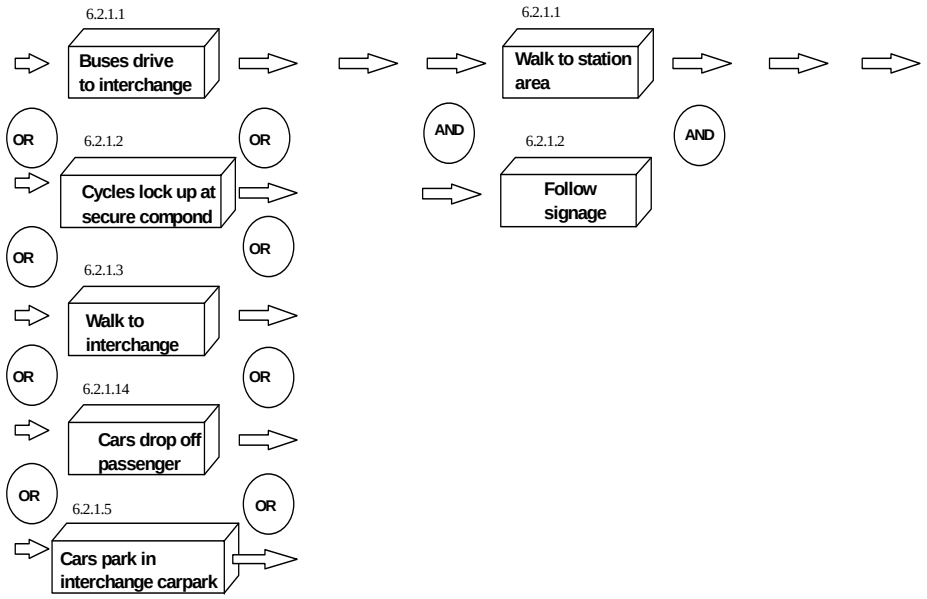
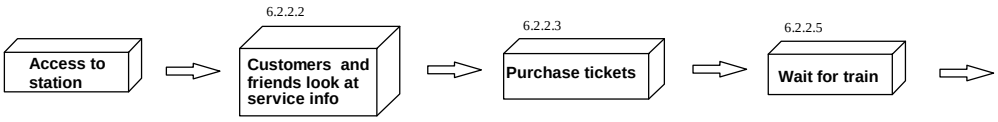

PRODUCT FUNCTIONS
6.2.3
INTERCHANGE BETWEEN TRAINS
6.2.1
INTERCHANGE WITH OTHER VEHICLES
6.2.2
ACCESS TO TRAINS
6.2.5
BOARD TRAIN
6.2.4
SHOPPING
6.5.1
ACCOMODATE PASSENGERS ON TRAIN
6.5.2
TRAIN TRAVELS TO NEXT STATION
6.5.4
PASSENGERS ALIGHT FROM TRAIN
6.5.3
TRAIN PASSES ANOTHER TRAIN

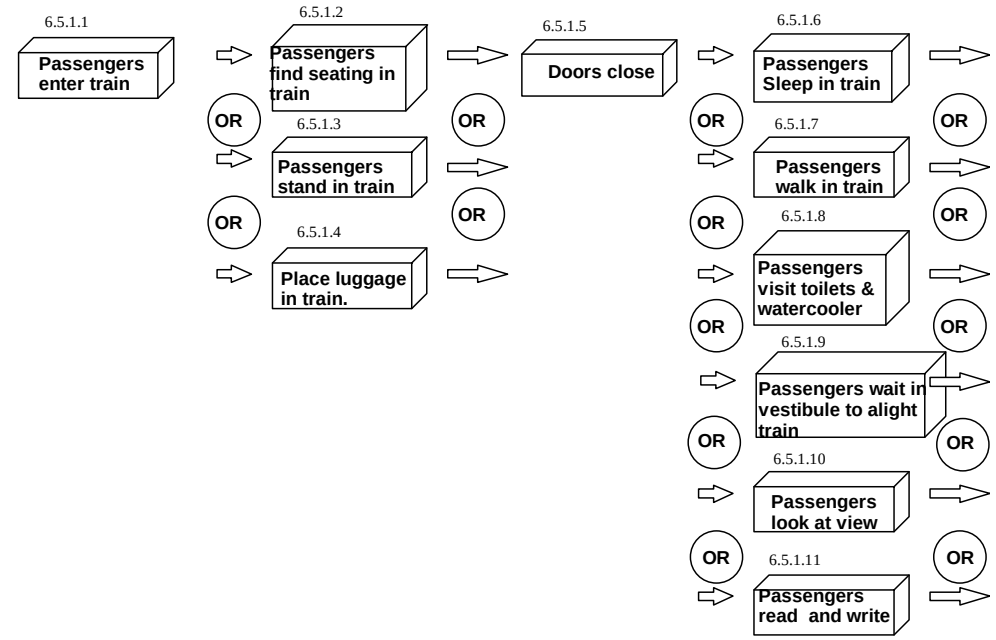
A further breakdown of the functions is as follows:
INTERCHANGE WITH OTHER VEHICLES:



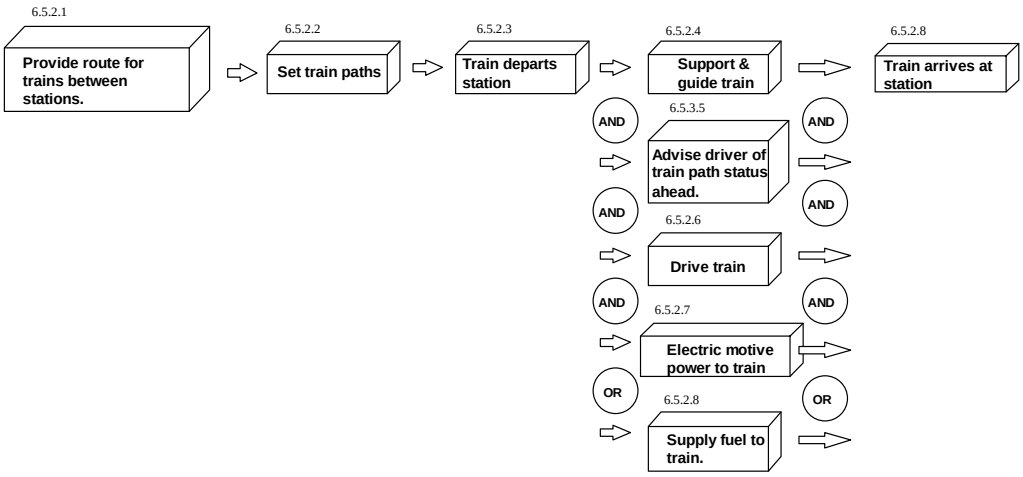
ACCESS TO TRAINS:



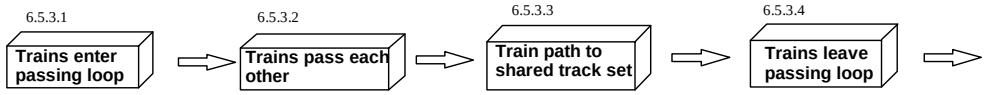
ACCOMMODATE PASSENGERS ON TRAIN:



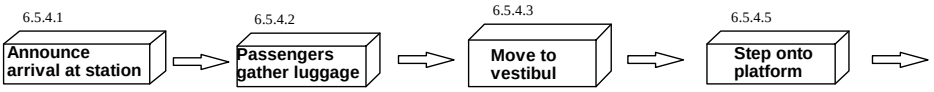
TRAIN TRAVELS TO NEXT STATION:



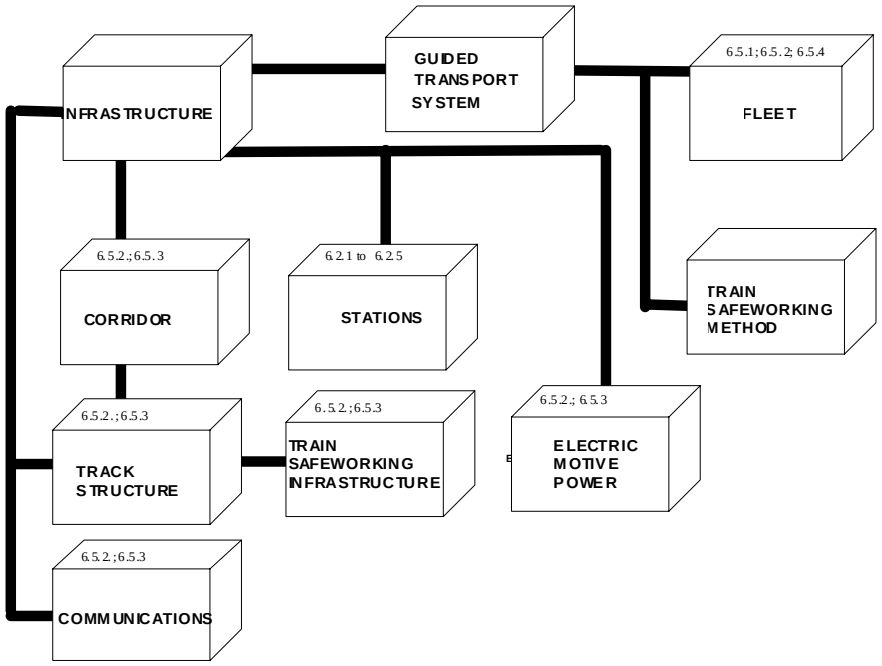
TRAIN PASSES ANOTHER TRAIN:

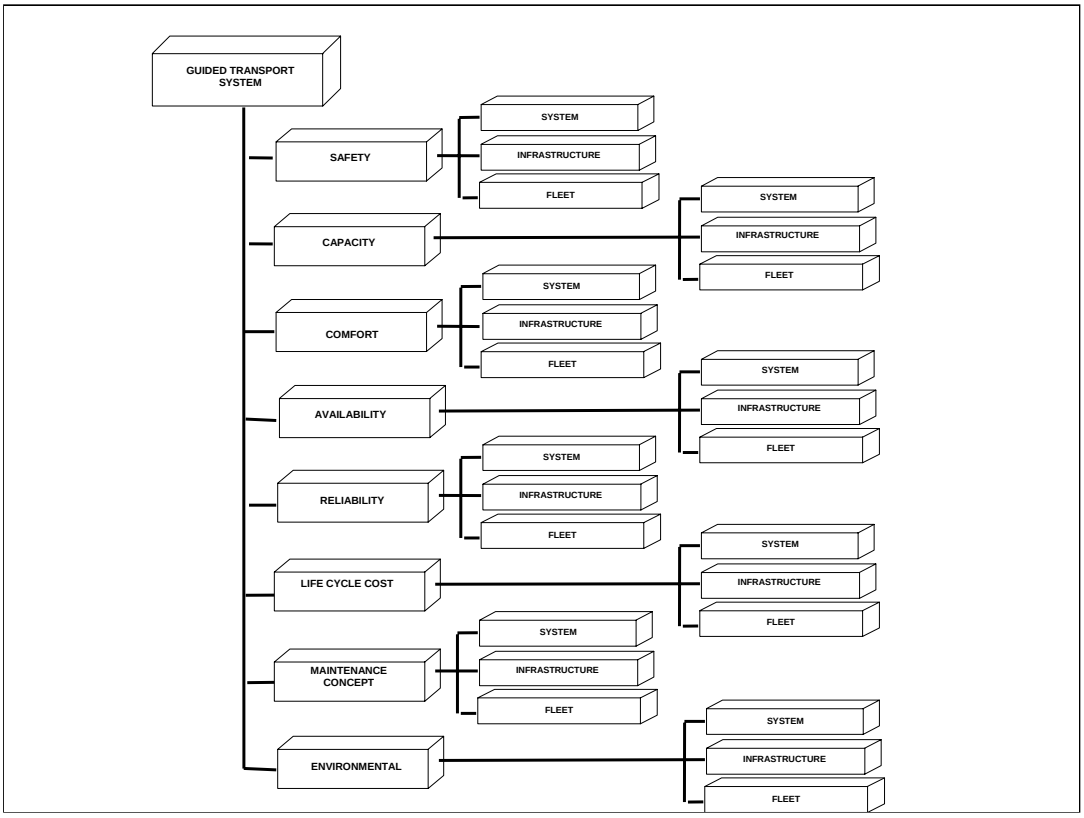


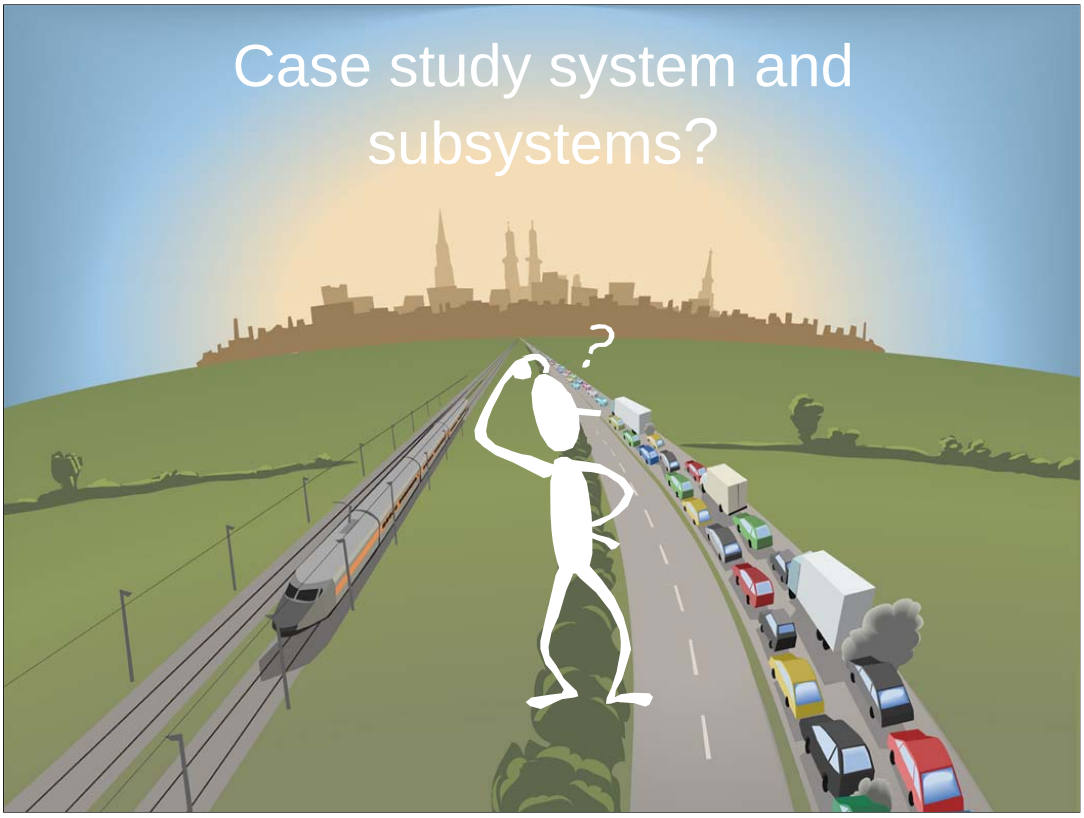
PASSENGERS ALIGHT FROM TRAIN:



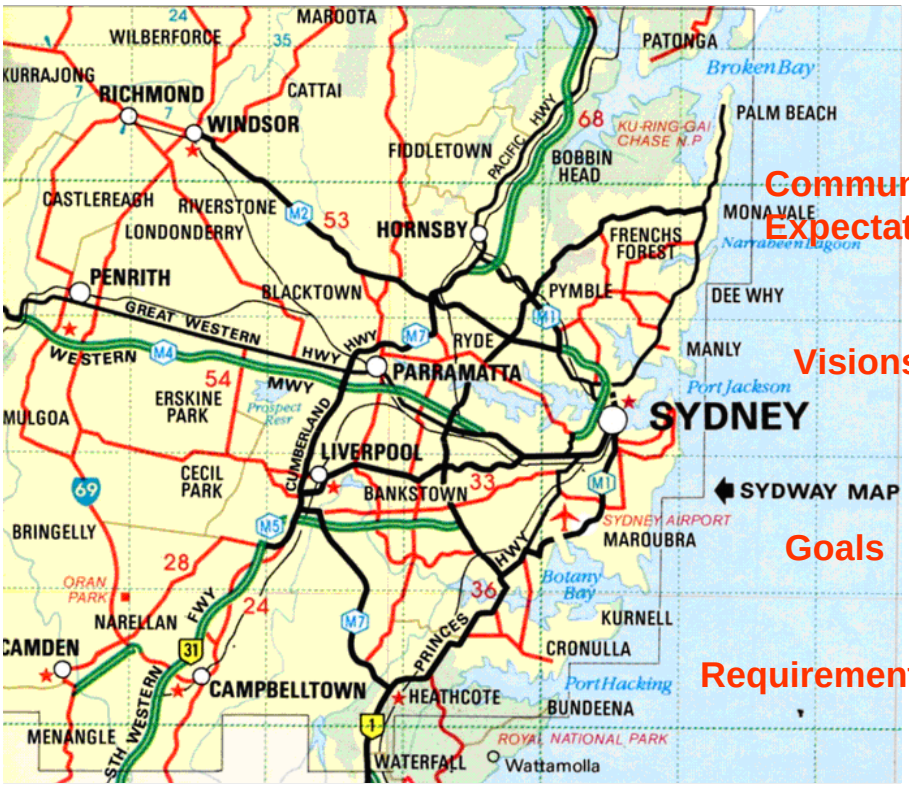
The system selected for delivering the product is represented in the following diagram.




GUIDED TRANSPORT SYSTEM
SAFETY
SYSTEM
INFRASTRUCTURE
FLEET
CAPACITY
SYSTEM
INFRASTRUCTURE
FLEET
COMFORT
SYSTEM
INFRASTRUCTURE
FLEET
AVAILABILITY
SYSTEM
INFRASTRUCTURE
FLEET
RELIABILITY
SYSTEM
INFRASTRUCTURE
FLEET
LIFE CYCLE COST
SYSTEM
INFRASTRUCTURE
FLEET
MAINTENANCE CONCEPT
SYSTEM
INFRASTRUCTURE
FLEET
ENVIRONMENTAL
SYSTEM
INFRASTRUCTURE
FLEET



Identifying option characteristics

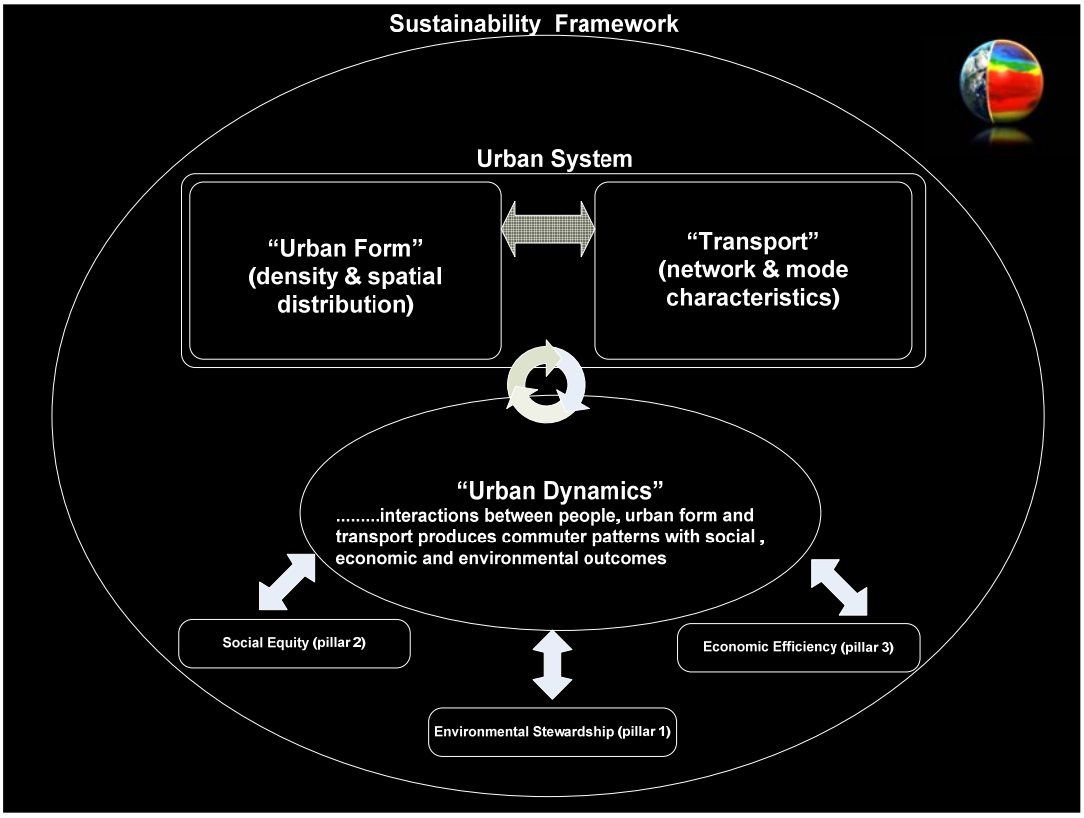


Community Expectations

Visions

Goals

Requirements

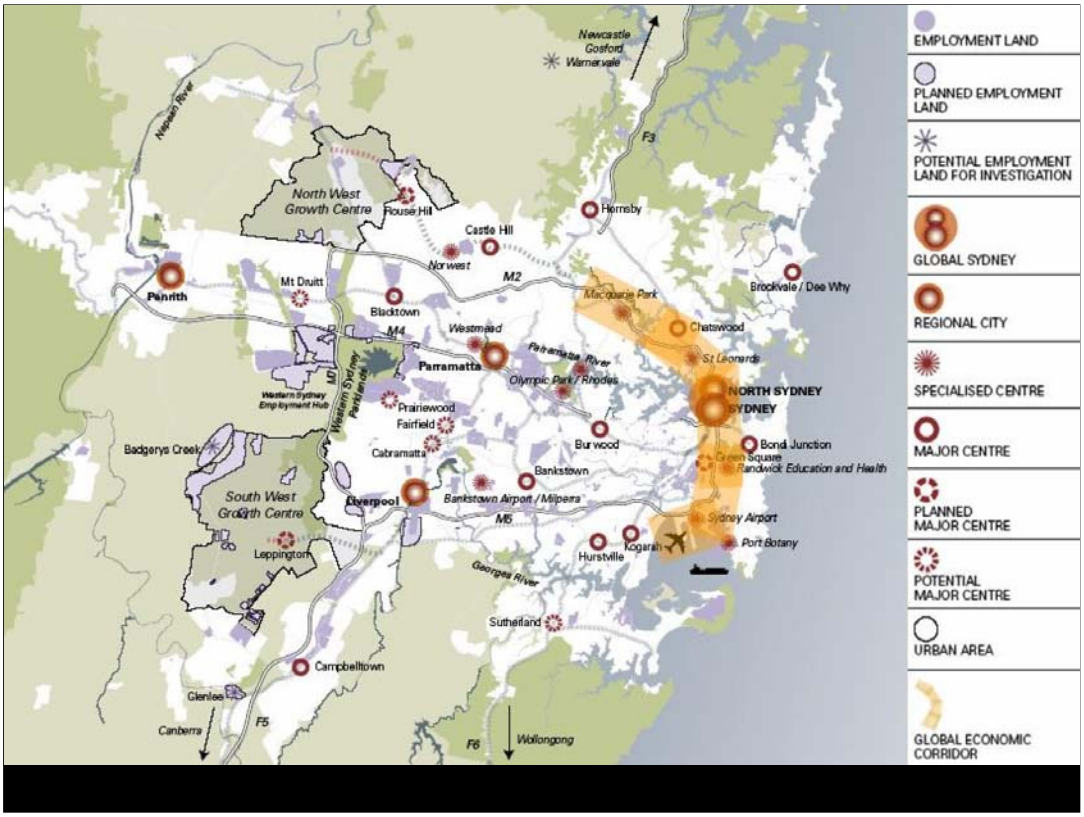


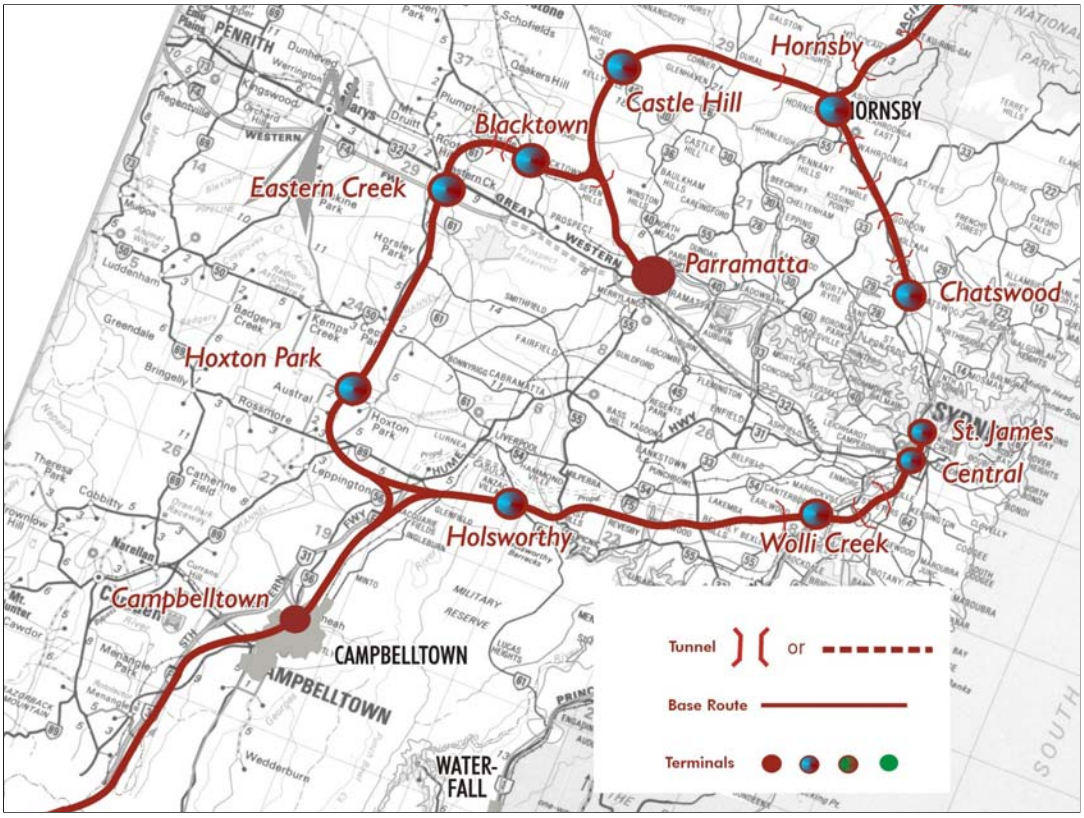
The "Urban System" is the physical aspect of the framework, consisting of the "Urban Form" and "Transport" elements which define the structural configuration of the city. Interaction between these two elements shows their interdependencies. "Urban Form" is characterised by density and spatial distribution of land-use. "Transport" on the other hand is characterised by the transport network spatial layout and the specific mode characteristics.

The case study system function is the transport element of the urban system, part of a system of systems. The context of the Metropolitan strategy the other systems are assumed as they appear in the strategy.

REQUIREMENTS?

- integration between all links in a multimodal transport web structure.
- when integrated provide door to door trip times for cross regional trips that are significantly (15% to 30%) better than the trip time by car only.
- passenger comfort and personal safety.


Newcastle
Gosford
Warnervale
Hornsby
F3
North West
Growth Centre
Rouse Hill
Castle Hill
Norwest
M2
Mt Druitt
Blacktown
M4
Westmead
Parramatta
Parramatta River
Olympic Park / Rhodes
Macquarie Park
Chatswood
St Leonards
NORTH SYDNEY
SYDNEY
Brookvale / Dee Why
Bondi Junction
Green Square
Randwick Education and Health
Prairiewood
Fairfield
Cabramatta
Bankstown
Bankstown Airport / Milperra
M5
Sydney Airport
Port Botany
Kogarah
Hurstville
Georges River
Sutherland
Liverpool
South West
Growth Centre
Leppington
Campbelltown
Glenlee
Canberra
F5
F6
Wollongong
Badgerys Creek
Western Sydney
Employment Hub
Western Sydney
Parklands
M7
Nepean River
EMPLOYMENT LAND
PLANNED EMPLOYMENT LAND
POTENTIAL EMPLOYMENT LAND FOR INVESTIGATION
GLOBAL SYDNEY
REGIONAL CITY
SPECIALISED CENTRE
MAJOR CENTRE
PLANNED MAJOR CENTRE
POTENTIAL MAJOR CENTRE
URBAN AREA
GLOBAL ECONOMIC CORRIDOR


Hornsby
Castle Hill
HORNSBY
Blacktown
Eastern Creek
Parramatta
Chatswood
Hoxton Park
St. James
Central
Holsworthy
Wolli Creek
Campbelltown
CAMPBELLTOWN
WATER-
FALL
Tunnel
or
Base Route
Terminals

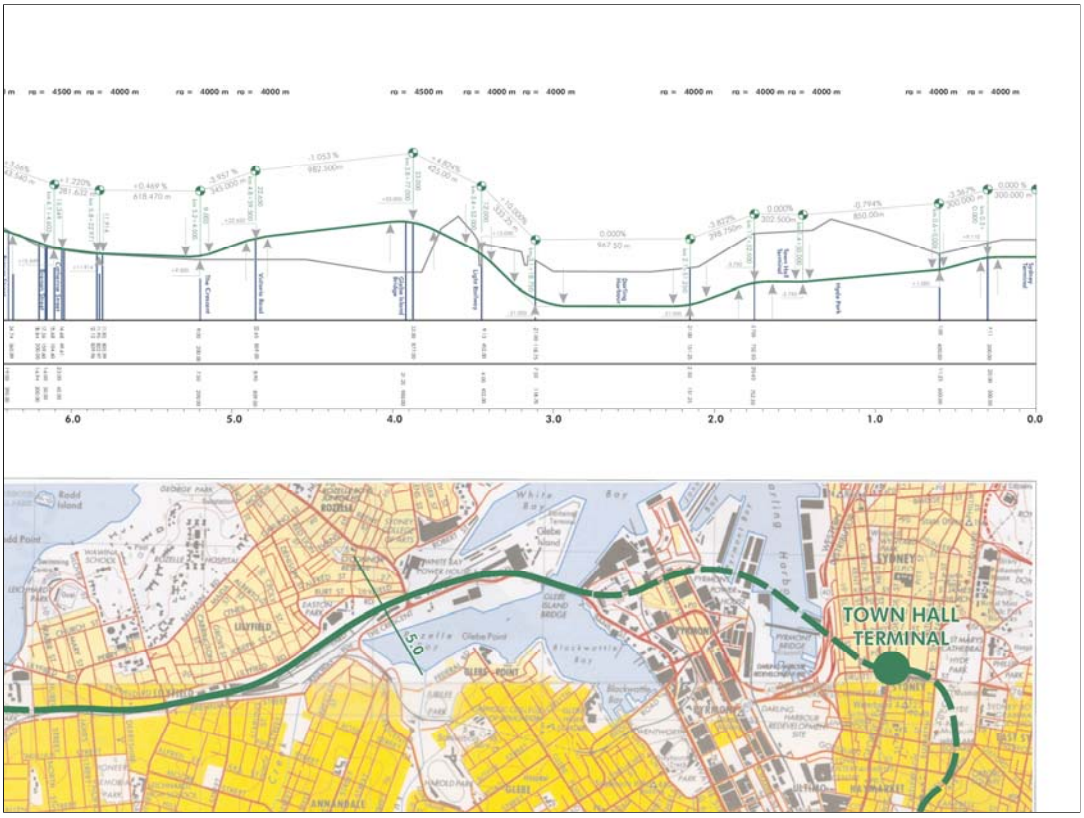

Eastern Creek
Parramatta
Homebush Bay
Hoxton Park
Wolli Creek
Holsworthy
Campbelltown
car only
re than 74%
% to 74%

What are the matching characteristics of the trunk orbital public transport arc?

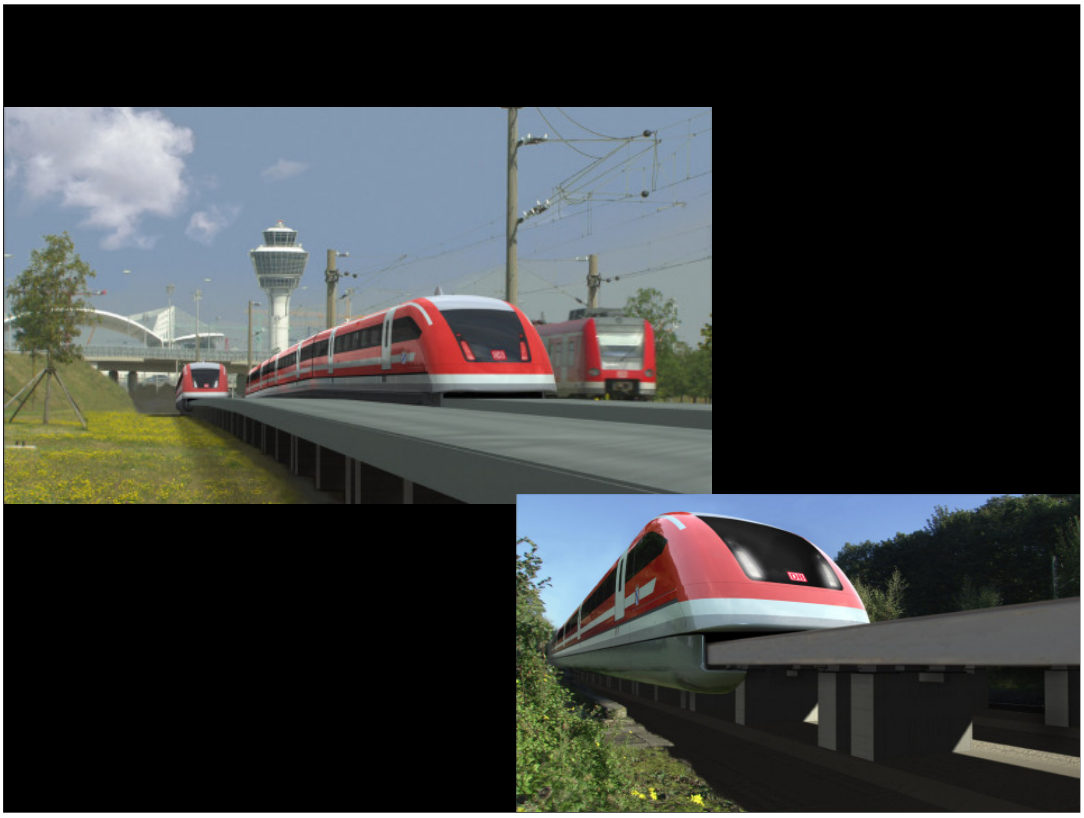
CHARACTERISTICS?

- integration with motorways/buses/rail and other feeders.
- interchanges 5 to 10 km apart
- rapid transit times ….. 2 to 4 minutes between stops
- stay within environmental noise capacity of corridor
- passenger comfort and personal safety onboard and within interchange areas.


CENTRAL

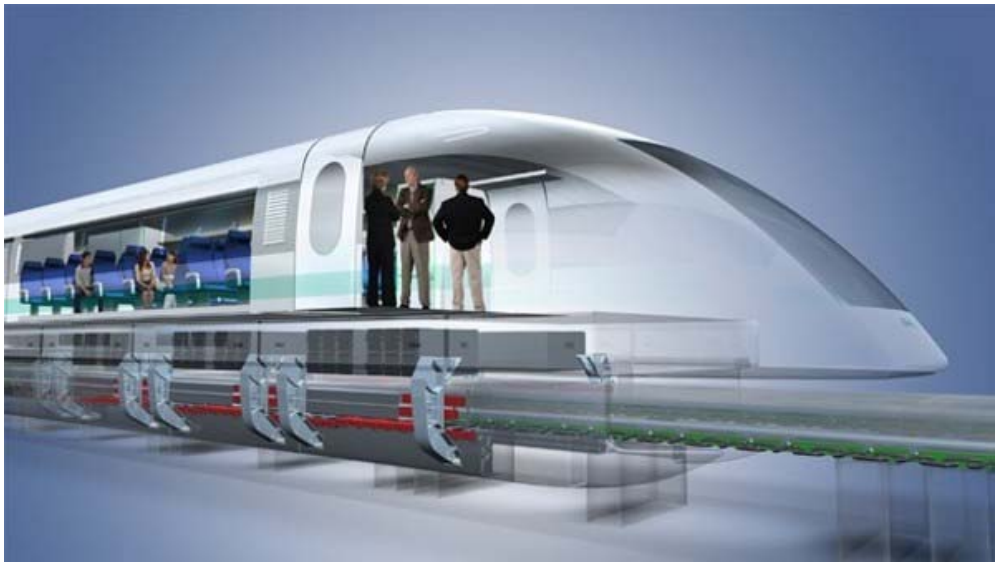

6.0
5.0
4.0
3.0
2.0
1.0
0.0
TOWN HALL
TERMINAL

Dist from/to	Holsworthy	Wolli Creek	Central	St James
Blacktown	37.0	56.2	63.8	65.5
Eastern Creek	29.9	49.1	56.7	58.4
Hoxton Park	15.4	34.6	42.2	43.9
Holsworthy		19.2	26.8	28.5
Wolli Creek			7.5	9.3
Central				1.7



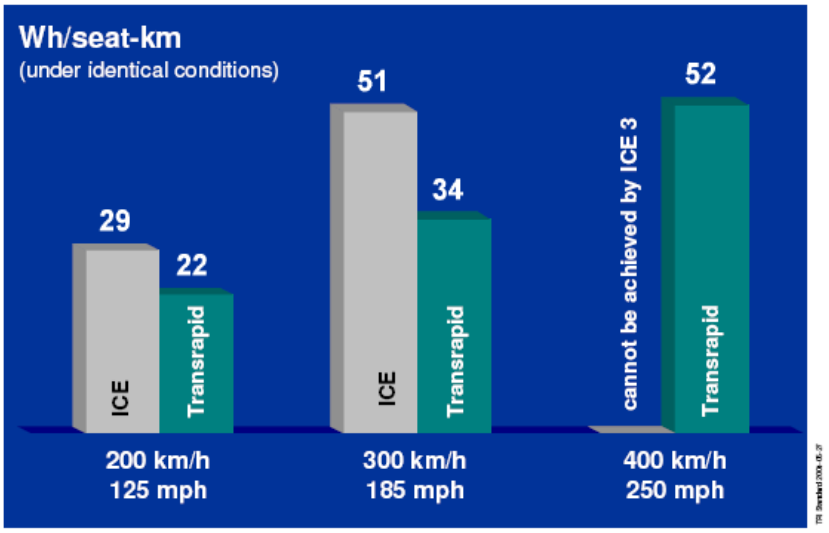
Case study:

"a high speed limited stop guided transport system"



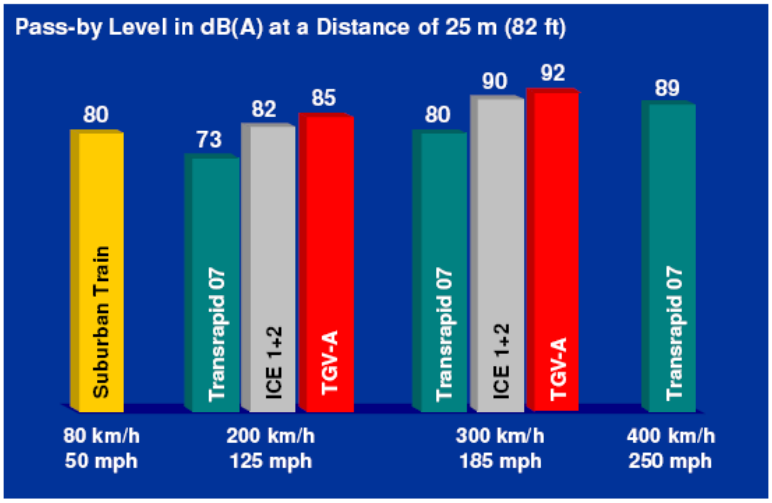
Specific Energy Consumption

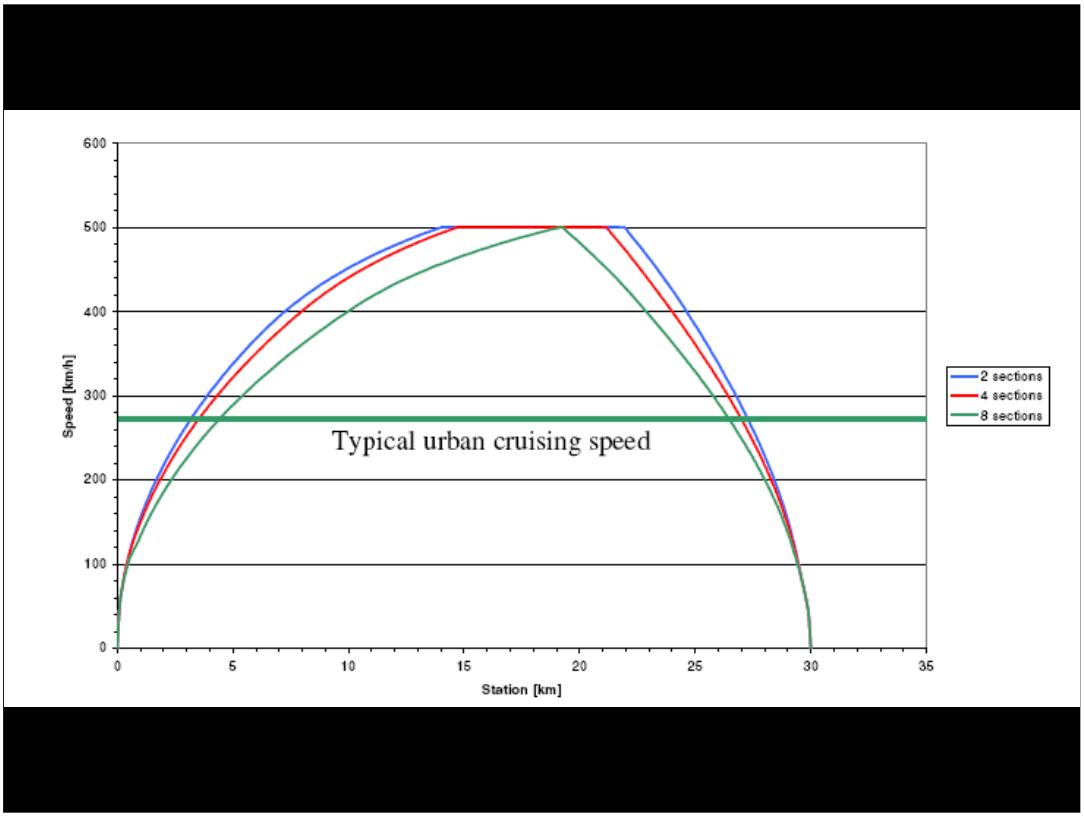
Transrapid International



Noise Emission

Transrapid International




600
500
400
300
200
100
0
Speed [km/h]
0
5
10
15
20
25
30
35
Station [km]
Typical urban cruising speed
2 sections
4 sections
8 sections

Time from/to	Holsworthy	Wolli Creek	Central	St James
Blacktown	14.8	22.0	26.4	29.0
Eastern Creek	10.5	17.7	22.1	24.7
Hoxton Park	4.8	12.0	16.4	19.0
Holsworthy		6.2	10.6	13.2
Wolli Creek			3.4	6.0
Central				1.6

	Cumulative Distance (km)	Travel Time (min)	Cumulative Travel Time (min)	Available Capa
Blacktown	0.0			
		3.3	3.3	
Eastern Creek	7.1			
		4.7	9.0	
Hoxton Park	21.6			
		4.8	14.8	
Holsworthy	37.0			
		6.2	22.0	
Wolli Creek	56.2			
		3.4	26.4	
Central	63.8			
		1.6	29.0	
St James	65.5			

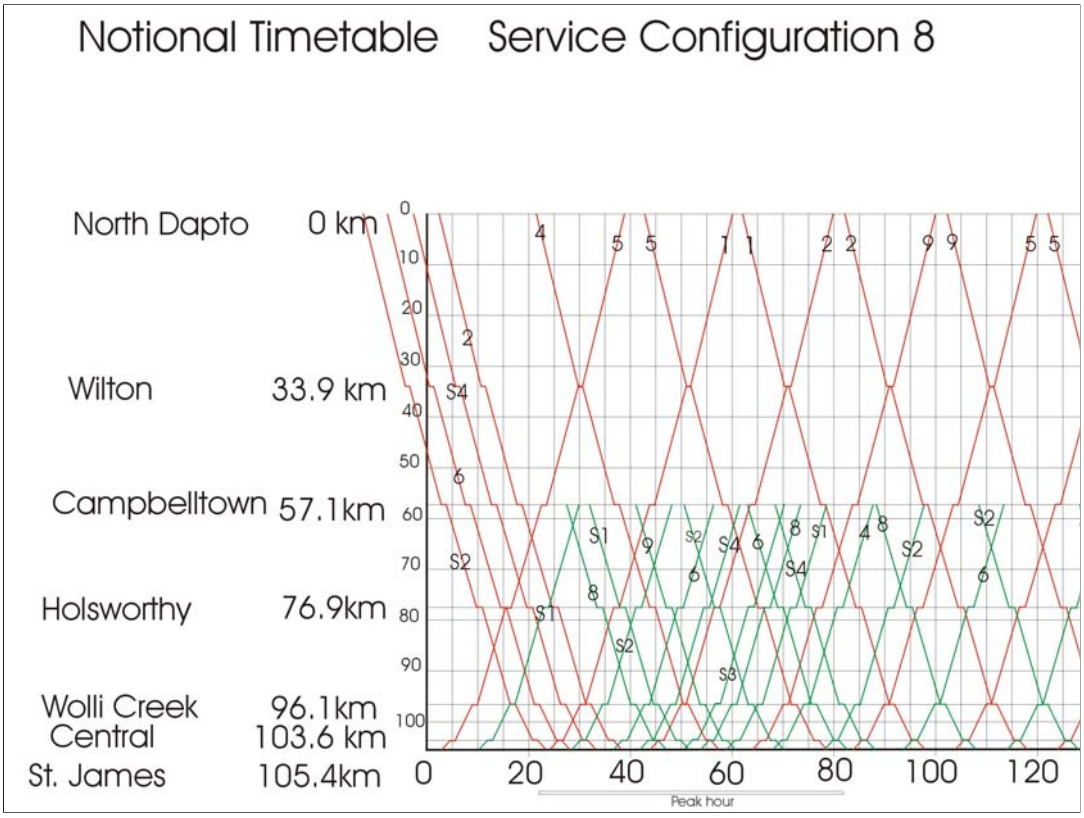
1 min dwell time at each stop

* assuming 20 trains/hr lim
# 2010 Illawarra/Campbell

Travel Time (min)	Cumulative Travel Time (min)	Available Capacity trains/hr/ guideway *
3.3	3.3	20.0
4.7	9.0	20.0
4.8	14.8	# 9
6.2	22.0	# 9
3.4	26.4	# 9
1.6	29.0	

1 min dwell time at each stop

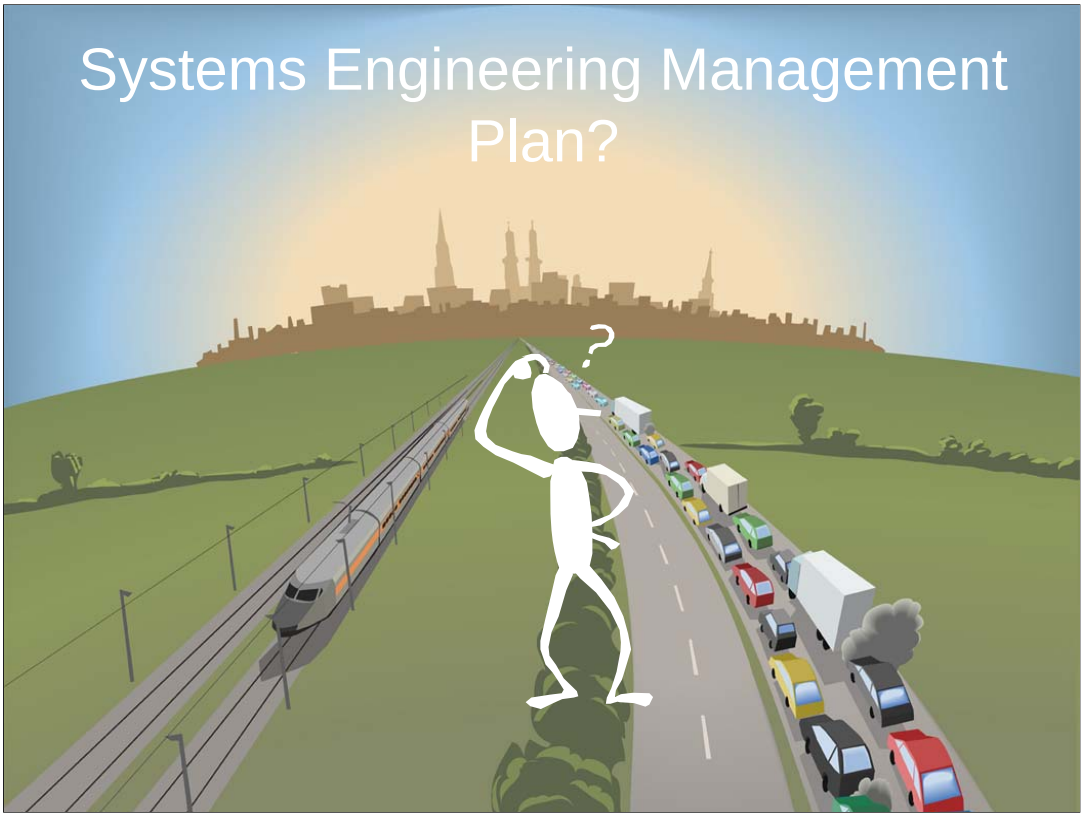
* assuming 20 trains/hr limiting guideway capacity or 3 minute headways
# 2010 Illawarra/Campbelltown use of twin guideway capacity


Notional Timetable Service Configuration 8
North Dapto 0 km
Wilton 33.9 km
Campbelltown 57.1km
Holsworthy 76.9km
Wolli Creek 96.1km
Central 103.6 km
St. James 105.4km
0
10
20
30
40
50
60
70
80
90
100
0
20
40
60
80
100
120
Peak hour

Timetable A

Service Configuration #	Section serviced	Pk Hr train runs	Cars per train	Pk Hr Seated capacity (high density)
1(+35%)	Eastern Creek - St.James	15	6	10,440
2(+35%)	Eastern Creek - St.James	15	8	14,100
3(+35%)	Eastern Creek - St.James	15	10	17,760
4(+35%)	Eastern Creek - St.James	20	8	18,800
5(+35%)	Eastern Creek - St.James	20	10	23,680

High Density Seating #s	6 car trains	696
	8 car trains	940
	10 car trains	1184



Identifying option characteristics

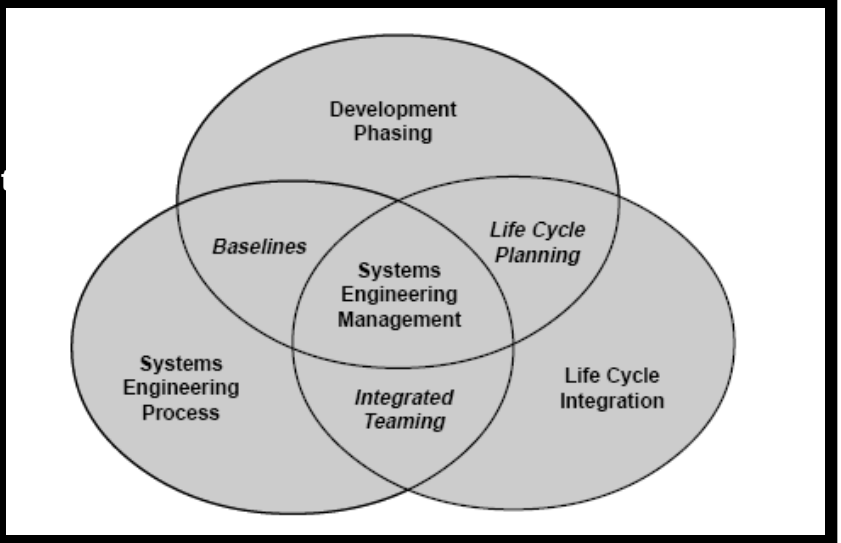
System Engineering Management

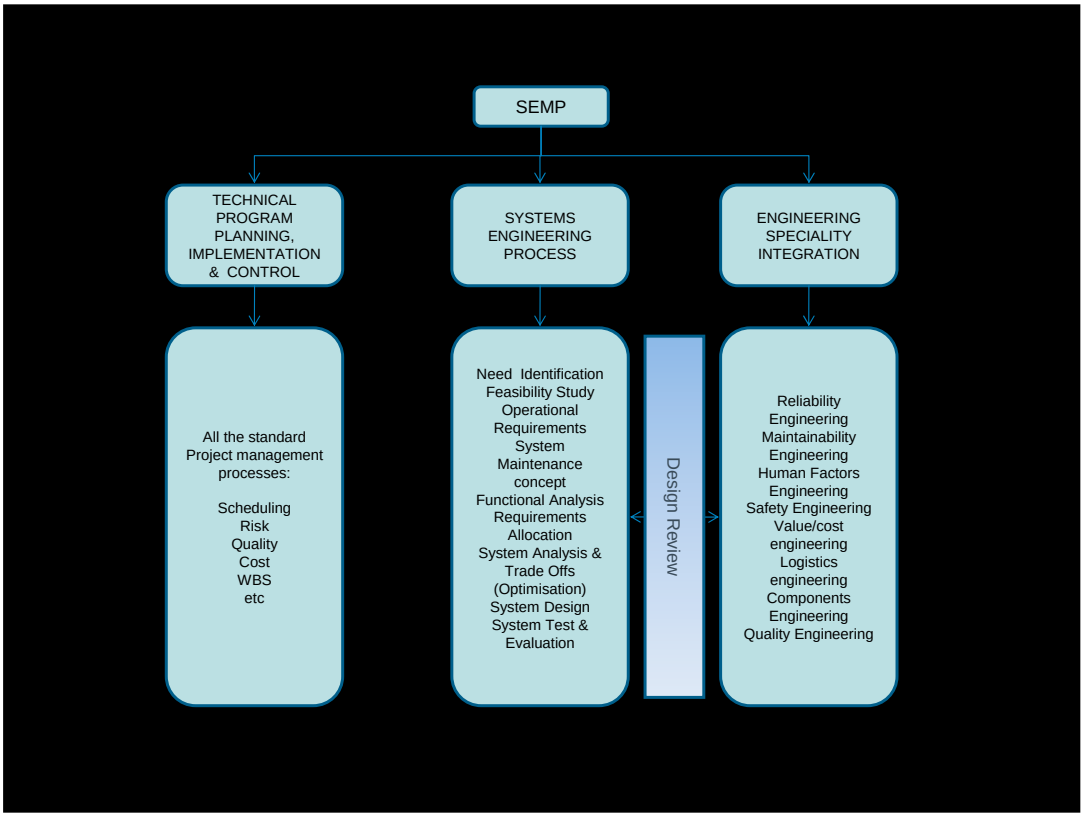
SEMP should include:

Sys Eng Process

Development Phasing

Life Cycle Integration




SEMP
TECHNICAL PROGRAM PLANNING, IMPLEMENTATION & CONTROL
SYSTEMS ENGINEERING PROCESS
ENGINEERING SPECIALITY INTEGRATION
All the standard Project management processes:
Scheduling
Risk
Quality
Cost
WBS
etc
Need Identification
Feasibility Study
Operational Requirements
System Maintenance concept
Functional Analysis
Requirements Allocation
System Analysis & Trade Offs (Optimisation)
System Design
System Test & Evaluation
Design Review
Reliability Engineering
Maintainability Engineering
Human Factors Engineering
Safety Engineering
Value/cost engineering
Logistics engineering
Components Engineering
Quality Engineering