

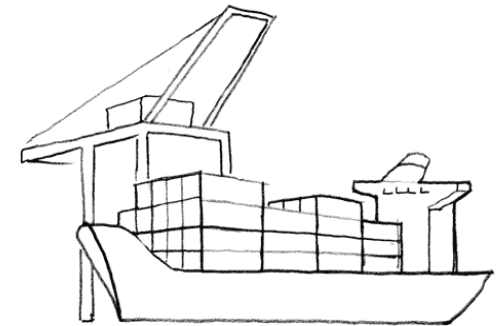
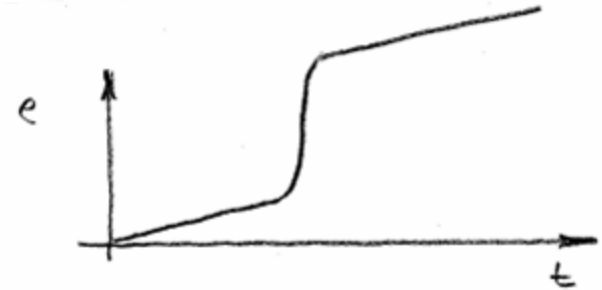


Transforming the Engineering Enterprise

By Scott Miller

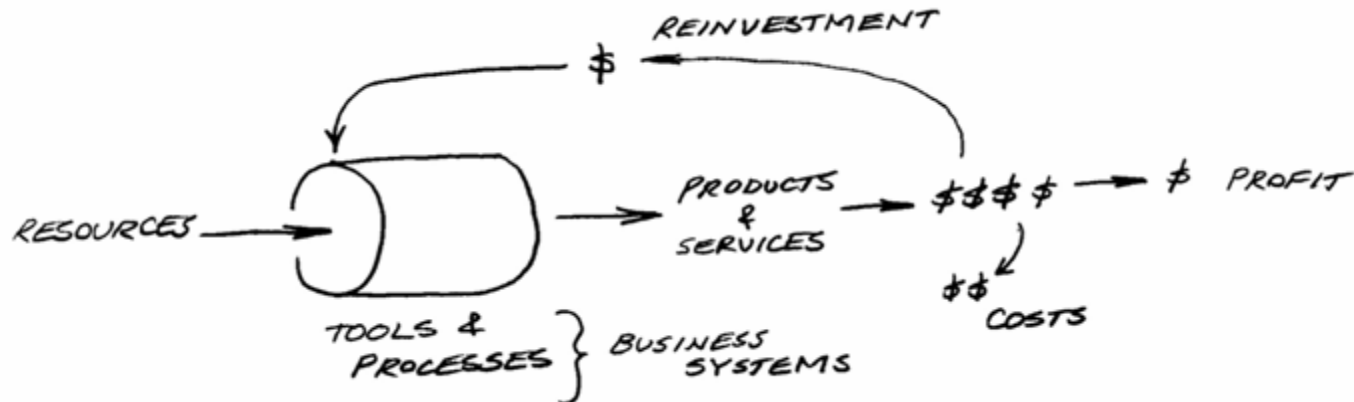
Discreet significant jump in efficiency

- Every company strives to get bigger or more efficient with time to grow returns for their shareholders
- Every now and then the technology advances that will significantly increase the efficiency of an industry.
- This is analogous to the shipping industry transformation.

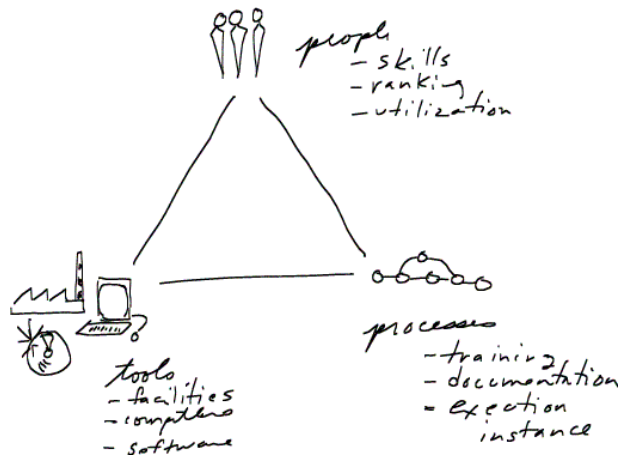


Business model

- The business model will allocate some moneys to reinvest into the business systems to improve this efficiency.
- This presentation is about providing the right information to the executive decision makers to manage this reinvestment allocation during the transforming period towards digital integration.

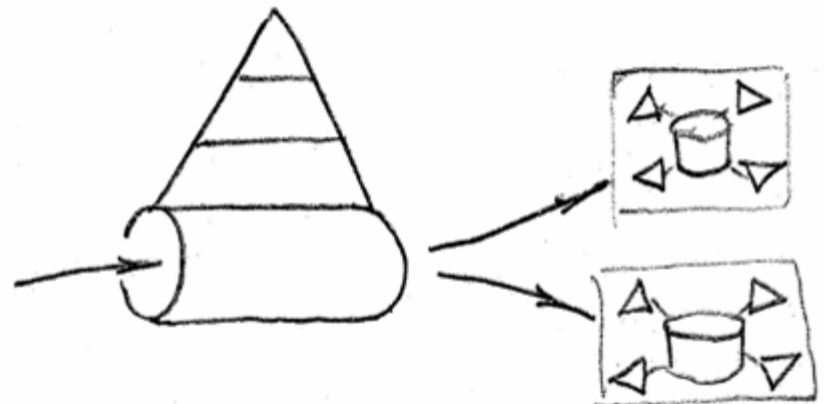


Business system as pipeline for products/services



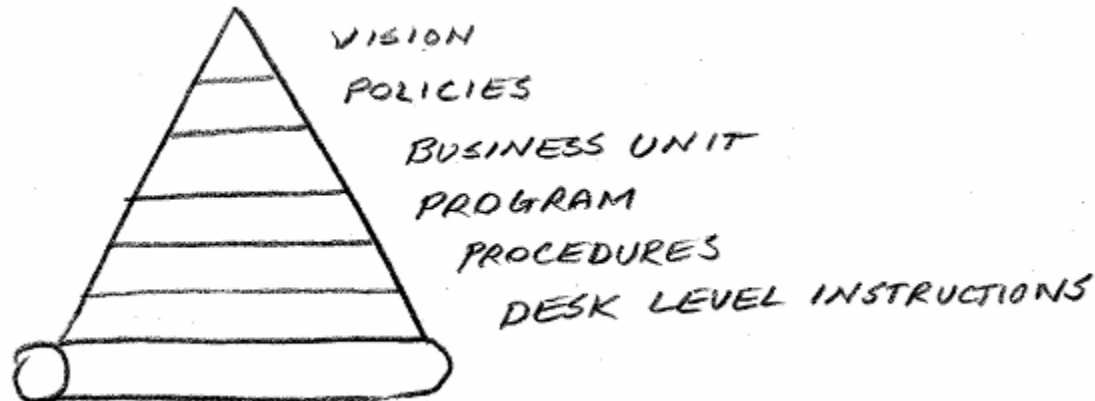
- The business systems are a collection of people, processes, and resources

- These business systems act as a pipeline to allow the development of products and services



Process structure

- The processes can be organized as a hierarchical collection of documentation
- This can be a structural arrangement of information
- We will draw a pipe underneath the triangle to refer to the process structure



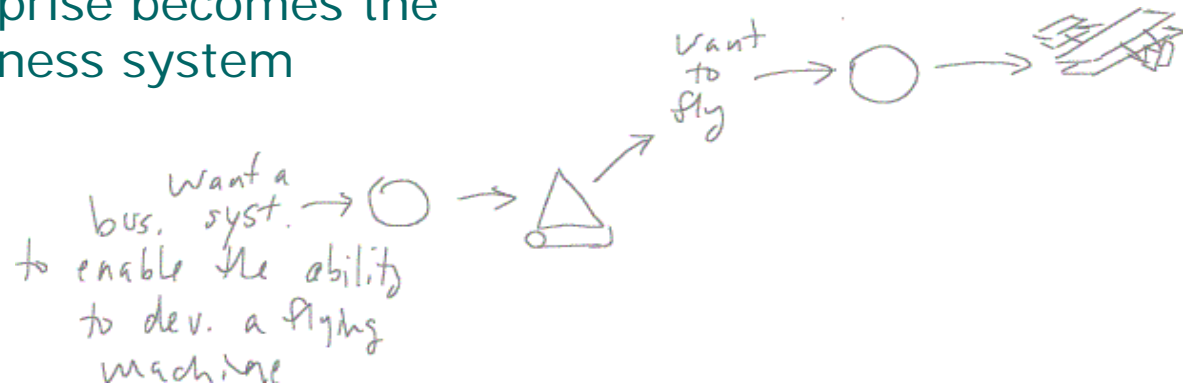
Need a business system to make a product



To convert customer wants into products or services for sale . . .

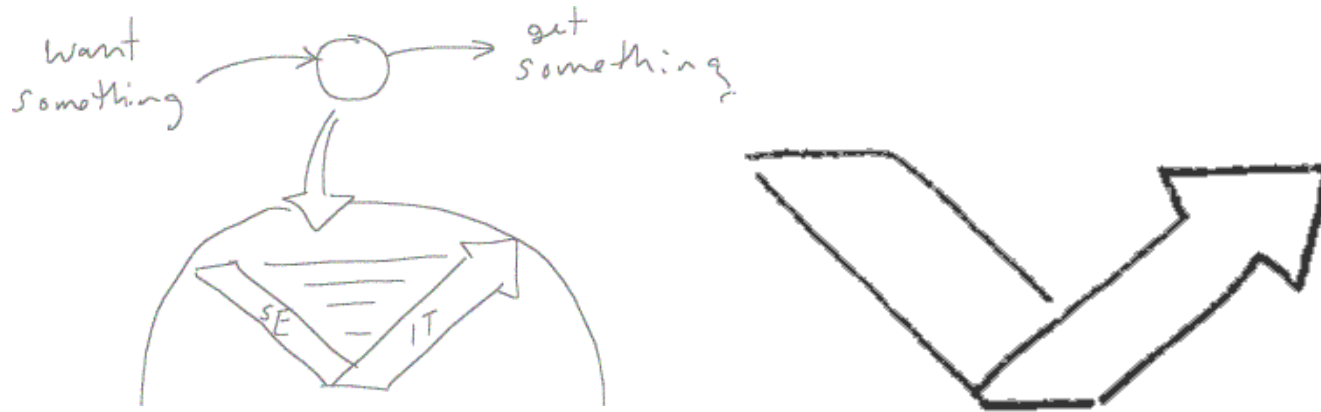
. . . we need a business system.

Therefore our enterprise becomes the customers of a business system developer.



Systems engineering process

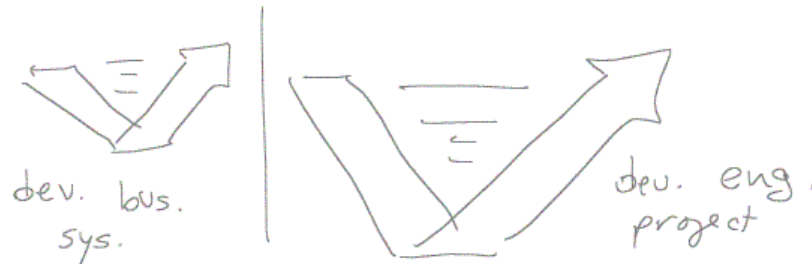
“Vee”



- The systems engineering process is the systematic development and decomposition downwards to lower levels of requirements on the front side and then production, integration, and verification back up on the back side.
- This works whether the system is for our customers products or services or for our own business systems.

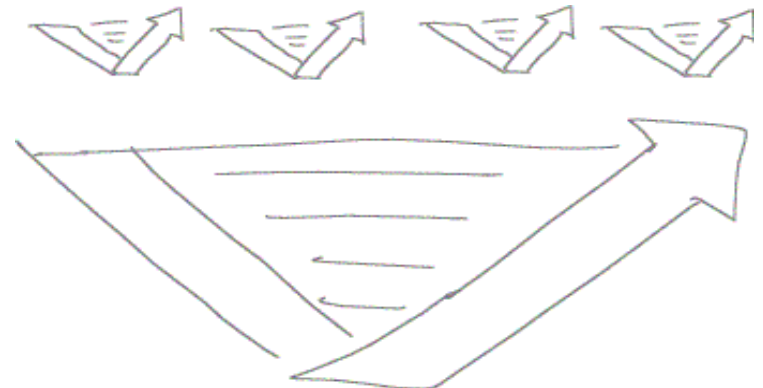
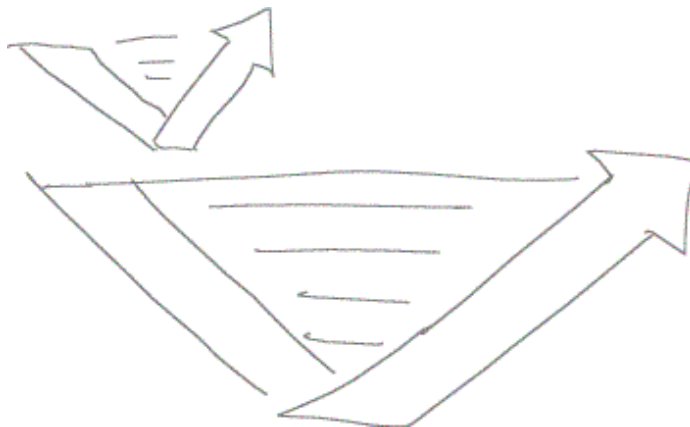
After all a business system is just a system.

When do we build our business system?



We can build our systems prior to the production of our engineering project.

Or we can build them at the start of the project, or during little subsequent development spirals.



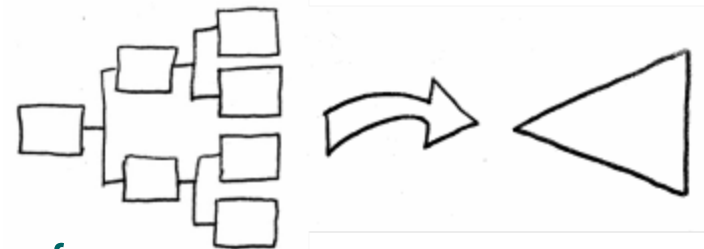
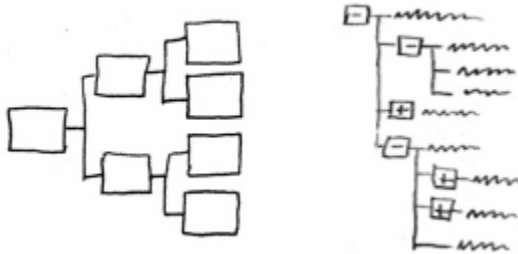
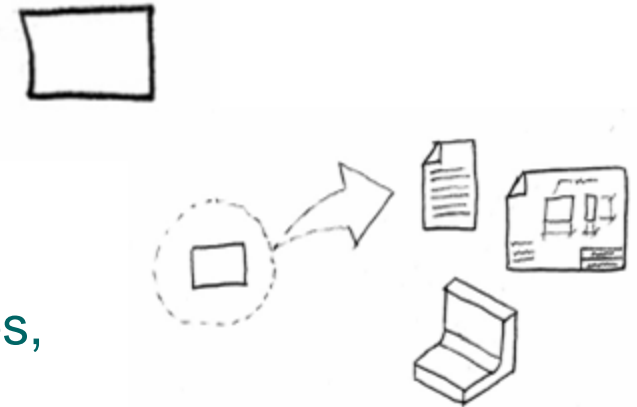


Transforming the Engineering Enterprise

Understanding digital information

Hierarchical data structures

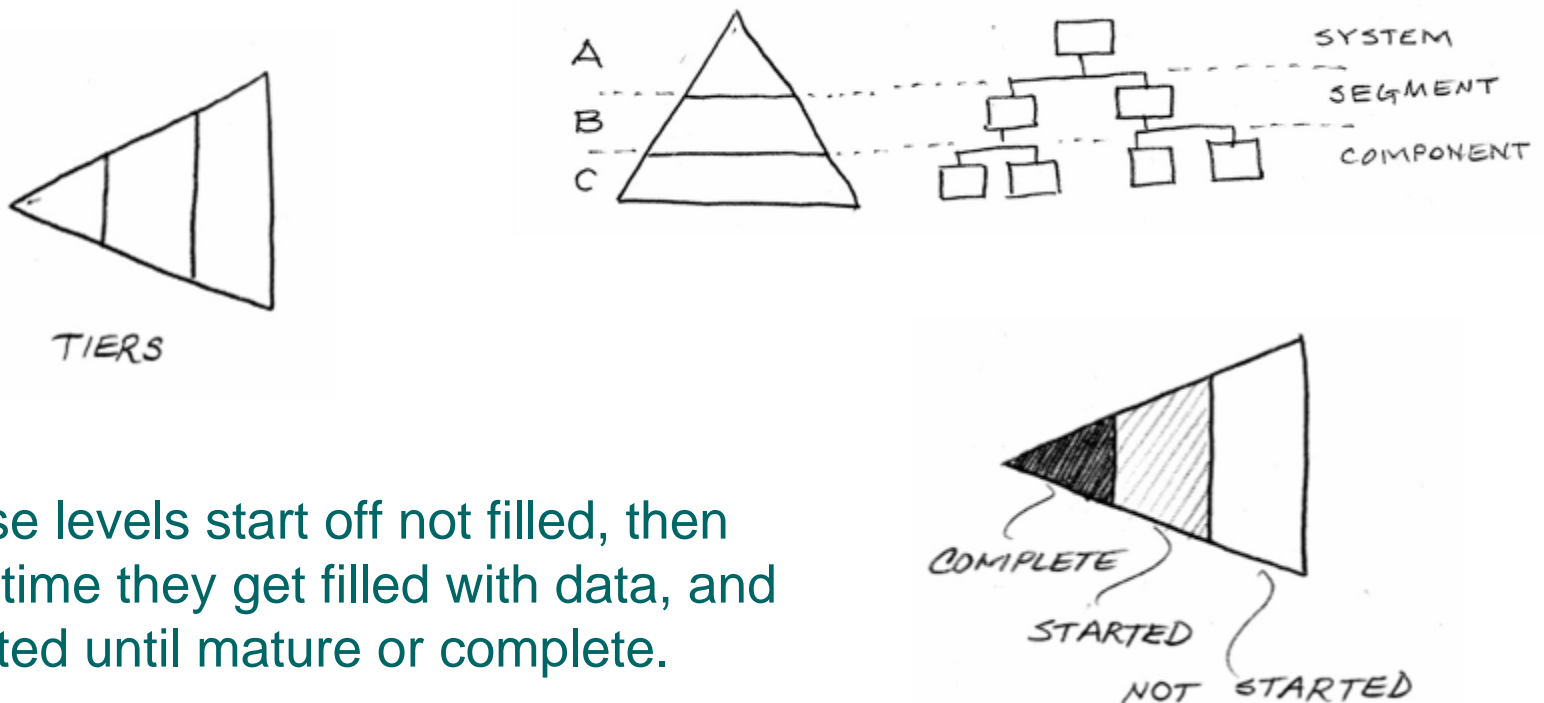
- Lets represent information as a square. It may take many data artifacts to represent a piece of information.
- Information organizes itself into structures, which are collections of like information



- Lets describe the particular configuration of this collection of information as a triangle

Tiers or levels in a structure

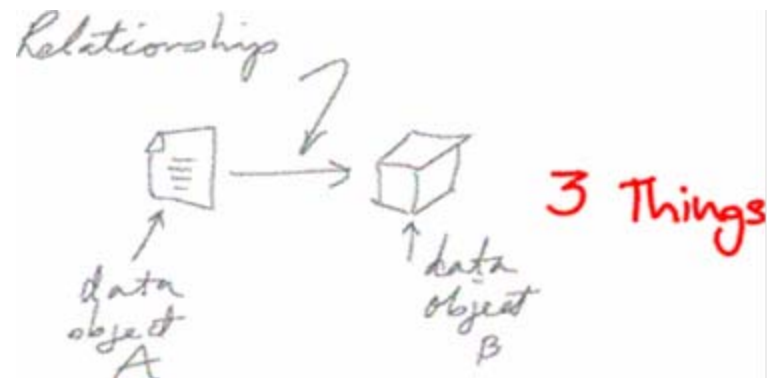
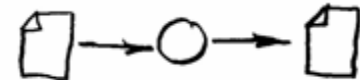
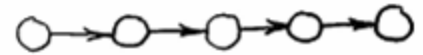
- As the project decomposes some data is required at each level of abstraction (requirements, engineering definition, etc.)



- These levels start off not filled, then with time they get filled with data, and iterated until mature or complete.

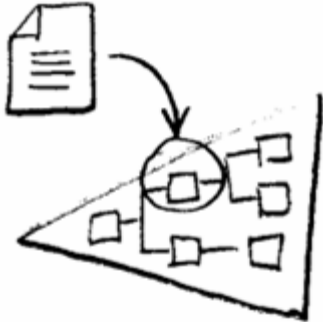
The new object, “Link”

- Process are a series of step to accomplish something.
- Each Step takes some inputs, adds some value, and creates some outputs. In this case digital information

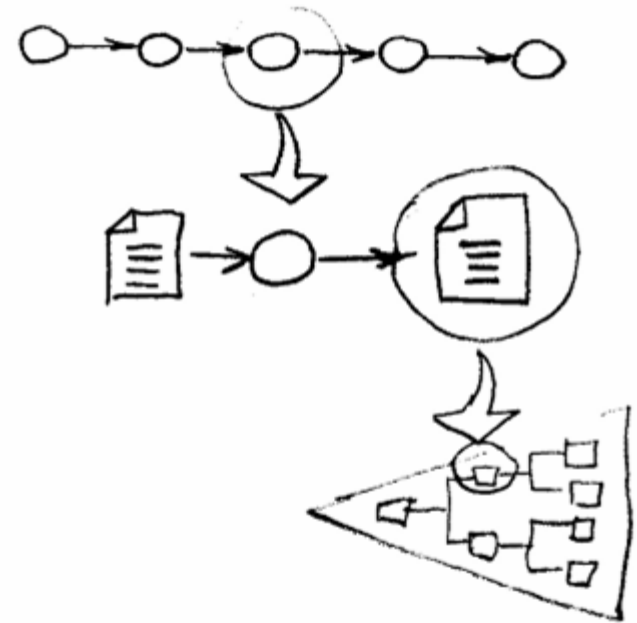


This link is the remembering of transfer of information.
It is what we mean by “digital integration”

Processes create data, fill structures



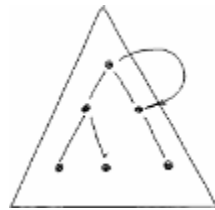
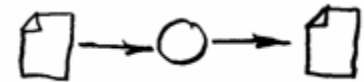
- Data elements are organized into the structures



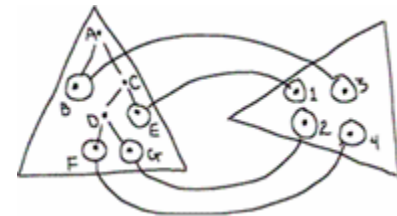
- Process steps create the data.
- Therefore these inputs and outputs are the data elements that are stored in databases and organized into data structures when presented for the purposes of communicating the information.

Data precedence

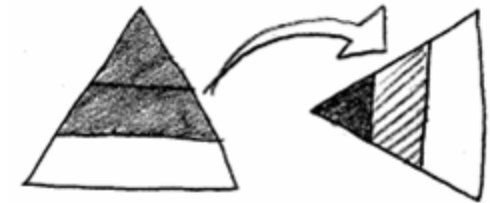
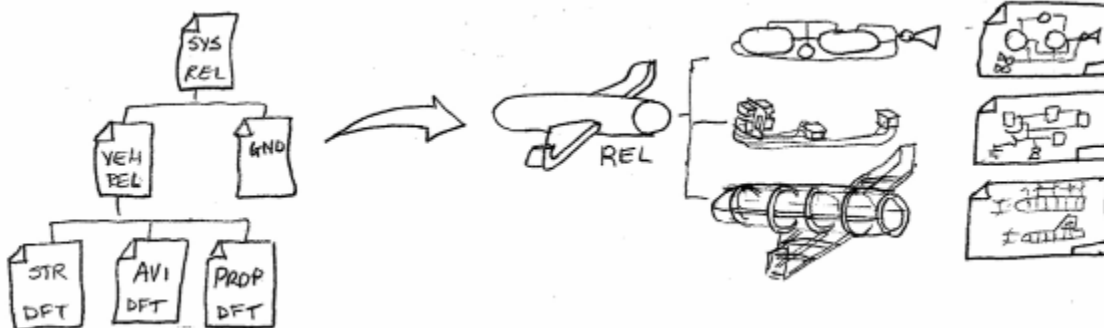
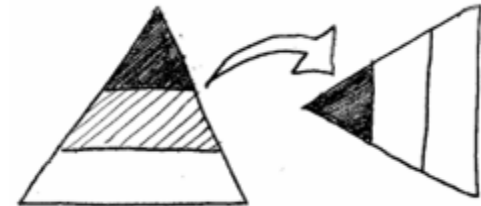
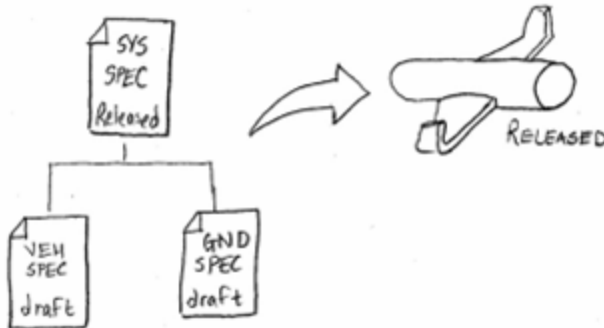
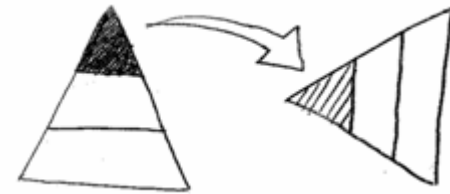
- Precedence is established by what data came first (input precedes output)



- The output can be of the same structure or another structure
- Or may even represent a more complex relationships.

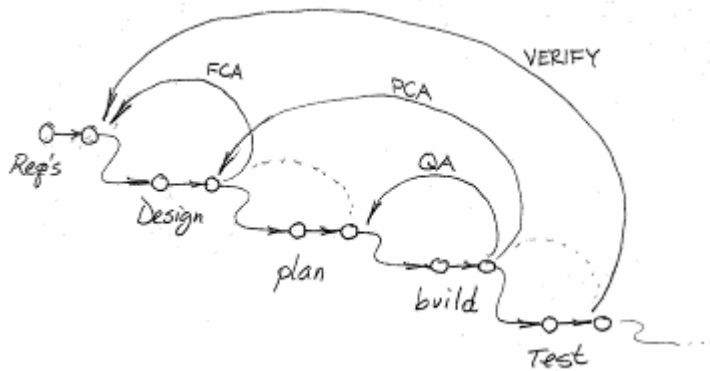
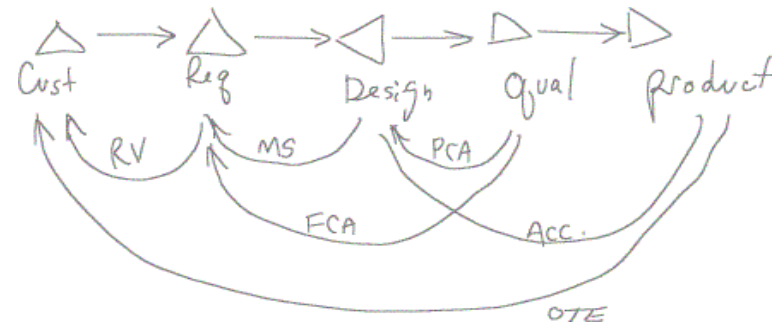


Example of data precedence



Project thread evolution

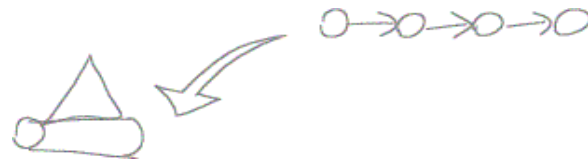
- The data output is the input for the next step in the evolution of the project.



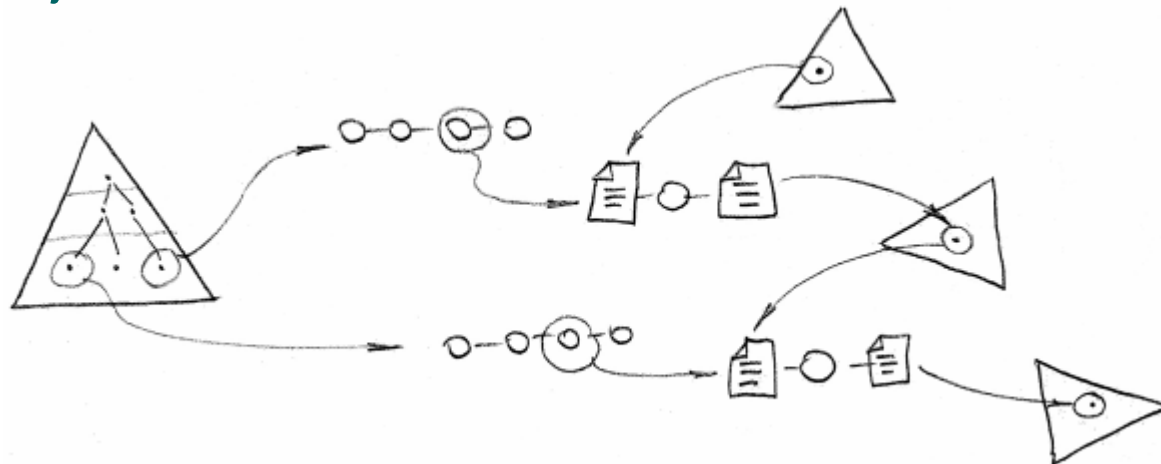
- The verification process is making sure that each of the previous steps was conducted successfully.

Document the process in the process structure

- All the processes can be documented into a data structure.



- These processes describe the steps to create all the project defining information stored in subsequent project data structures.

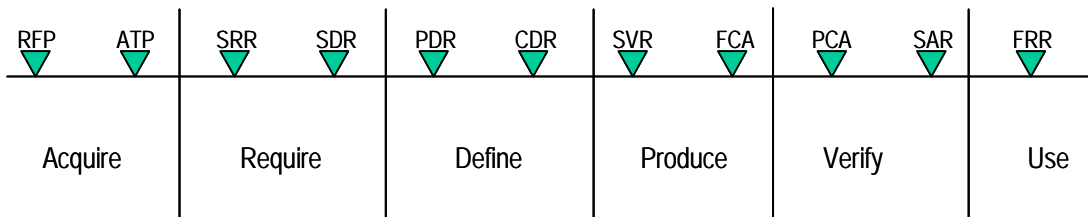


Life cycle of a project

DoD 5000 Acquisition	Concept Refinement		Technology Development	System Development & Demonstration (SDD)			Production & Deployment			Operations & Support	
				System Integration		System Demonstration	Low-Rate Initial Production	Full-Rate Production & Deployment		Sustainment / Disposal	
IEEE	System Definition				Subsystem Definition			Production		Customer Support	
					Preliminary Design	Detailed Design	Fabrication, Assembly, Integration & Test				
DoD	Mission Needs Determination		Concept Exploration	Program Definition & Risk Reduction		Engineering & Manufacturing Development			Production, Deployment & Operational Support		
NASA	Mission Feasibility	Mission Definition	System Definition		Preliminary Design	Final Design	Fabrication & Integration		Prep for Deploy	Deploy & Ops Verif	Mission Operations

IEEE		ACR		SDR	PDR	DDR	TRR	PAR			
DoD		ASR	SRR	SDR/SFR	PDR	CDR	TRR/SVR	PRR			
NASA	MCR	MDR	SRR	SDR	PDR	CDR	FQR	SAR	FRR	ORR	DR

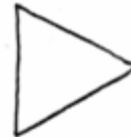
- Many organizations define the engineering projects lifecycle
- For our purposes of defining simple graphics to illustrate points we will use a simple concept of the engineering lifecycle.



Acquire → Require → Define → Produce → Verify → Use

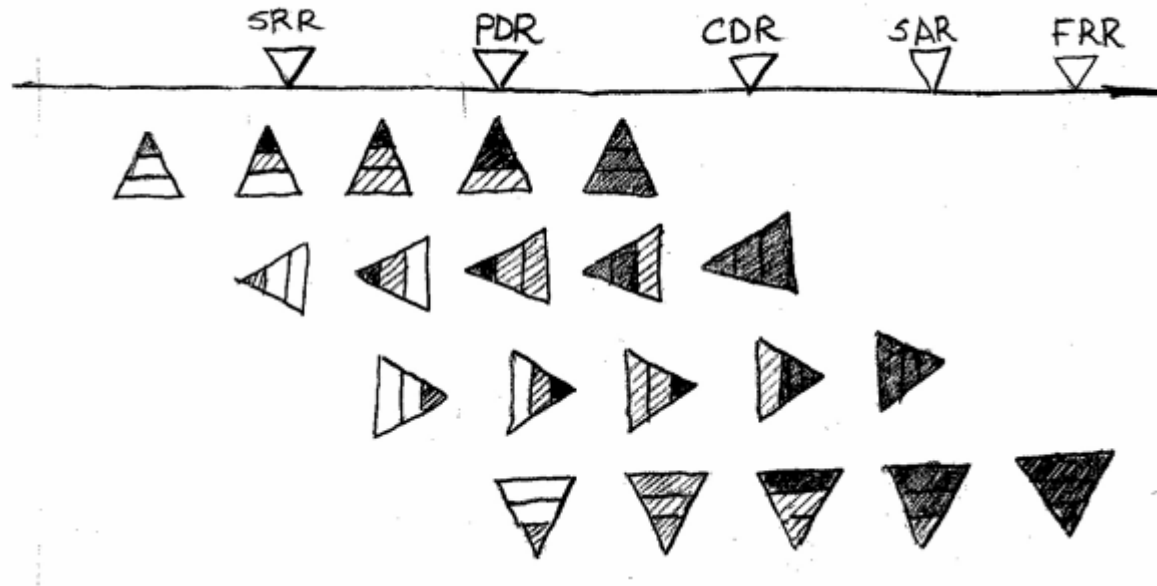
Types of data structures

Acquire → Require → Define → Produce → Verify → Use



Trades Requirements Specialty Engineering Analysis Verification Architectures Models	Simulation, Visualization Layouts Concept Configurations Configuration Analysis Detailed Analysis Production Detailed Design Definition	Build Plan Production Planning Purchase Orders Shop Instructions Tool designs/NC tool paths/Assembly Simulations/Jigs/ Fixtures	Quality Inspections Component Tests Qualification/Ac ceptance Tests Tests/Analysis/In spections/Demon strations Systems Tests
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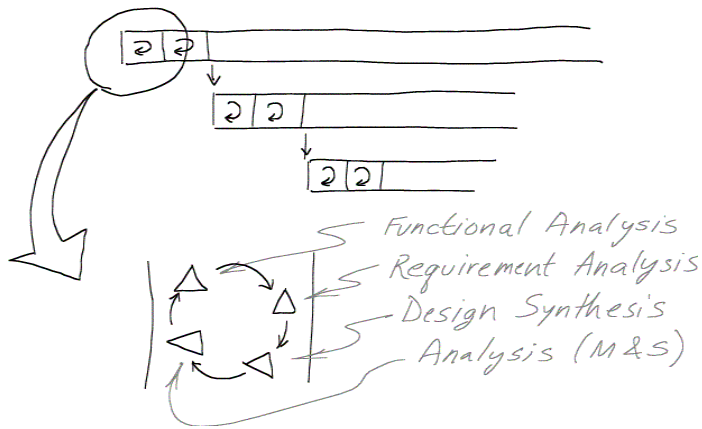
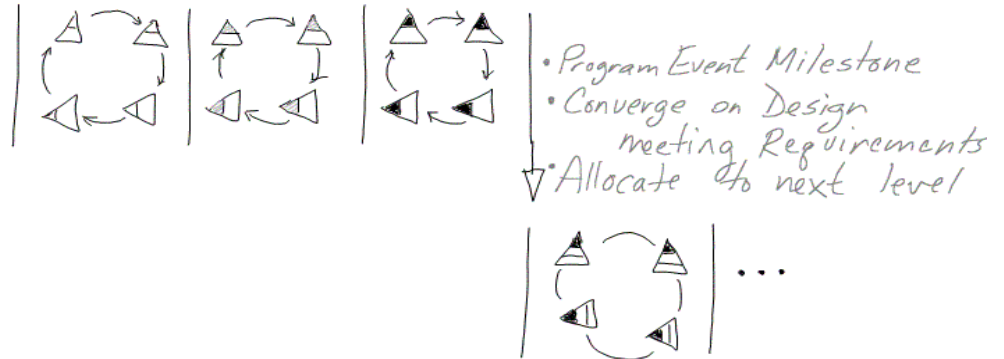
Sequential data development throughout lifecycle



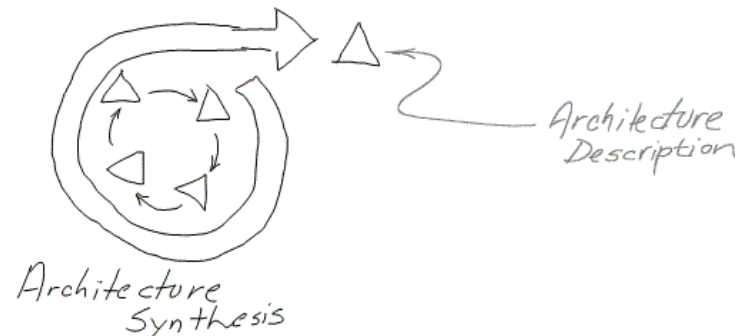
- The Lifecycle of the project can be viewed as a collection of data structures whose data files are stored in databases and start off empty and get filled up and iterated until complete as the project progresses.

Levels of abstraction

- Functions, Requirements, Design Concepts, and Analysis data are all synthesized together

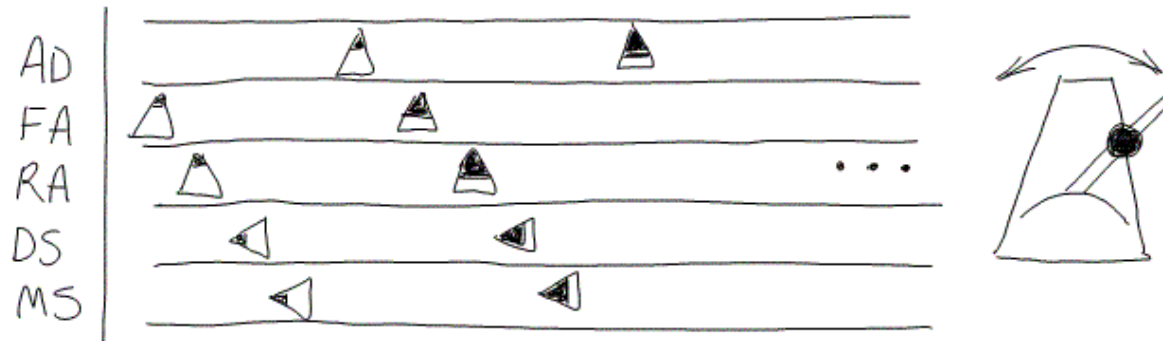


- The system concept at that level of abstraction converges (i.e. analysis shows that the concept meets its requirements). It can then be decomposed to lower levels

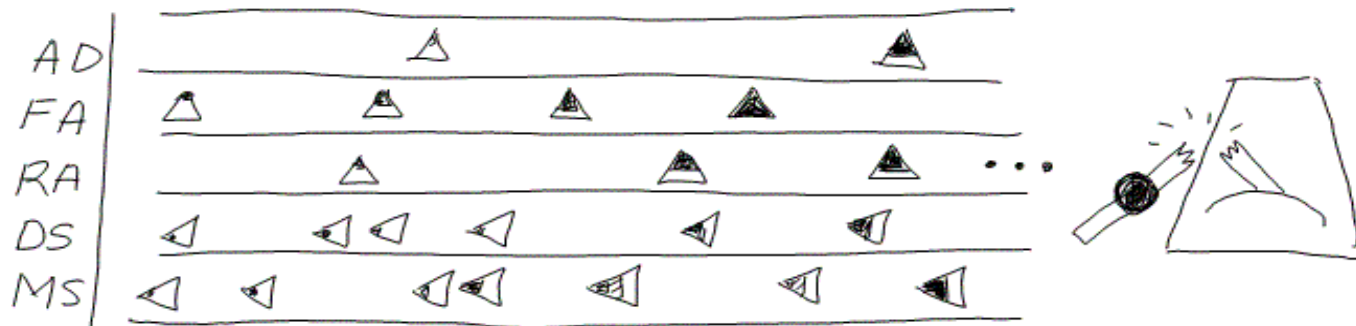


- The system can be described by its architectural diagrams.

Synchronized development

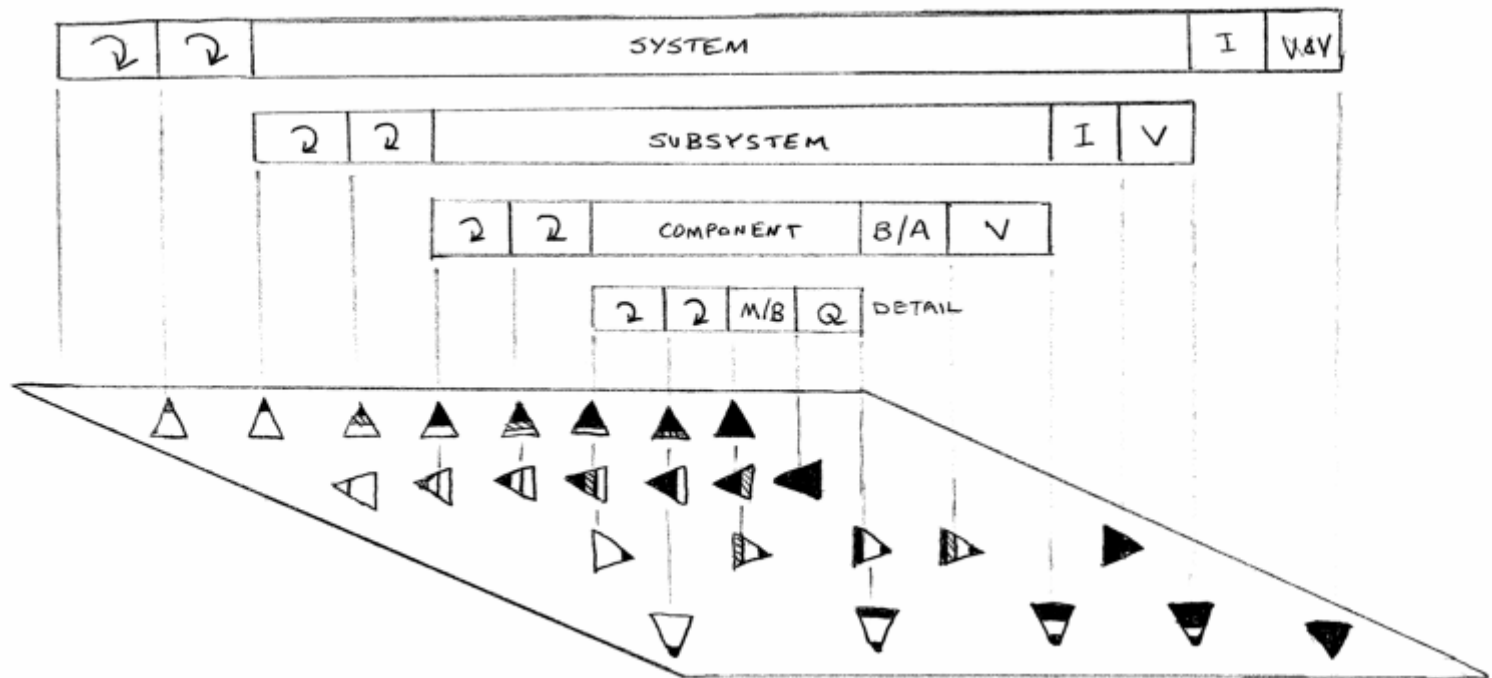


- The systems engineering management should coordinate the teams development.

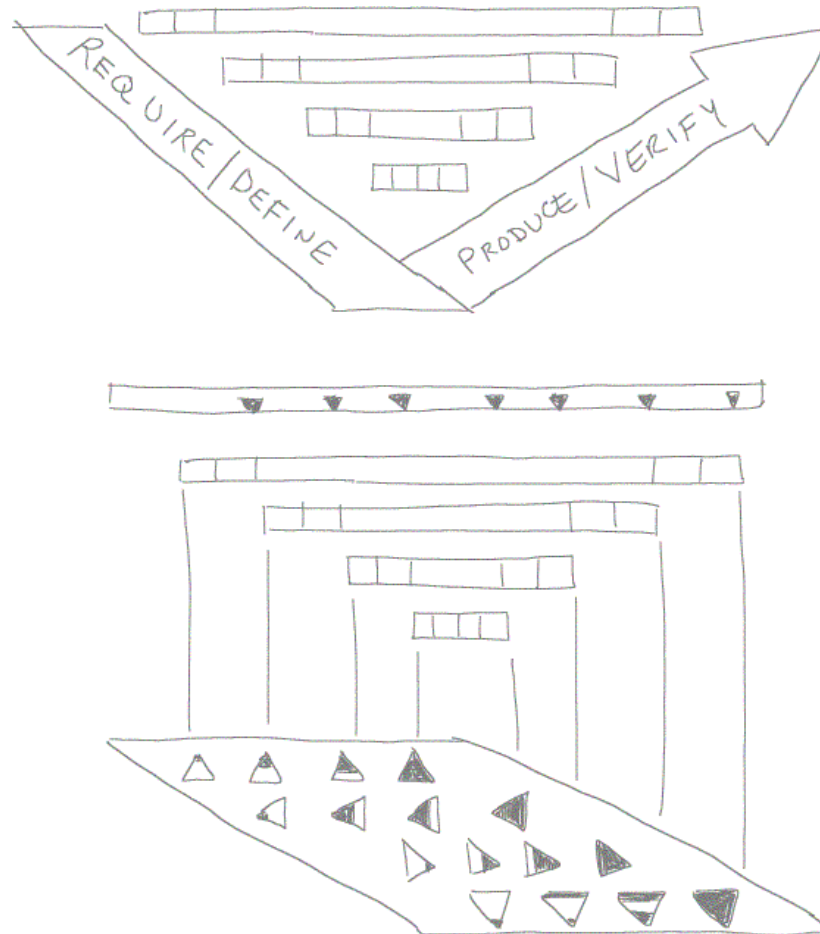


- If they do not, well . . . need I say more?

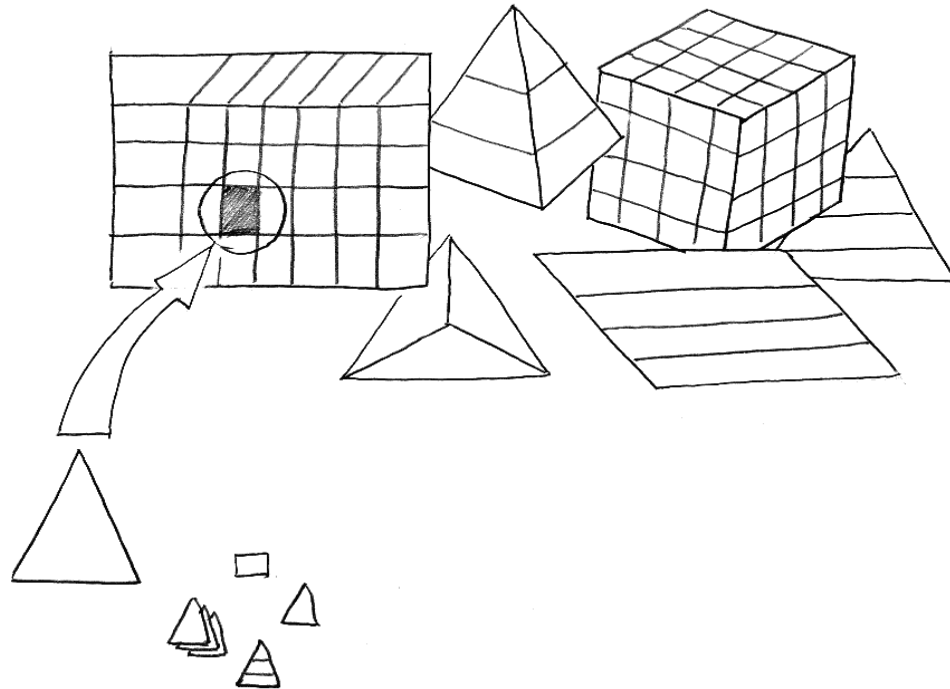
Map the SE Vee with the data structure view of the project



Mapping the process view to the data view



Data structures defined in the architecture framework



- Regardless of the architecture framework the describing data is comprised of these configurations of information stored in databases and organized into structures.

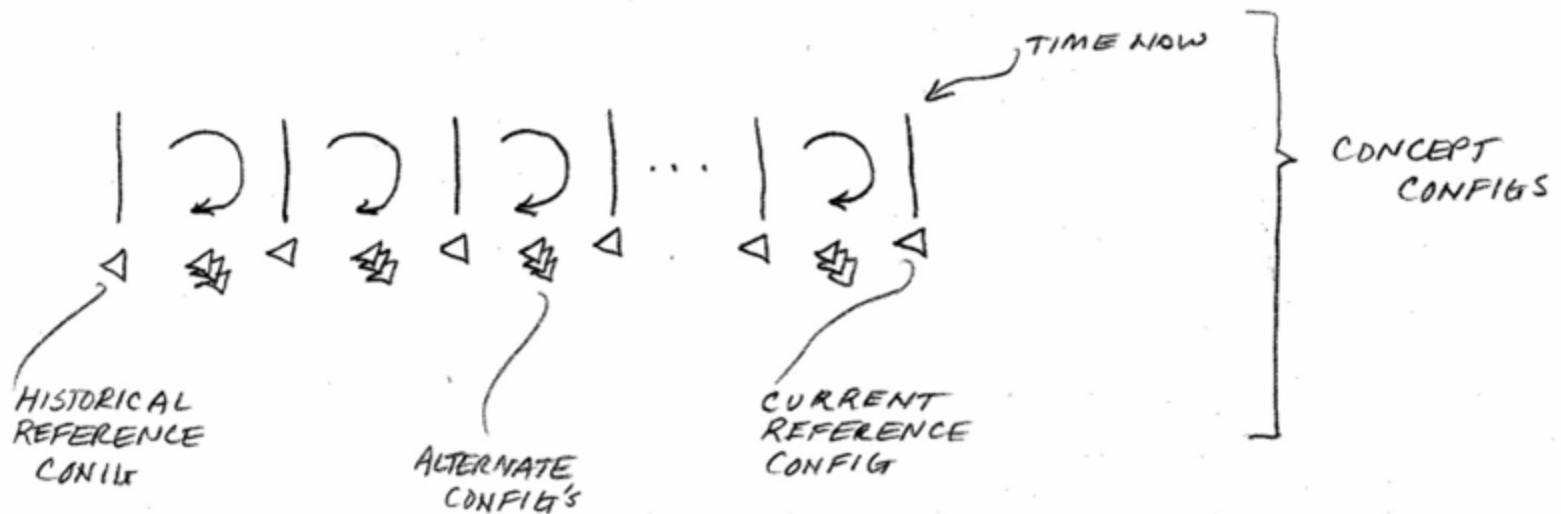


Transforming the Engineering Enterprise

Aspects of Managing Configuration of Data Structures

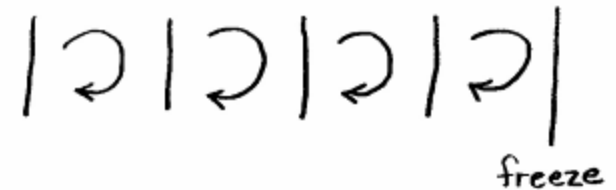
Concept cyclical development

- Design cycles start with the establishment of the design concept, whose definition will remain unchanged as a reference configuration.
- Over time the definition will mature and will be compared to alternate configurations.

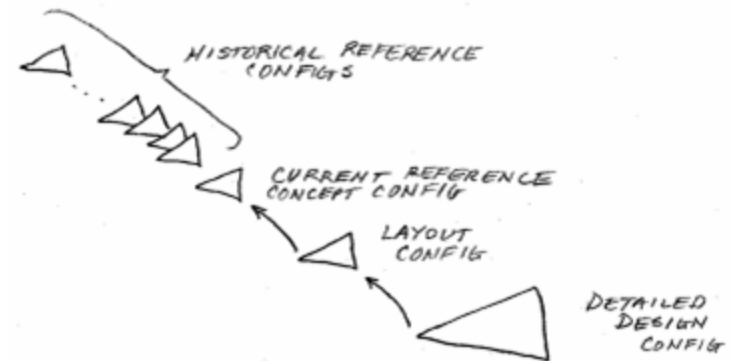
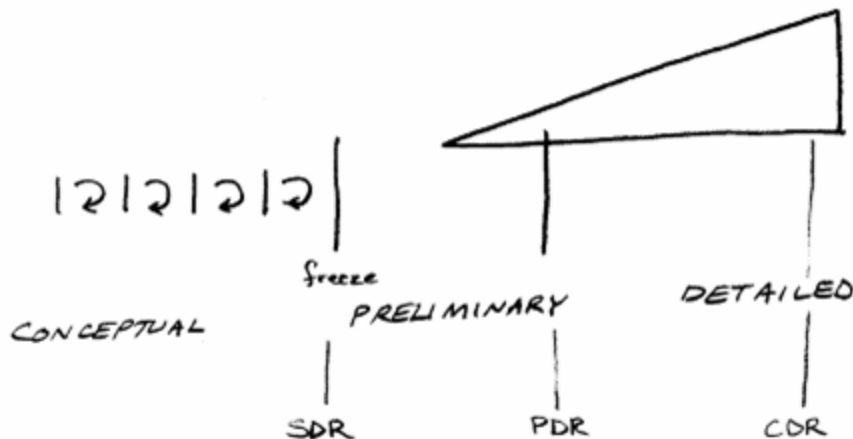


Phase of a structure

- The design will iterate until the concept definition is frozen.



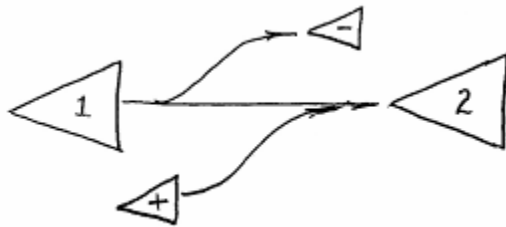
- The frozen design concept ends the conceptual design phase.
- That configuration feeds the preliminary design phase where sufficient definition is defined . . .
- . . .in order to generate a detailed plan to hold the team accountable to during the detailed design phase.



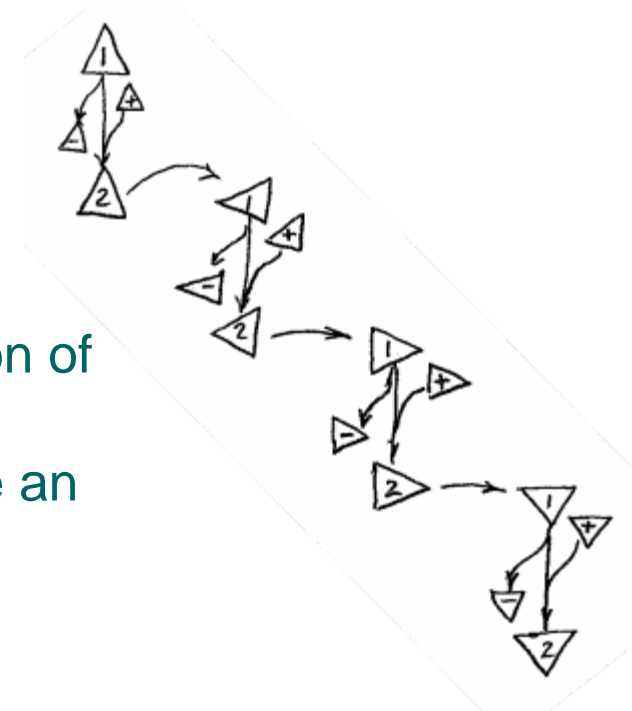
- Each configuration is unique and independent.

Object of configuration

- Digital information can be saved overwriting the original.
- If you only want to know the current state, however if you want to remember how it was 'when' then you will need to do more than just save and overwrite the digital file.
- This desire to remember 'how' 'when' is the definition of information as an object of configuration.



- Any change in the configuration can be collection of adds and deletes.
- Any change in the enterprise will potential ripple an impact throughout the entire project.

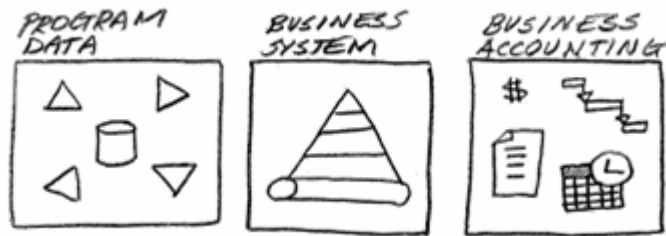




Transforming the Engineering Enterprise

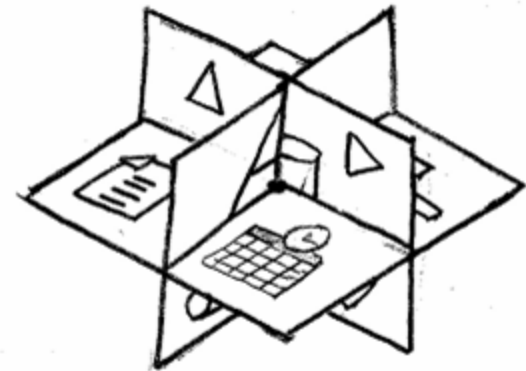
The Digitally Integrated Vision

Independent planes of information

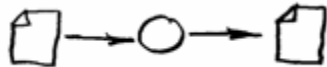


- Program Data defines the project or product.
- The Business System contains the process instructions used to develop the data above
- The business accounting plane describes how efficient those processes were executed.

- The enterprise info sphere can be viewed as three independent planes of related information.
- Any piece of information can be traced into any of these three planes.



Data reads and writes

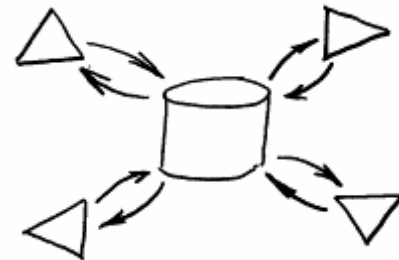


- Process steps take input data and generate new data

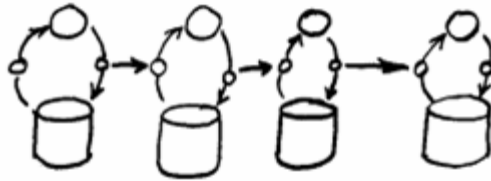
- This data is stored in databases
- The data is organized into structures.



- So the enterprise business systems are a collection of reading and writing this data

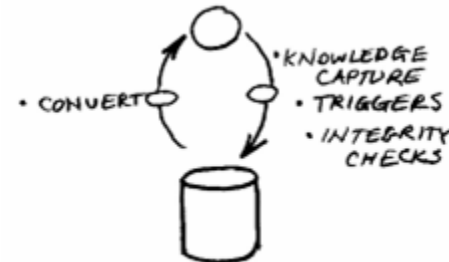


Improve the reads and writes



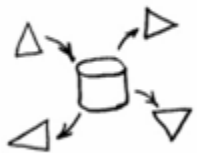
- A process is a collection of these reads and writes

- Reads and writes can improve the efficiency of the process by automating steps
- Auto data conversion
- Knowledge capture
- Trigger work flows
- Integrity checks . . .



Incremental improvement plan

1. Centralized database write the data-sphere. Other processes read from the common data-sphere
2. More and more processes include their data into the enterprise solution until everyone reads and writes their data from the data-sphere.
3. Knowledge capture, workflow triggers, integrity checks are incorporated into the reads and writes
4. As the data is integrated, an initial changes can be automatically propagated.
5. Future integrated environments will automatically propagate any change in the enterprise.



1.



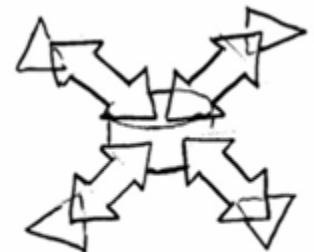
2.



3.

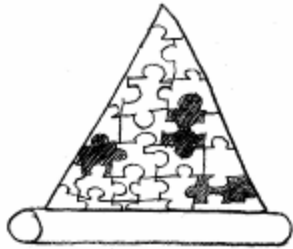


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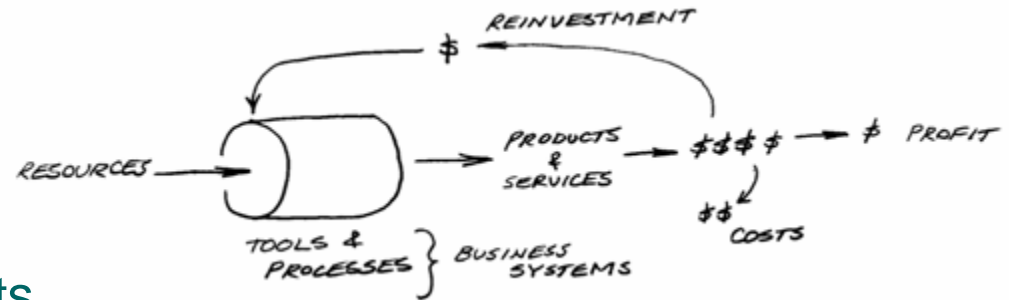


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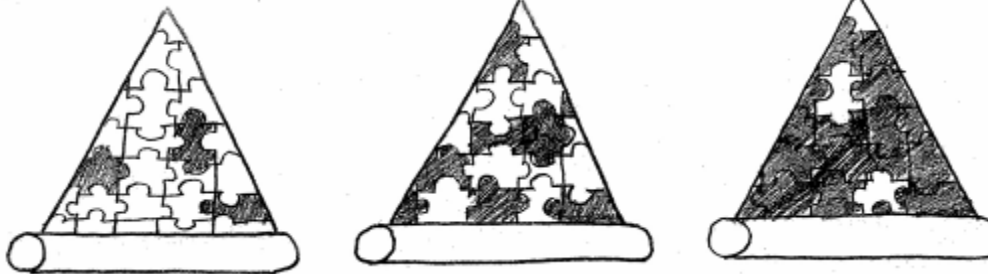
Allocate limited resources



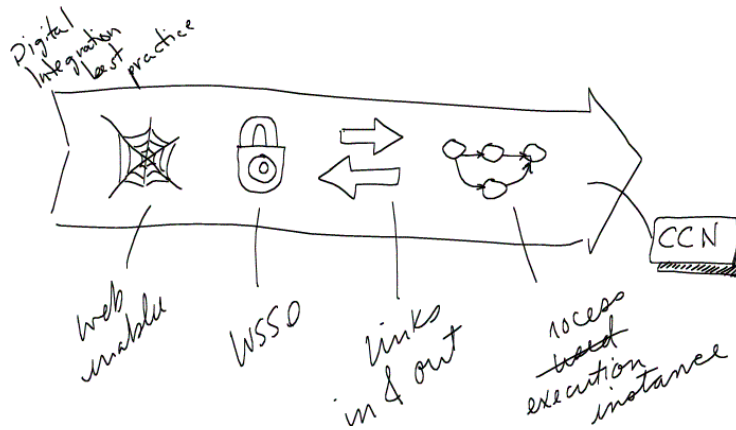
- Each process is like a piece of the puzzle



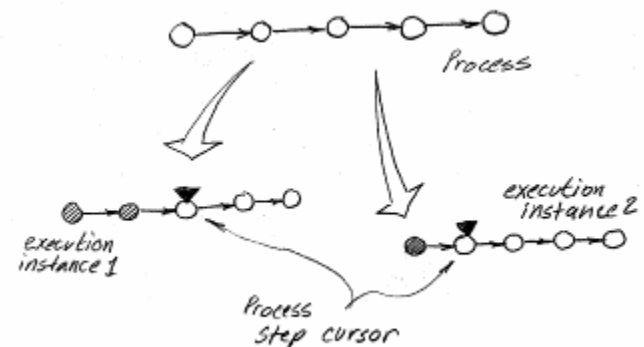
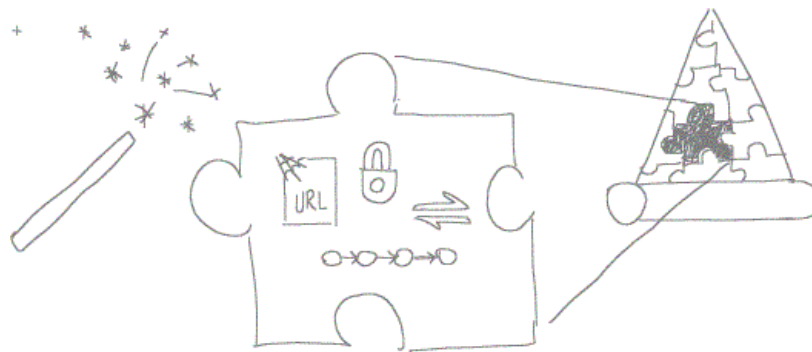
- Slowly each piece will have its process modified improvements and to implement the concepts digital integration.



The elements of the digitally integrated info sphere

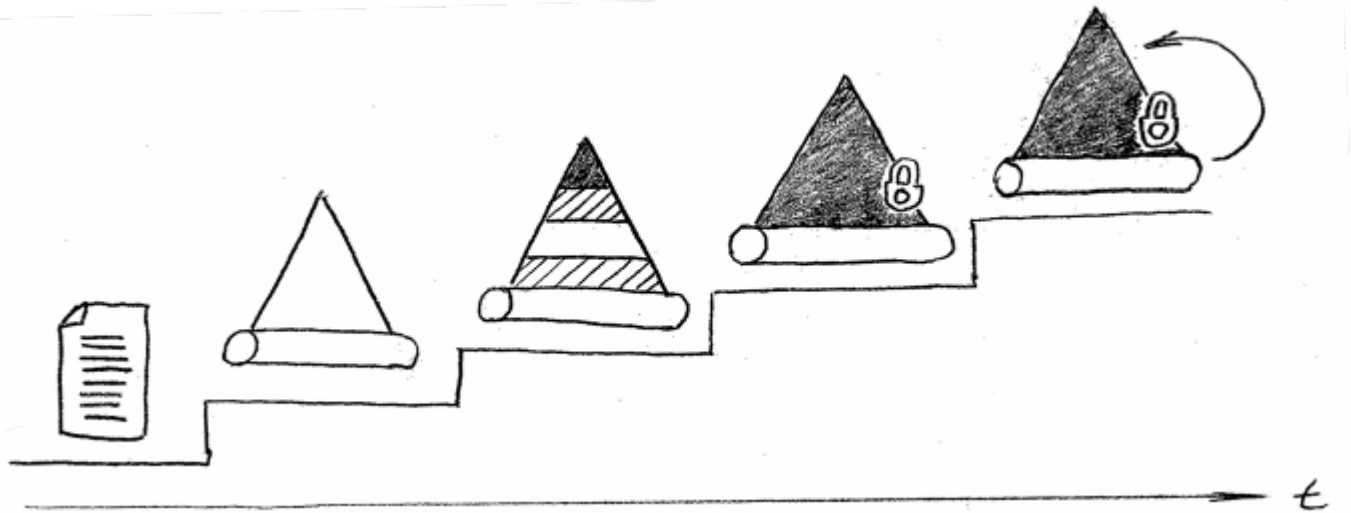


- Web enabled
- Common authentication schema
- Each data contains the links in and out
- Contains a link to the process execution instance.



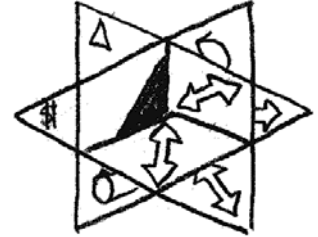
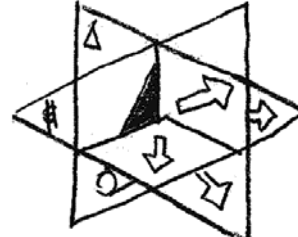
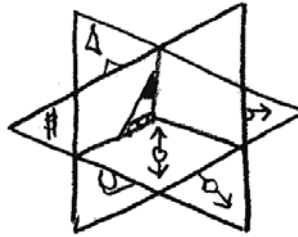
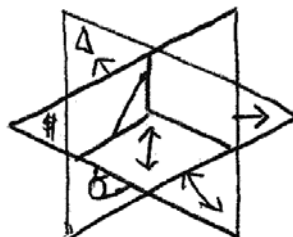
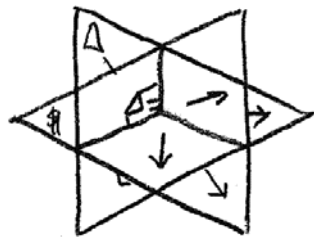
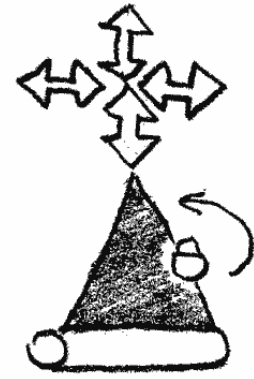
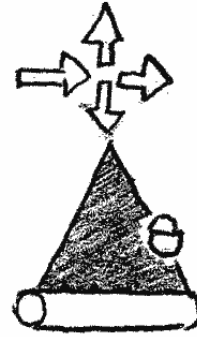
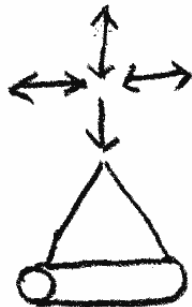
- The vision plan calls for each process to get to a certain level of digital integration.

Process plane plan



- Document the process.
- Have their documented process available to be link to the data it creates.
- Bring all the processes up to the current level of digital integration.
- Lock the configuration down.
- Continuously improve the system by modifying the processes.

The vision plan





Transforming the Engineering Enterprise

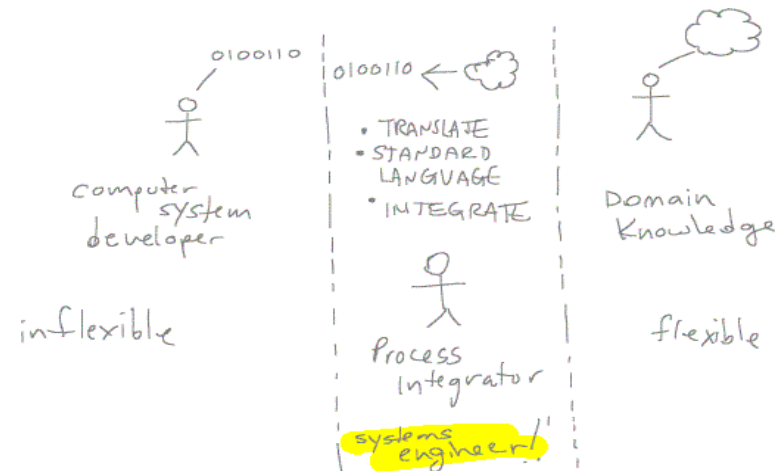
Developing the business systems

Engineer the business system



- Business systems IT development requires a system engineer to translate the domain requirements such that they can be implemented.

- Business systems are systems so their development uses the same systems engineering “Vee”.



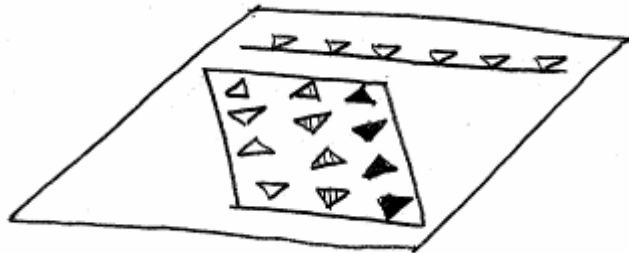
Know the business system

- To know which elements to be vying for the redevelopment dollars in order to upgrade our systems to implement our digitally integrated vision . . .



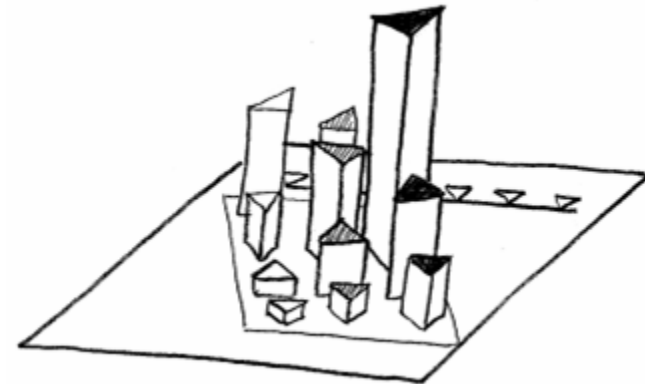
- . . . the entire enterprise must be known and documented. Priority can then be ascertained to use only the discretionary money that fits within the companies business model.

Big stones first



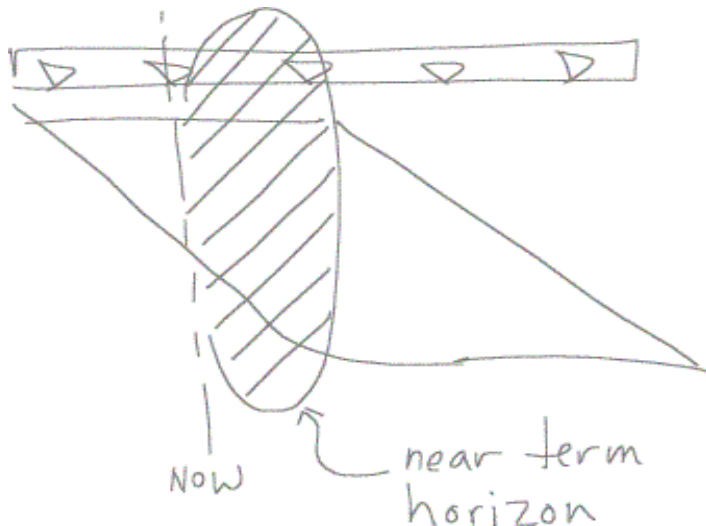
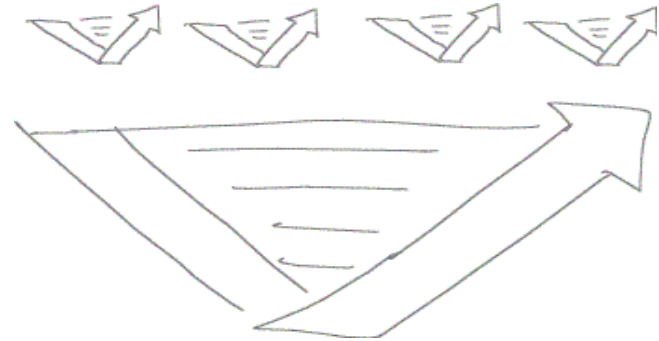
- Imagine the data view laid on the side. Now project the costs associated with creating that data into the third dimension . . .

. . . priority is given to those process and associated tools/rules/databases and applications that consume the largest resource expenditure.



Priority for simultaneous development.

- For the sequential development during the projects execution . . .



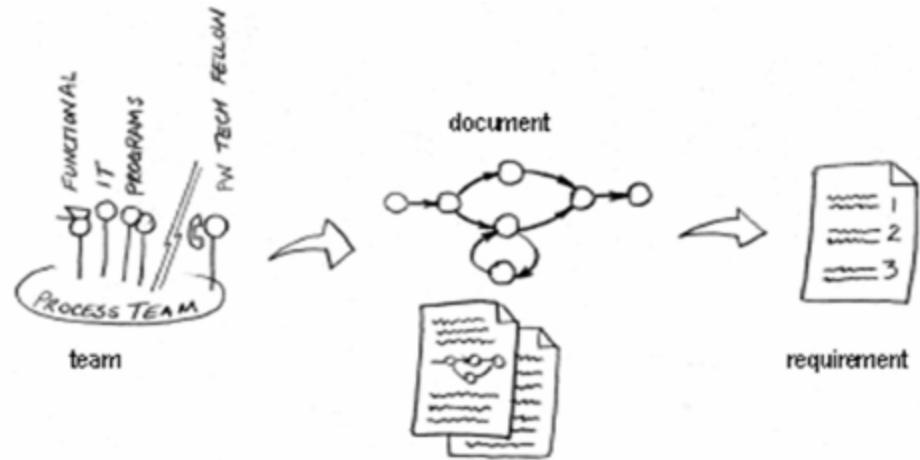
- . . . priority is given to those processes that will be used in the very near term.

Establish the requirements



- Establish all relevant stakeholders.
- Document the business process.
- Establish the requirements for the future system.

- Prioritize these requirements into what will be done now versus in later development cycles.
- Fix existing problems.
- Current sequential steps of the Vision based improvements
- Criteria base improvements



Develop the system



- Now the development team can create a plan and can begin implementing the solution.

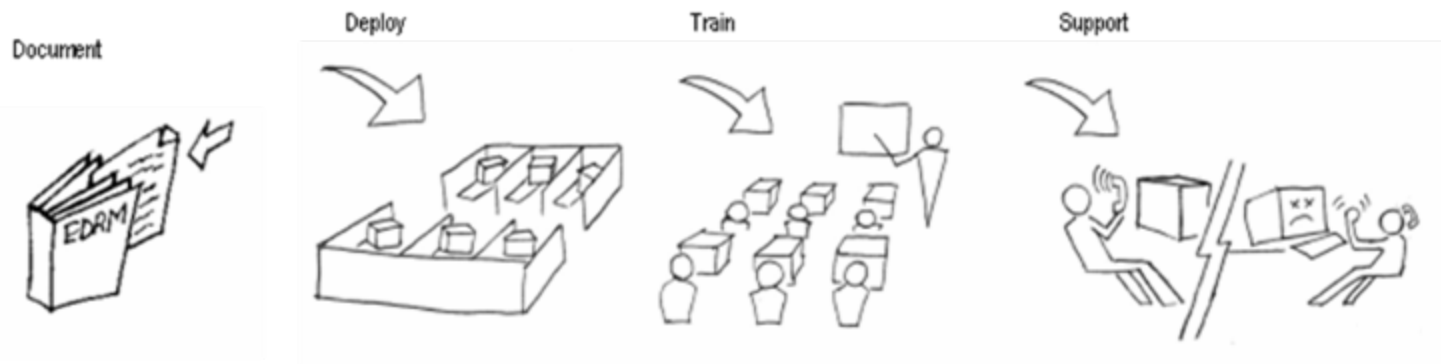


- The relevant domain team can verify that the solution meets the desired intent. Issues that cannot be resolved can be elevated up the management chain for executive resolution.

Deploy the solution



- The business system is not ready for production until the documentation has been updated.
- The solution is deployed.
- The staff has been trained and . .
- A sufficiently funded support infrastructure is in place.

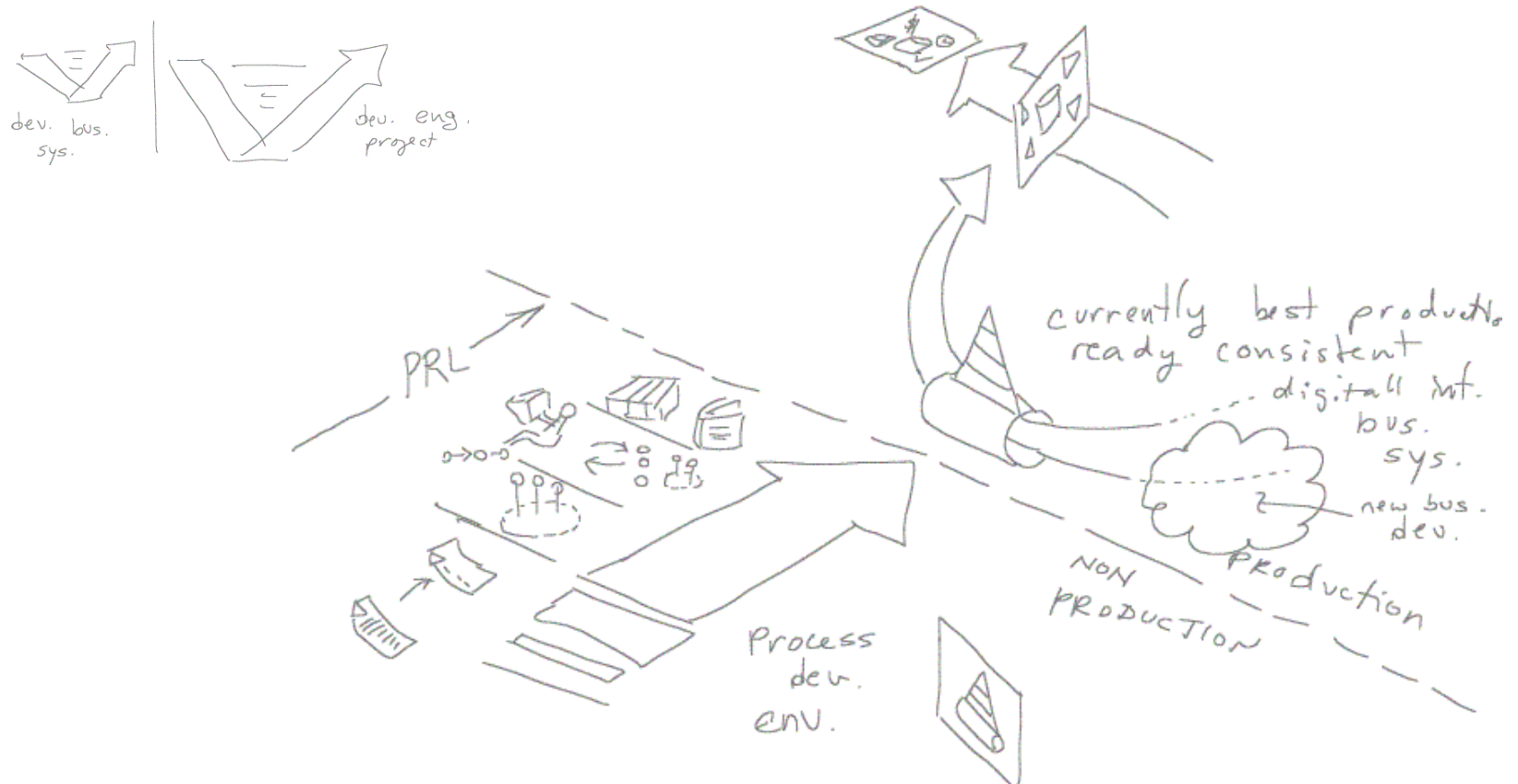




Transforming the Engineering Enterprise

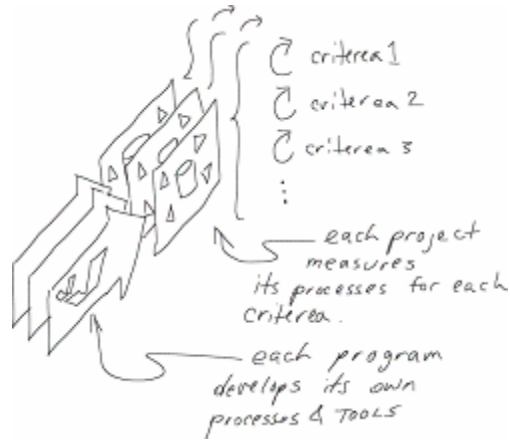
Bringing it all together

Offline maturing of the business system elements

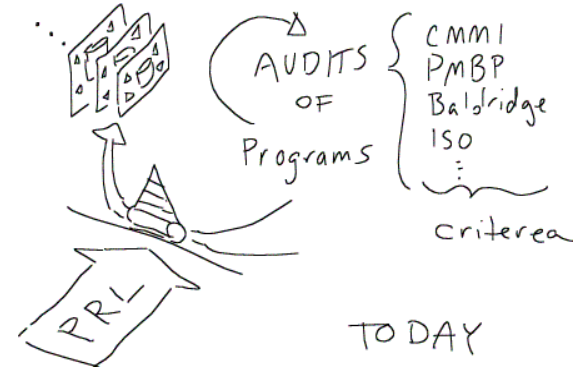


- We can now bring it all together as the enterprise develops and improves the business system.

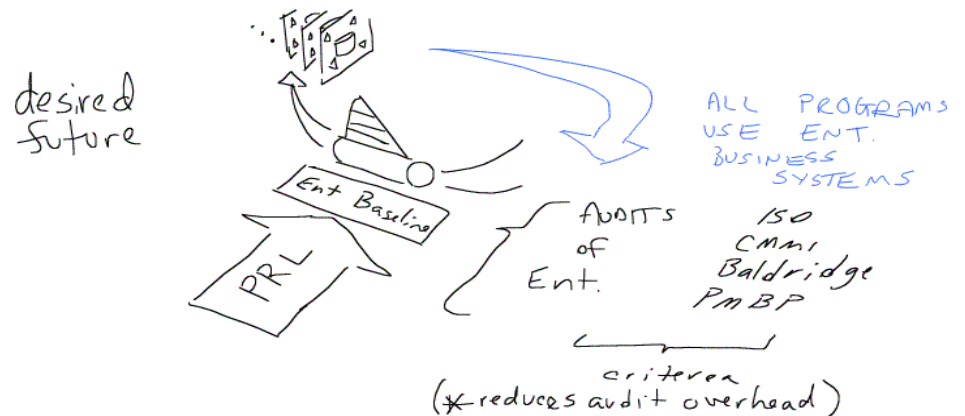
Criteria based efficiency audits



- Today's enterprises judge their efficiency against several criteria using audits.



- To minimize the cost impacts of these criteria based audit evaluations an enterprise can combine them into a single audit against the full enterprise.



The Managed Enterprise

The enterprise measures itself against the full set of criteria

New projects take the current best executing system

Process Readiness Level (includes the necessary tools to support)

Prioritize where to allocate improvement dollars

Must have a vision of where the enterprise is going

All changes view for the discretionary redevelopment dollars

