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Force Level Manpower Modeling with the Improved Performance Research Integration Tool (IMPRINT)

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Agenda

- Overview
- Components
- Reports
- Applications
- Potential Enhancements





IMPRINT Pro Capabilities

- Four analysis capabilities:
 1. Warfighters (personnel modeling)
 2. Mission (operations modeling)
 3. Equipment (maintenance modeling)
 4. **Force (manpower modeling)**





Force Overview

- Purpose: To predict manpower and materiel resources needed to perform work not necessarily associated with a particular system
- Simulation uses stochastic modeling to predict manpower requirements at force unit level
- A parameterized model (data driven)

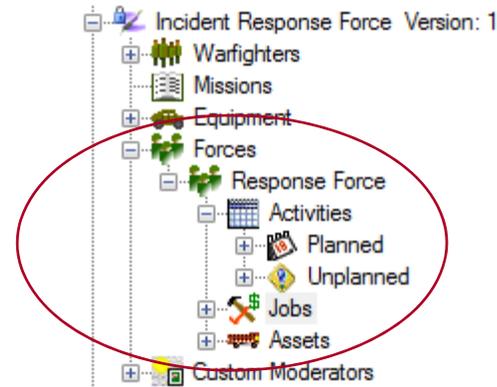
Questions it can answer

- Can the available crew given the current resource inventory perform all the activities that are a part of an emergency situation?
- Is there enough crew and resources available to do all the emergency activities?
- What is the elapsed time for the planned and unplanned activities?
- What is the cumulative amount of time an activity was performed over the course of the entire model run?
- What is the crew's quality of life in terms of personal time, routine duties, and CM related incident response work?



Force Components

- **Force Units** - Groups of individuals (Jobs) who perform activities (planned or unplanned) according to a schedule using assets (materiel resources)



- **Schedules** - A pre-defined sequence of planned activities over a specific amount of time

Schedule	Duration (Days)
EMT	1
EMT Assets	1
EMT Shift 2	1
Fire Dept Assets 1	1
Fire Dept Assets 2	1
Fire Dept Chief	1
Fire Dept Operator	1
NBC Recon	1
NBC Recon equipment	1
Police Dept Assets 1	1
Police Dept Chief	1
Police Dept Officer	1
Police Dept Officer 2	1



Force Components (Cont.)

➤ **Jobs** – Jobs represent people that complete the activities and have different types of functions they can perform within the unit

The screenshot shows a 'Jobs' tree on the left with the following items: Comms Op, Comms Op 2, Detective, EMT Resp, and EMT Resp 2. A red arrow points from the 'EMT Resp' job to the configuration panel on the right.

Name: EMT Resp
Specialty: Transport Care Giver-Rides In Back With Patient
Rank: E4

Availability:

Schedule	Number Available
EMT	2
EMT Assets	0
EMT Shift 2	0
Fire Dept Assets 1	0
Fire Dept Assets 2	0
Fire Dept Chief	0
Fire Dept Operator	0
Police Dept Assets	0
Police Dept Chief	0
Police Dept Officer	0
Police Dept Officer	0

➤ **Jobs Roles** – Roles describe the manner in which a job contributes to the unit

The screenshot shows the same 'Jobs' tree as above. A red arrow points from the 'EMT Resp' job to the 'Roles' list on the right.

Roles:

- Communications
- EMT
- Fire Leader
- Fire Member
- Fire Sub-Leader
- Police Leader
- Police Member
- Police Sub-Leader
- Police Unit 2



Force Components (Cont.)

➤ **Assets** – materiel resources used to address unplanned activities

The screenshot shows a tree view of assets under the heading 'Assets'. The items listed are: Ambulance, Armored SWAT Vehicle, Engine Truck, Ladder Truck, Mobile Command Center, Patrol Car, Rescue Truck, and TAC. A red arrow points from the 'Ambulance' item to a detailed panel on the right. This panel shows 'Name: Ambulance' and 'Availability:' followed by a table.

Schedule	Number Available
EMT	0
EMT Assets	0
EMT Shift 2	0
Fire Dept Assets 1	1
Fire Dept Assets 2	1
Fire Dept Chief	0
Fire Dept Operator	0
Police Dept Assets	0
Police Dept Chief	0
Police Dept Officer	0
Police Dept Officer	0

➤ **Asset Features** – unique aspects of asset which an unplanned event may require

The screenshot shows the same tree view of assets as above. A red arrow points from the 'Ambulance' item to a 'Features:' panel on the right. This panel contains a list of features with checkboxes.

- Ambulance
- Command Center
- Fire Mobility
- Ladder
- Mobile Command Center
- Police Mobility
- SWAT Mobility
- Water Pump



Force Components (Cont.)

- **Planned Activities** - Routine tasks performed by Jobs. Examples may include personal time, daily paperwork, hygiene, eating and sleeping
- **Planned Activities Schedule** – Planned Activities follow a schedule that repeat over the course of the simulation run



Schedules				
Activity	Start Time	End Time	Total Activity Time	
Arrive At Station	00:00	00:15	00:15	Fire Dept Assets 1
Replacement Meeting	00:15	01:00	00:45	Fire Dept Assets 2
Shift Start	01:00	01:15	00:15	Fire Dept Chief
Radio Check	01:15	01:30	00:15	Fire Dept Operator
Personal Time	01:30	02:30	01:00	Police Dept Assets 1
Fire Hydrant Check	02:30	03:30	01:00	
Personal Time	03:30	06:00	02:30	
Assets Inspection And Clean	06:00	08:00	02:00	
Eat	08:00	09:00	01:00	
Training Certification Update	09:00	11:00	02:00	
Station Cleaning	11:00	13:00	02:00	
Eat	13:00	14:00	01:00	
Sleep	14:00	21:00	07:00	
Hygiene	21:00	21:15	00:15	
Personal Time	21:15	23:30	02:15	
Replacement Meeting	23:30	23:55	00:25	
Shift End	23:55	1 00:00	00:05	



Force Components (Cont.)

Unplanned Activities –

- i. Simulates a consequence that must be addressed or managed.
- ii. These activities interrupt a normal schedule.
- iii. Task Priorities determine if the resources (manpower and materiel) can be pulled.
- iv. These unplanned activities may require certain type of job roles and asset features.
- v. Additional crew members can have an effect on the unplanned activity duration.
- vi. Examples may include fire and terrorist threats.

1) Initial Terrorist call

Unit Name: Response Force

Activity: 1) Initial Terrorist call

Sleep Activity: False Priority: 3 Interrupt Strategy: Restart

Job Roles	Required	Desired
Communications	0	1
EMT	0	0
Fire Leader	0	0
Fire Member	0	0
Fire Sub-Leader	0	0
Police Leader	1	1
Police Member	1	2
Police Sub-Leader	0	0

Adding Crew Members

has no effect

reduces Time Proportionally

10 Maximum # crew members

reduces Time Somewhat

10 Maximum # crew members

0.00 % reduction per additional

Asset Features	Required	Desired
Ambulance	0	0
Command Center	0	0
Fire Mobility	0	0
Ladder	0	0
Mobile Command C	0	0
Police Mobility	1	1
SWAT Mobility	0	0
Water Pump	0	0

Start Duration Cancel Repeat Stop Repeat

Enter Time Use Distributions Use Expression (evaluates to hours)

Enter Time: 3 02:30 D HH:MM



Forces Case Study Model

- FY08 LWI “Campus Incident” case study
- Student claiming to have hazardous materials and threatening to utilize them
- Several different agencies responded to threat
 - Local police and fire department
 - Local unit of Homeland Security
 - Weapons of Mass Destruction (WMD) Civil Support Team (CST)
 - FBI



Case Study Data

Challenges Encountered

- Lack of availability of subject matter experts(SME) in each of the responding agencies
- Risk associated with collecting schedule data from agencies all located at the same geographical location

Challenges Overcome By

- Narrowing the list of agencies to five – Dispatcher, Police Department, Fire Department, EMT, and Civil Support Team (CST NBC team)
- Talking to SMEs located at different geographical locations(different US states) with in each of the selected departments for schedules and jobs-jobs role and assets-assets feature data
- Conducting research to best approximate the statistics behind certain types of events (local fire calls)



Specialty- Job – Roles Assignment

Jobs	Specialty	Dispatcher Roles	EMT Roles	Fire Dept. Roles			NBC Roles				Police Dept. Roles		
		Dispatcher	EMT	Leader	Member	Sub-Leader	Communication	Decontamination	Leader	Member	Leader	Member	Sub-Leader
Comms Op	Switch Board Operator-Switch Board Operator	Yes	No	No	No	No	No	No	No	No	No	No	No
Detective	Detective-Police Detective	No	No	No	No	No	No	No	No	No	No	Yes	Yes
EMT Driver	EMT Driver-Asset Driver	No	Yes	No	No	No	No	No	No	No	No	No	No
EMT Resp	Transport Care Giver-Rides In Back With Patient	No	Yes	No	No	No	No	No	No	No	No	No	No
Fire Department Driver	EMT Driver-Asset Driver	No	Yes	No	Yes	Yes	No	No	No	No	No	No	No
Fire Chief	Chief-Fire Chief	No	Yes	Yes	Yes	Yes	No	No	No	No	No	No	No
Fire Ladder Operator	Ladder Operator-Ladder Operator	No	Yes	No	No	Yes	No	No	No	No	No	No	No
Fire Pump Operator	Pump Operator-Pump Operator	No	Yes	No	No	Yes	No	No	No	No	No	No	No
NBC Recon NCO	NBC Recon NCO-Coordinates team actions	No	No	No	No	No	Yes	Yes	Yes	Yes	No	No	No
NBC Recon Team	NBC Recon Team Member-Carries out plans	No	No	No	No	No	No	Yes	No	Yes	No	No	No
NBC Recon Team Leader	NBC Recon Team leader-Responsible for all section	No	No	No	No	No	Yes	No	Yes	No	No	No	No
NBC Team Chief	NBC Recon Team Member-Carries out plans	No	No	No	No	No	No	Yes	Yes	Yes	No	No	No
Police Chief	Chief-Police Chief	No	No	No	No	No	No	No	No	No	Yes	Yes	Yes
Police Unit	Patrol Officer-Patrol Officer	No	No	No	No	No	No	No	No	No	No	Yes	Yes
SWAT Member	Swat Team Member-Description	No	No	No	No	No	No	No	No	No	No	Yes	Yes



Assets – Assets Feature

Assets	Asset Roles										
	Ambulance	Command Center	Fire Mobility	Ladder	Mobile Command Center	NBC Detection	NBC Mobility	NBC Personnel Protection	Police Mobility	SWAT Mobility	Water Pump
Ambulance	Yes	No	No	No	No	No	No	No	No	No	No
Armored SWAT Vehicle	No	No	No	No	No	No	No	No	No	Yes	No
Detection Equipment	No	No	No	No	No	Yes	No	No	No	No	No
Engine Truck	No	No	Yes	No	No	No	No	No	No	No	Yes
Ladder Truck	No	No	Yes	Yes	No	No	No	No	No	No	No
Mobile Command Center	No	Yes	No	No	Yes	No	No	No	No	No	No
NBC Recon Truck and Trailer	No	No	No	No	No	No	Yes	No	No	No	No
Patrol Car	No	No	No	No	No	No	No	No	Yes	No	No
Rescue Truck	Yes	No	Yes	No	No	No	No	No	No	No	No
Safety Suits	No	No	No	No	No	No	No	Yes	No	No	No
TAC	No	No	No	No	Yes	No	No	No	No	No	No





Activities Data

Priority	Name	Type	Sleep
1	3) Quarantine	Unplanned	No
1	C) NBC Recon offsite training	Unplanned	No
2	4) NBC Recon Support	Unplanned	No
2	4) NBC Recon - powder	Unplanned	No
2	5) NBC Recon - bomb	Unplanned	No
3	1) Initial Terrorist call	Unplanned	No
4	2) Call Followup	Unplanned	No
5	A) Local Fire Call	Unplanned	No
8	B) Mutual Aid Call	Unplanned	No
68	Shift Start	Planned	No
69	Fire Hydrant Check	Planned	No
70	Check In With Duty Officer	Planned	No
72	Gear Inspection	Planned	No
75	On Shift Meeting	Planned	No
76	End Shift Paperwork	Planned	No
77	Off Shift Meeting	Planned	No
79	Arrive At Station	Planned	No
80	Training Certification Update	Planned	No
97	Eat	Planned	No
98	Shift End	Planned	No
99	Off Duty	Planned	No
100	Replacement Meeting	Planned	No
101	Radio Check	Planned	No
102	Station Cleaning	Planned	No
103	Patrol	Planned	No
104	Hygiene	Planned	No
105	Sleep	Planned	Yes
107	Assets Inspection And Cleaning	Planned	No
108	Personal Time	Planned	No
109	Daily Paperwork	Planned	No
110	Asset Available	Planned	No
112	Standard Work	Planned	No
113	Asset In Daily Use	Planned	No
114	Asset Being Cleaned	Planned	No
115	Physical Training	Planned	No
116	Classes/Training	Planned	No





Unplanned Activities Data

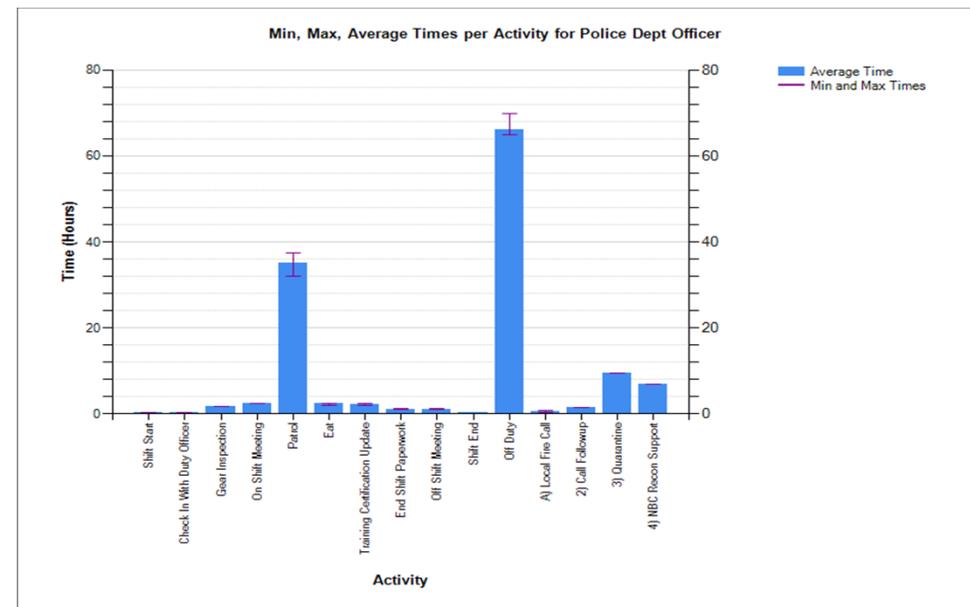
Name	Sleep Task	Interrupt	Time			Repeating			
			Start	Duration	Cancel	Is Repeating	Repeat Interval	Stop Repeating	Stop Time
1) Initial Terrorist call	<input type="checkbox"/>	Restart	Value: 3 02:30	Value: 00:30	Value: 00:00	<input type="checkbox"/>	Distribution: Normal	<input type="checkbox"/>	Distribution: Normal
2) Call Followup	<input type="checkbox"/>	Resume	Value: 3 03:00	Value: 01:30	Value: 00:00	<input type="checkbox"/>	Distribution: Normal	<input type="checkbox"/>	Distribution: Normal
3) Quarantine	<input type="checkbox"/>	Resume	Value: 3 04:30	Value: 09:30	Value: 00:00	<input type="checkbox"/>	Distribution: Normal	<input type="checkbox"/>	Distribution: Normal
4) NBC Recon - Powder	<input type="checkbox"/>	Restart	Value: 3 08:00	Value: 05:00	Value: 00:00	<input type="checkbox"/>	Distribution: Normal	<input type="checkbox"/>	Distribution: Normal
4) NBC Recon Support	<input type="checkbox"/>	Resume	Value: 3 08:00	Value: 07:00	Value: 00:00	<input type="checkbox"/>	Distribution: Normal	<input type="checkbox"/>	Distribution: Normal
5) NBC Recon - Bomb	<input type="checkbox"/>	Restart	Value: 3 13:00	Value: 02:00	Value: 00:00	<input type="checkbox"/>	Distribution: Normal	<input type="checkbox"/>	Distribution: Normal
A) Local Fire Call	<input type="checkbox"/>	Abort	Distribution: Log Norma	Distribution: Log Norma	Value: 00:00	<input checked="" type="checkbox"/>	Distribution: Log Normal	<input checked="" type="checkbox"/>	Value: 4 00:00
B) Mutual Aid Call	<input type="checkbox"/>	Abort	Value: 3 08:00	Distribution: Log Norma	Value: 00:30	<input type="checkbox"/>	Value: 00:00	<input type="checkbox"/>	Distribution: Normal
C) NBC Recon offsite training	<input type="checkbox"/>	Restart	Value: 00:01	Value: 4 00:00	Value: 00:00	<input type="checkbox"/>	Distribution: Normal	<input type="checkbox"/>	Distribution: Normal





Case Study Results

- Other than the **failed Mutual Aid Call**, the local services and NBC Recon Civil Support team are able to address and handle the situation without much of a disruption of normal activities.
- **Local Fire Call activity is affected by the number of crew members.** There are four instances of Local Fire Calls, which have three different numbers of responders among the four instances.
- Because of this variation in the number of crew members available, fire call duration is varied. That is **reduction in time is achieved when more members are assigned to Local Fire call.**
- For Police Dept. Officers, **patrol time is negatively impacted by the threat incident.**
- For Fire Department Driver, **Asset Inspection and Cleaning is reduced.** During an extended incident, this activity could suffer to the point where asset failure may be more likely to occur.





Areas of Application

- Ability to predict Manpower for Joint Service Operations
- Ability to see the impact of Force Structure changes proposed by the Army & Air Force
- Ability to see the impact of Manpower allocation on Consequence Management Operations
- To develop ship board crew schedules and estimate ship manning requirements





Potential Future Enhancements

- Currently in the IMPRINT forces module, manpower and resource allocation is done only at the start of an unplanned event. The ability to allocate extra resources to an unplanned event at any time during the response would alleviate the response time.
- Currently in the forces module, an unplanned activities duration can be effected if more manpower is allocated to it. However, there is no ability to effect an unplanned activities duration if more resources are allocated to it. The addition of this feature would allow the user to play what-if scenarios more accurately.
- There exists no mechanism in the forces module that a user can set such that manpower and resources are not pulled from an unplanned activity. All though such a behavior can be simulated by artificially giving an unplanned activity a higher priority, there can be certain situations where the intention might be to not interrupt a low priority activity. Therefore, an easier fix would be to let the user decide if the particular unplanned activity can be interrupted or not.