Interoperability of the Human View and IMPRINT Modeling

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Task Order 124: Task 7 - Human View and IMPRINT Interoperability

Project Objectives

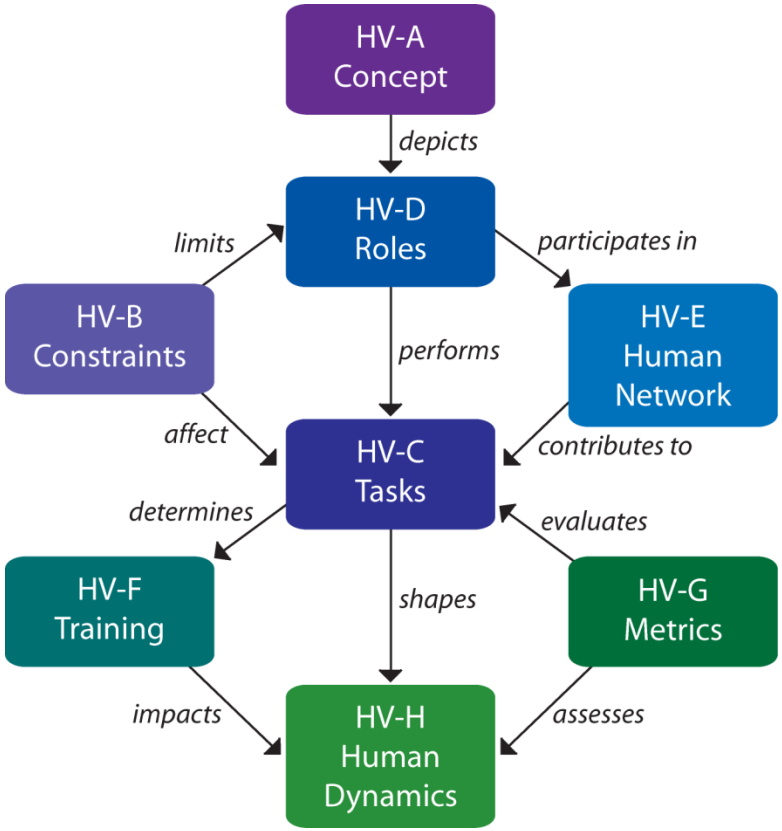
- Evaluate the use of the Human View as a methodology to provide the required information for human system simulations.
- Demonstrate the use of the Improved Performance Research Integration Tool (IMPRINT) as an appropriate technology for the Human View dynamic model.
- Contribute to the design of virtual teams with respect to the concept of reachback.

NATO Human View

- Result of a three year NATO Research & Technology Organization Panel
  - Evaluated emerging human view concepts,
  - Proposed a candidate human view construct,
  - Developed a NATO Human View Handbook.
- Provides a architectural view point designed to inform on how the human impacts the system design
  - Integrated with the NATO Architecture Framework to provide a complete set of system data.
- The Human View describes eight products that represent the integration of humans and systems.

Human View Product Descriptions

HV-A Concept	a high-level representation of the human component of the system
HV-B Constraints	a repository for different sets of limitations
HV-C Tasks	describes the human-specific activities
HV-D Roles	describes the job functions that have been defined for the humans interacting with the system
HV-E Human Network	captures the human to human communication patterns that occur as a result of team formation
HV-F Training	accounting of training requirements, strategy, and implementation
HV-G Metrics	a repository for human-related values, priorities and performance criteria
HV-H Dynamics	the information necessary to complete a simulation of the human impact on the system



IMPRINT

- The Improved Performance Research Integration Tool (IMPRINT) is a human performance modeling tool developed by the US Army Research Laboratory (ARL).
- It incorporates task analysis, workload modeling, performance shaping and degradation functions, and embedded personnel characteristics data.
- Data are entered through user interfaces and task-network diagrams; underlying human performance algorithms are then employed to perform simulations.
- It can be used to capture the interaction of the human system components defined in the static Human View products to provide a dynamic view of the human system.

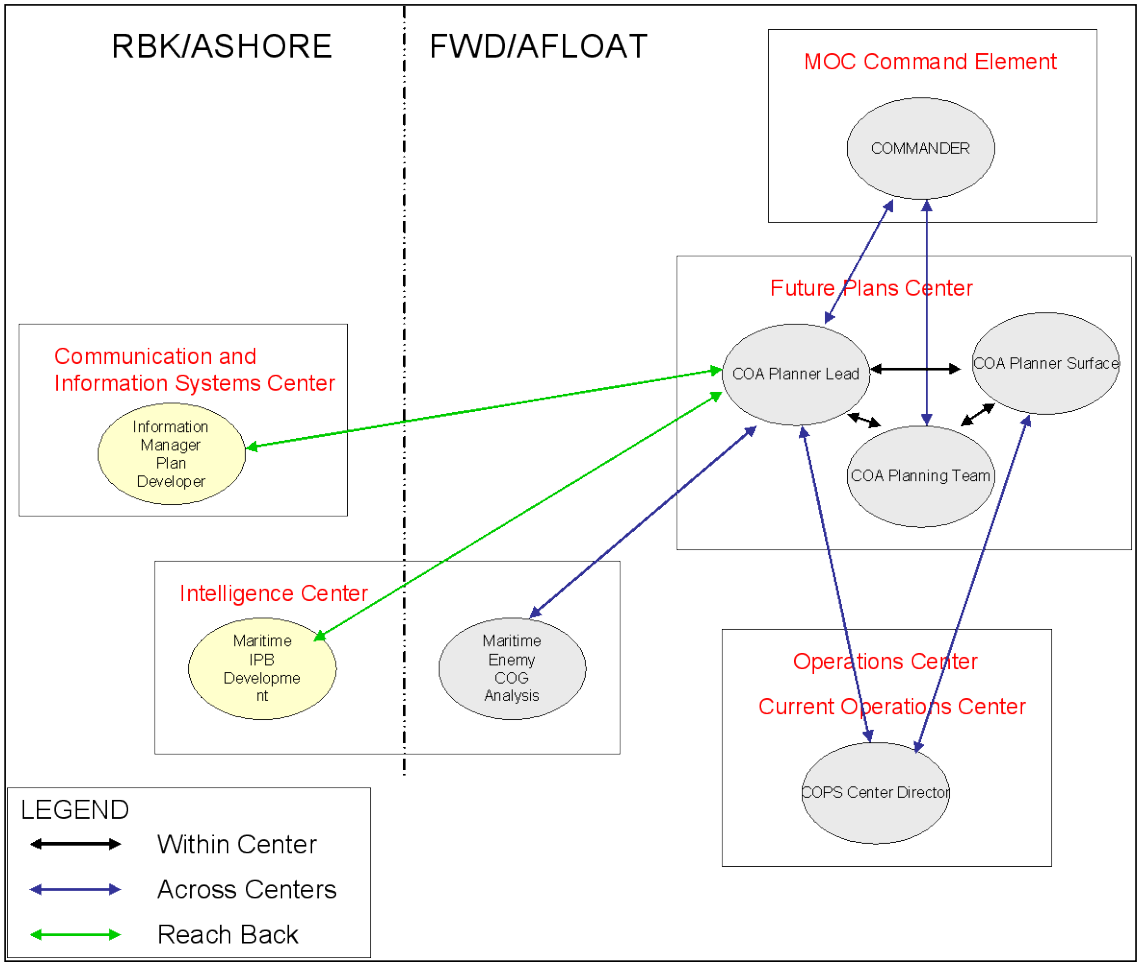
Virtual Teams

- Virtual teams exist when decision-making activities are distributed across a team and the team is also distributed across physical locations.
- The need for a technology-supported human information network is often driven by a *reachback* situation.
- Reachback occurs when a forward deployed role “reaches back” for information or services.
- Human centered aspects of reachback, such as differences in operational tempo and priorities can affect the performance of a work process performed by a virtual team.

Virtual Team Example

<u>Parameters of interest</u>:

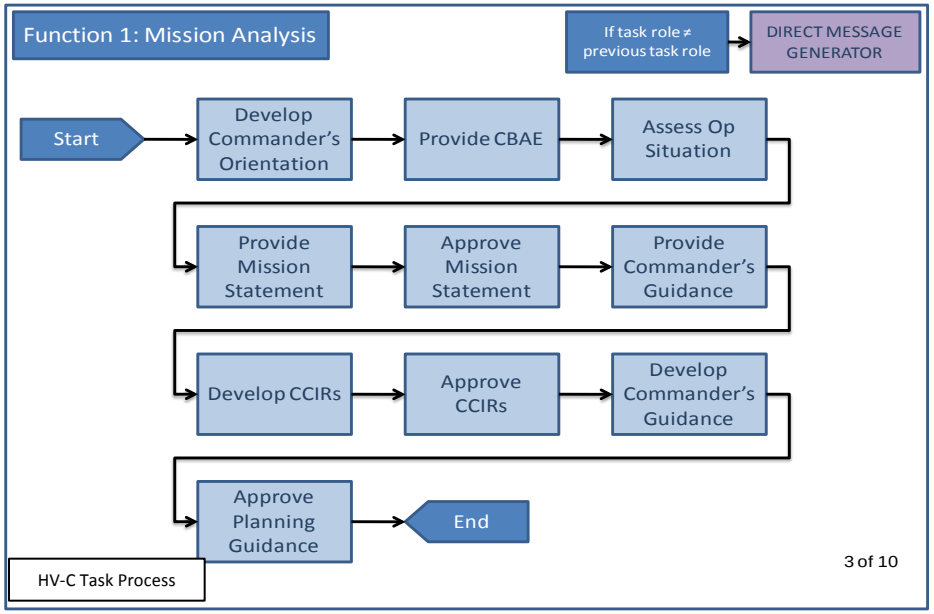
- Role groupings
- Interactions
- Information requirements
- Communication methods
- Locations



Project Case Study

- A sample work process was defined based on the Maritime Operations Center (MOC) concept.
- The set of Human View products were completed for this system, and these design documents were then used as the input data to the IMPRINT model.
- A method to identify the presence or absence of reachback in the model was defined by adjusting the workload parameters.
- An experimental design was created by identify the independent and dependent variables.

Human View Products



1 MISSION ANALYSIS	Model ID	Code	Task Name "C2 3 Role EDITED"	Timeliness Value	Workload Values	Taxons
1.1 Develop Commander's Orientation	1_1		"Develop" (2_16_4)	GenericConversionVariable = Model.RandomInteger(5,15);; return GenericConversionVariable;	Auditory=4.90 Cognitive=7.00 Fine Motor=7.00 Visual=5.90	Num: .35 FM Discrete: .35 Read/write: .30
1.2 Provide CBAE (Commander's Battlespace Area Evaluation)	1_2	DMG V-C	Future Planning: Compare Courses of Action (2_16_8)	GenericConversionVariable = Model.RandomInteger(5,20);; return GenericConversionVariable;	Auditory=4.90 Cognitive=7.00 Fine Motor=2.20 Visual=5.90	Num: .39 Oral: .28 Read/write: .33
1.3 Assess Op Situation	1_3	DMG D-C	COPS: Has Anything Changed ? (1_1)	Normal Mean=.07	Cognitive=6.80	Info: 1
1.4 Provide Mission Statement	1_4	DMG V-C	Future Planning: Seek Course of Action Approval (2_16_9)	GenericConversionVariable = Model.RandomInteger(5,15);; return GenericConversionVariable;	Auditory=4.90 Cognitive=7.00 Fine Motor=7.00 Visual=5.90	Info: .33 Oral: .30 Read/write: .37
1.5 Approve Mission Statement	1_5	DMG V-C	"Approve" (2_16_9)	GenericConversionVariable = Model.RandomInteger(5,15);; return GenericConversionVariable;	Auditory=4.90 Cognitive=7.00 Fine Motor=7.00 Visual=5.90	Info: .33 Oral: .30 Read/write: .37
1.6 Provide Commander's Guidance	1_6	DMG V-C	Future Planning: Conduct Mission Analysis (2_16_7)	GenericConversionVariable = Model.RandomInteger(5,45);; return GenericConversionVariable;	Auditory=4.90 Cognitive=6.80 Fine Motor=2.20 Visual=4.90	Info: .38 Oral: .38 Read/write: .34
1.7 Develop CCIRs (Commander's Crititcal Information Requirements)	1_7	DMG V-C	"Develop" (2_16_4)	GenericConversionVariable = Model.RandomInteger(5,15);; return GenericConversionVariable;	Auditory=4.90 Cognitive=7.00 Fine Motor=7.00 Visual=5.90	Num: .35 FM Discrete: .35 Read/write: .30
1.8 Approve CCIRs	1_8	DMG D-C	"Approve" (2_16_9)	GenericConversionVariable = Model.RandomInteger(5,15);; return GenericConversionVariable;	Auditory=4.90 Cognitive=7.00 Fine Motor=7.00 Visual=5.90	Info: .33 Oral: .30 Read/write: .37
1.9 Develop Commander's Guidance	1_9	DMG V-C	"Develop" (2_16_4)	GenericConversionVariable = Model.RandomInteger(5,15);; return GenericConversionVariable;	Auditory=4.90 Cognitive=7.00 Fine Motor=7.00 Visual=5.90	Num: .35 FM Discrete: .35 Read/write: .30
[illegible]	1_10	DMG D-C Start 2_7 & 2_8	"Approve" (2_16_9)	GenericConversionVariable = Model.RandomInteger(5,15);; return GenericConversionVariable;	Auditory=4.90 Cognitive=7.00 Fine Motor=7.00 Visual=5.90	Info: .33 Oral: .30 Read/write: .37

HV-G Metrics

2 of 8

Task	Operating Cell				
MISSION ANALYSIS	Command Element	Assessment Cell	Future Plans Cell	Future Ops Cell	Remote Cell
1.1 Develop Commander's Orientation			✓		
1.2 Provide CBAE			✓		
1.3 Assess Op Situation		✓			
1.4 Provide Mission Statement			✓		
1.5 Approve Mission Statement	✓				
1.6 Provide Commander's Guidance	✓				
1.7 Develop CCIRs			✓		
1.8 Approve CCIRs	✓				
1.9 Develop Commander's Guidance			✓		
1.10 Approve Planning Guidance	✓				

Reachback Experiment
HV-C Tasks X Role Table

1 of 3

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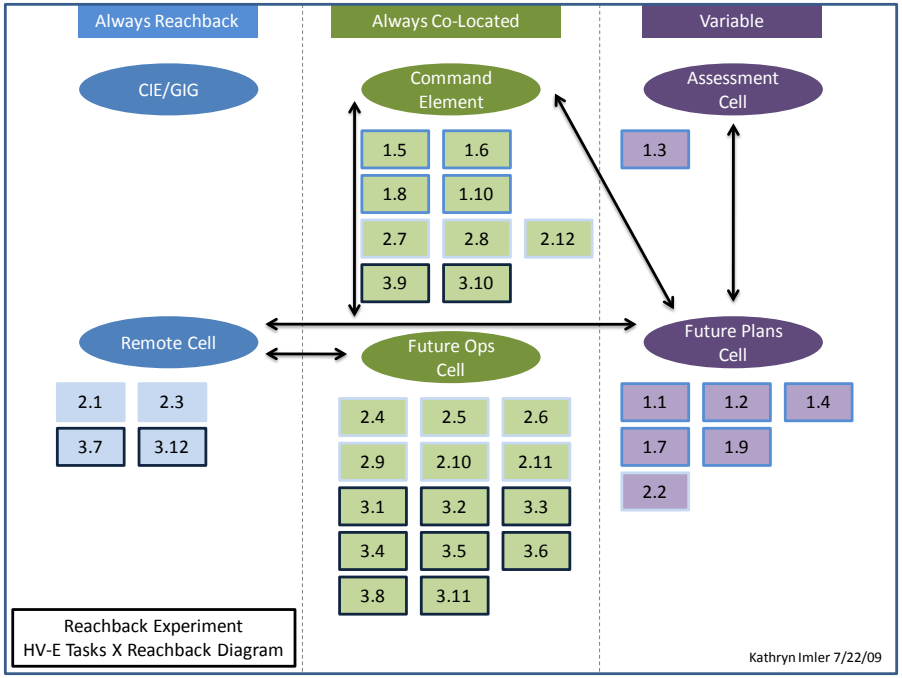
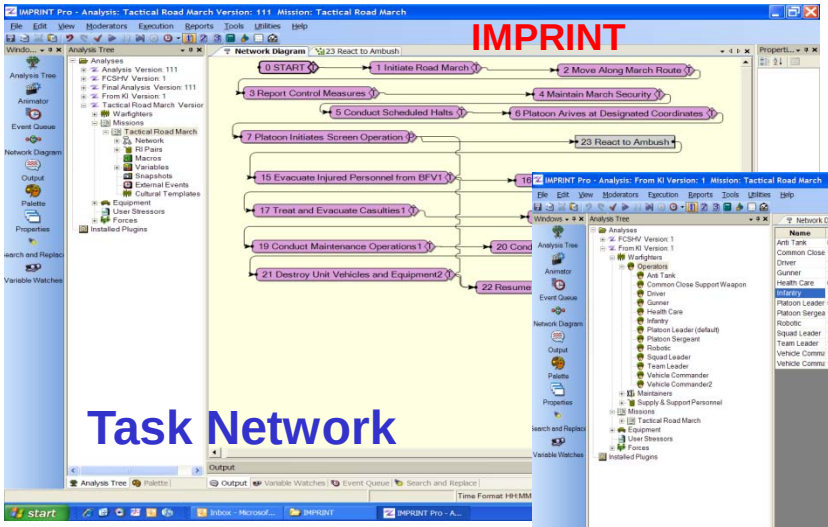
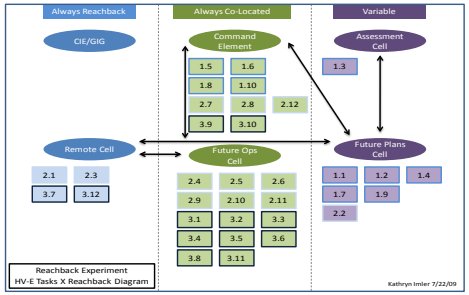
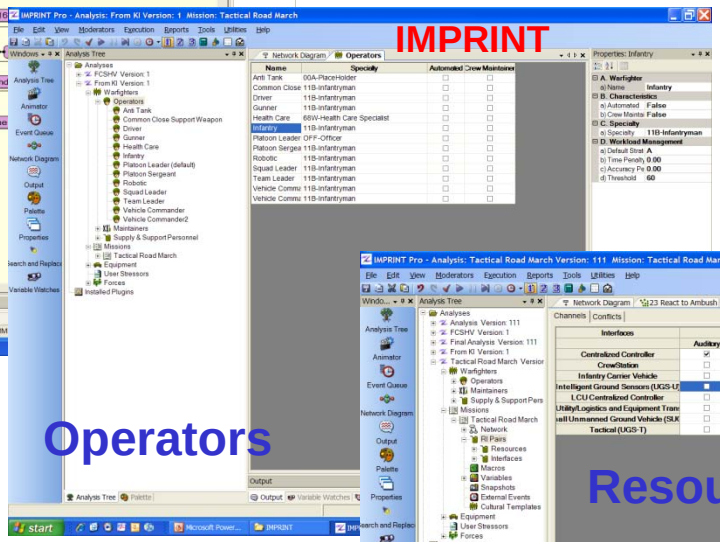


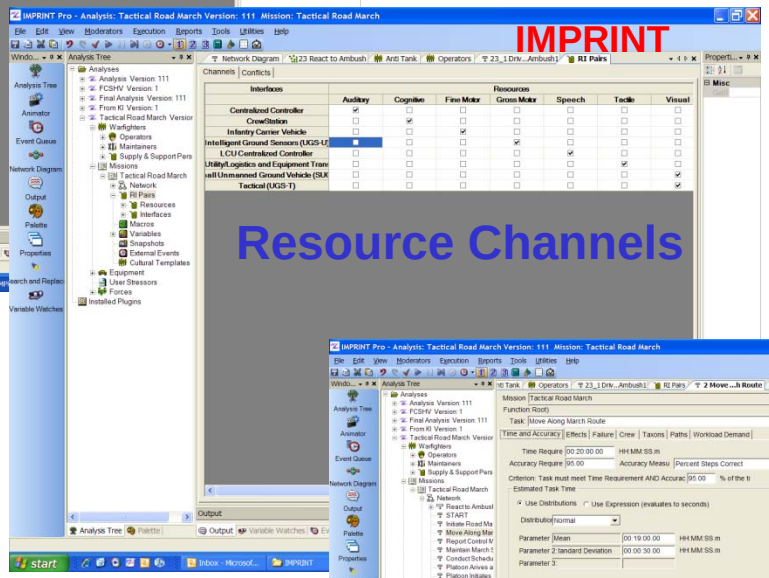
IMPRINT Configuration



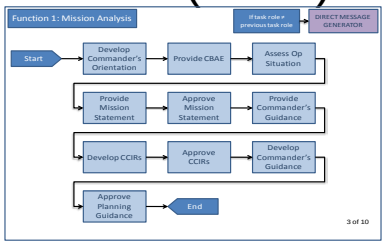
Network (HV-E)



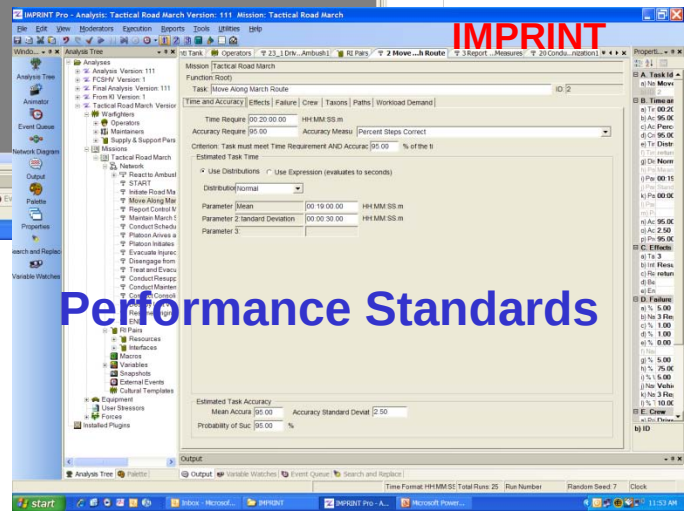




Tasks (HV-C)



Roles (HV-D)



Task	Operating Cell				
MISSION ANALYSIS	Command Element	Assessment Cell	Future Plans Cell	Future Ops Cell	Remote Cell
1.1 Develop Commander's Orientation			✓		
1.2 Provide CBAE			✓		
1.3 Assess Op Situation		✓			
1.4 Provide Mission Statement			✓		
1.5 Approve Mission Statement	✓				
1.6 Provide Commander's Guidance	✓				
1.7 Develop CCIRs			✓		
1.8 Approve CCIRs	✓				
1.9 Develop Commander's Guidance			✓		
1.10 Approve Planning Guidance	✓				

Reachback Experiment
HV-C Tasks X Role Table

1 of 3
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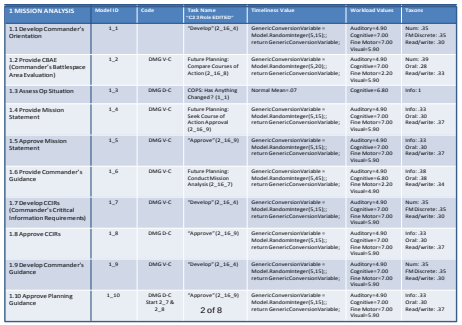
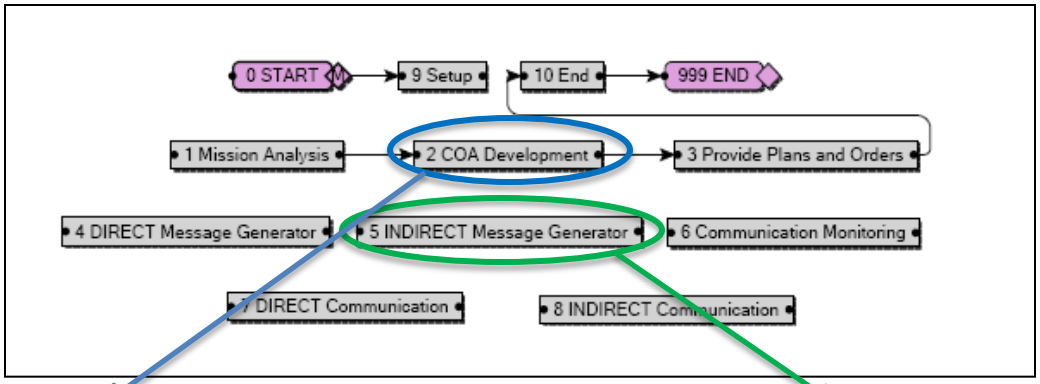
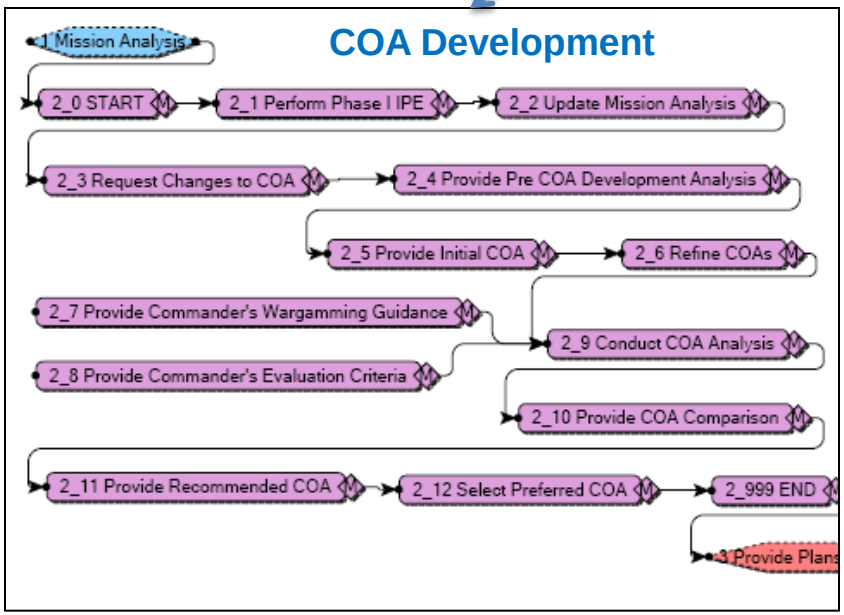


Metrics (HV-G)

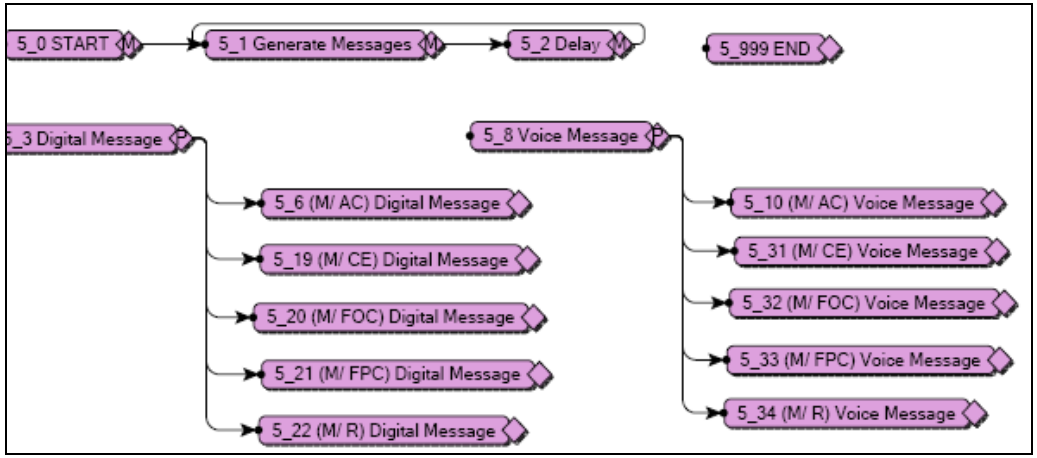
IMPRINT Task Network Model



COA Development



INDIRECT Message Generator



Incorporating Reachback

- The cognitive and speech/auditory parameters within IMPRINT were used as surrogate variables to represent the presence of reachback in the model:
  - Roles are more interdependent (increased cognitive demand)
  - Roles require more interaction (increased communication demand)
- Several variables will impact the severity of the performance impact, including the workload threshold, the timeliness penalty, and the workload management strategy.

Entity / Attribute	**IMPRINT Workload Demand Settings*** *Workload Demand scale is 0 to 7	
	Without Reachback	**With Reachback**
Collaborative Team: *Interdependent* Shared Awareness	Cognitive = 4.6 Eval/Judge/ Consider Single Aspect	Cognitive = 6.8 Eval/Judge/ Consider Several Aspects
Collaborative Team: *Interaction* Team History	Speech = 2.0 Simple Auditory = 3.0 Simple	Speech = 4.0 Complex Auditory = 6.0 Interpret Speech Complex (Sentences)

Experimental Design

Independent Variables – Model Settings		
Variable	Description	Setting
Location	Role Co-located or Reachback	Co-located / Partial / Reachback
Task Time	Time Delay for Process Tasks	Equal / Variable
Operational Tempo	Indirect Message Generator Delay	Low (25) / High (20)
Communication Network	Roles Process Messages	All / Key Players

Dependent Variables – Outcome Measures		
Metric	Description	Measure – From Output Report
Operator Workload	Average Workload	Operator Workload Summary
Peak Workload	Maximum Workload	Graph Data
Workload Limit	Crosses Workload Threshold	Graph Data

<u>Expected Results:</u>

Workload will increase with role in reachback

Location = Reachback

Workload will increase in the more stressed conditions

Operational Tempo = Fast (10) & Communication = Key Players

Simulation Results by Reachback

- Independent Variable: Role Location – Co-located or Reachback
- Outputs Measured – Operator Average Workload

Average Workload	Command Element	Future Operations Cell
Baseline	22.6	27.9
Reachback	23.3	35.3
Maximum Workload	Command Element	Future Operations Cell
Baseline	62.4	64.3
Reachback	64.6	82.8
Crosses Threshold	Command Element	Future Operations Cell
Baseline	2	2
Reachback	2	18

For both roles, the average workload is increased, however rarely is this enough to cause the role to go over the workload limit in normal operations:

Command Cell – Beginning and Ending of Scenario

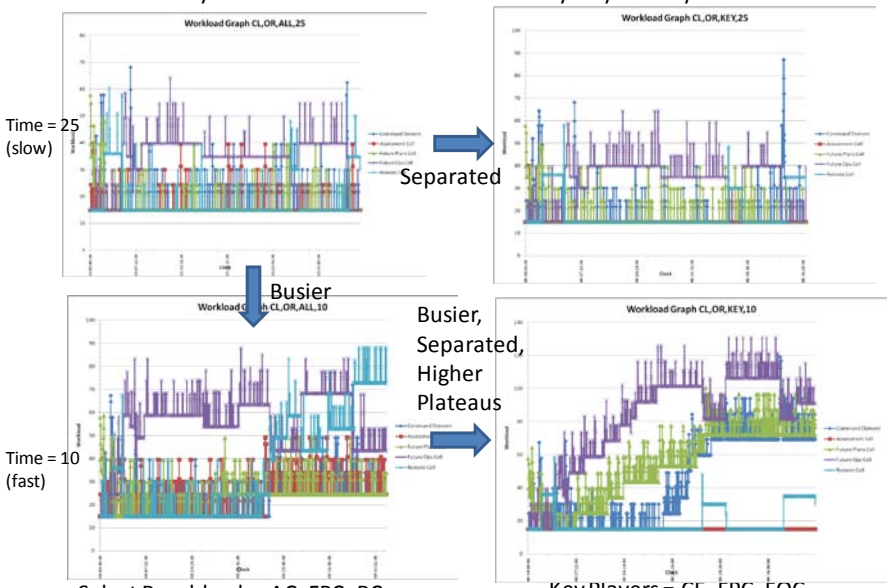
Future Operations Cell – Throughout Scenario

Simulation Results by Conditions

Co Located – *Original Scenario*

All Players – Even Dist Comm

Key Players Only – Uneven Dist Comm



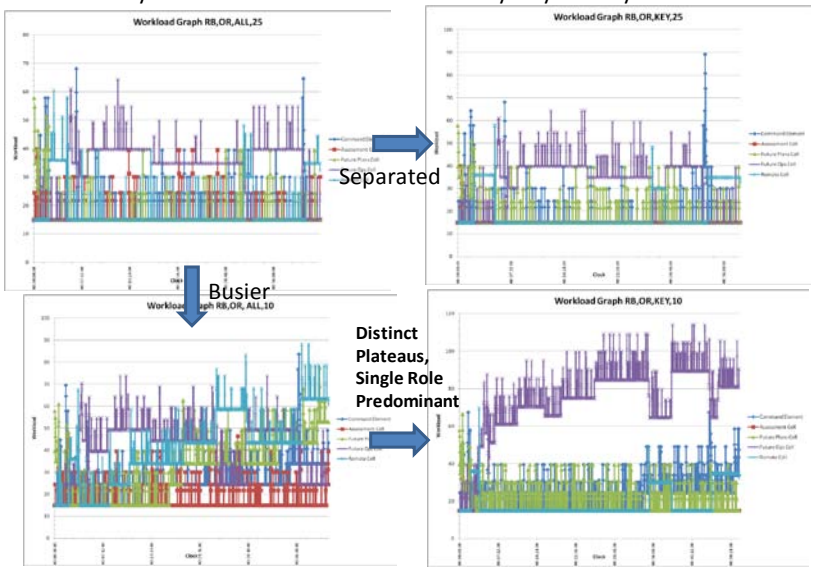
Select Reachback = AC, FPC, RC

Key Players = CE, FPC, FOC

Reachback – *Original Scenario*

All Players – Even Dist Comm

Key Players Only – Uneven Dist Comm



Select Reachback = AC, FPC, RC

Key Players = CE, FPC, FOC

Tempo = Slow **Comms = All** Least Stressed	**Tempo = Slow** **Comms = Key**
Tempo = Fast Comms = All	Tempo = Fast Comms = Key Most Stressed

Overall Results

- When a role is in a reachback position, the workload of the other roles communicating with this role increase.
  - However, in most cases the increase is small and does not significantly raise the overall workload.
- The exception is roles that are communicating frequently over small periods of time or are already highly tasked.
  - In these cases the additional workload is enough to send the roles into an overloaded condition.
  - This is further exacerbated with an increase in operational tempo.
  - The communication patterns and tasking may need to be adjusted to balance the workload among the roles.

Conclusion

- This project demonstrated the interoperability of the Human View products and the IMPRINT dynamic modeling capability.
  - The Human View is an appropriate methodology to provide information about the human in the system to the simulation domain.
  - The Improved Performance Research Integration Tool (IMPRINT) is an appropriate technology for the Human View dynamic model.
- Together they can be used to study the impact of humans on system performance and contribute to improved system designs.

Follow on Work

- Identify appropriate metrics that characterize the workload outcomes of the IMPRINT tool:
  - Workload for comparison across groups,
  - Metrics for comparison within scenarios,
  - Use of statistics with workload metrics.
- Investigate the use of the C3TRACE tool as an alternative modeling environment:
  - Complete a simulation using the same case study,
  - Compare the IMPRINT and C3TRACE outcomes.
- Continue to develop the Human View products as they pertain to dynamic modeling:
  - Design formats based on model input needs,
  - Create templates for easy use by practitioners and modelers.