“Ready-to-Use” Building Layouts and ‘Combustible Packages’ for 3-D Fire Simulations

Alberto ALVAREZ and Brian J. MEACHAM, WPI

2011 Fire and Evacuation Modeling Technical Conference
Baltimore, MD, 16 August 2011

Global PBD framework

- In general, PBD approaches require:
  - Definition of goals, objectives, performance criteria,
  - Selection of fire design scenarios upon which trial design are evaluated
  - Assessment of the consequences of the fire design scenarios using fire effects tools (and evacuation tools…) that are selected according to the needed degree of analysis.
  - Input data, describing the considered built environment and the fire, for use with the tools in the analysis.

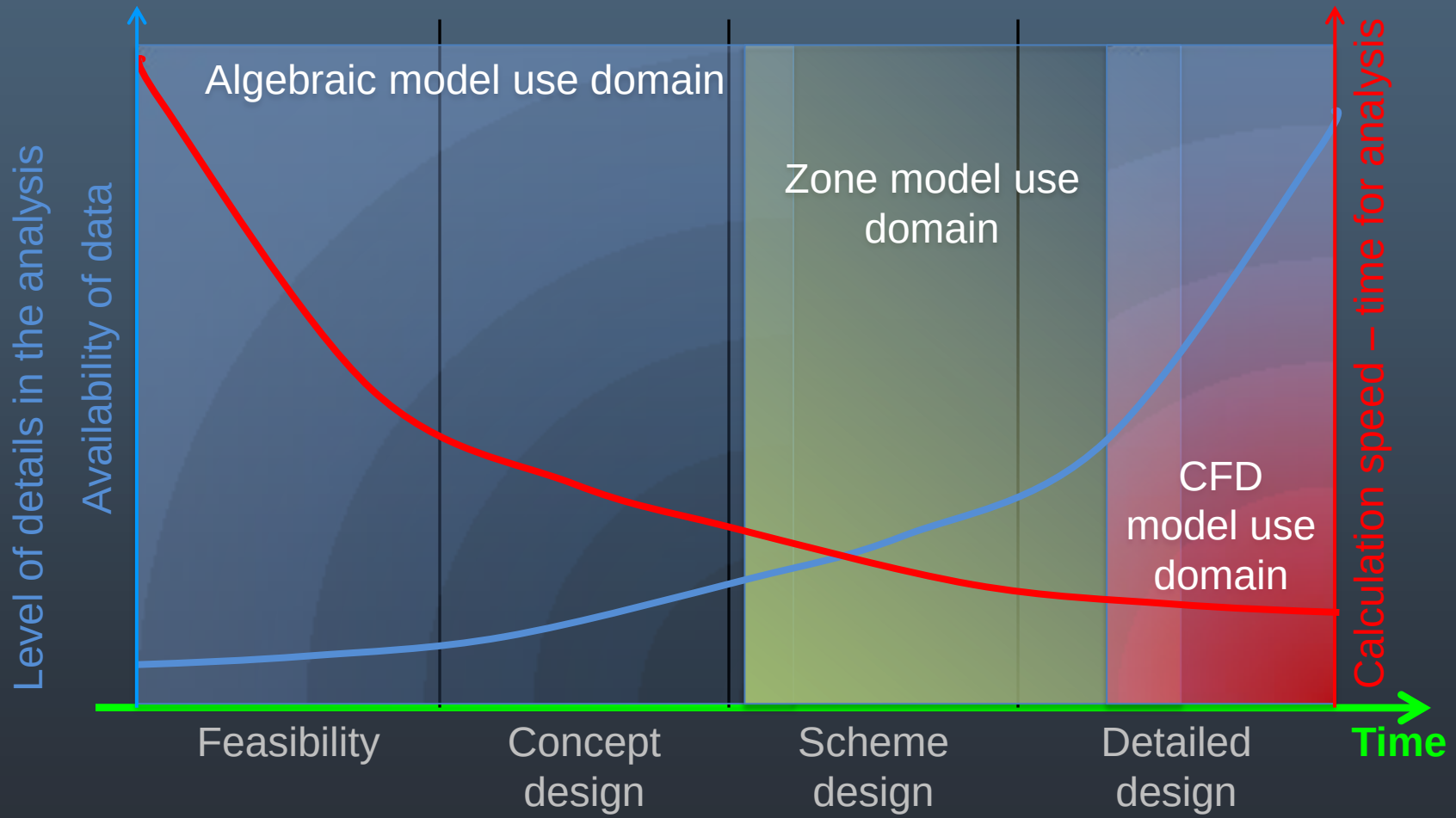
Focus of this presentation

- Selection of tools for use in PBD based on applicability to building and FP problem of concern, specifically fire effects tools

  (Concepts also apply to tools for evacuation analysis and structural response to fire threat, but not discussed today)
- Different level of complexity (fire effects)
  - algebraic models
  - zone or lumped parameter models
  - Computational Fluid Dynamics (CFD) models
  - hybrid tools

Different uses with different constraints

Fire Protection Engineers



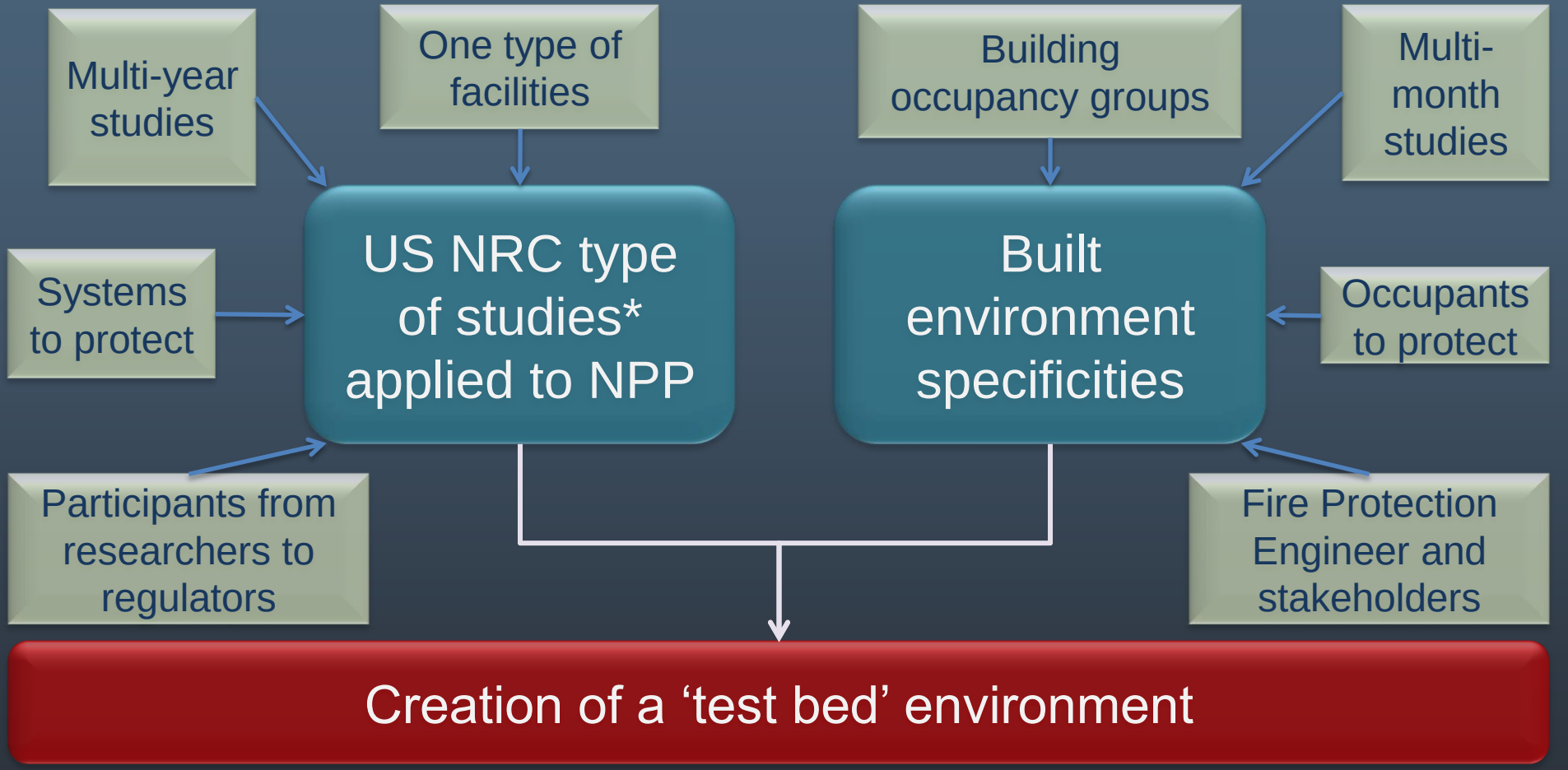
Different uses with different constraints

In Academia or research environments

- multi-year studies
- Example 1: creation of a hybrid tool for tunnel application
- Example 2: collaborative project for Nuclear Power Plant application

How to get rid of fire scenarios with no consequences?	Screening method	Algebraic models + conservative assumptions
How to deal with thousands of fire scenarios?	Fire simulation batches for “Shoebox” rooms	Zone models
How to deal with detailed fire scenarios?	3D spatial representation	CFD models

How to apply to the built environment?



* Nuclear Power Plant Fire Modeling Application Guide (NPP Fire MAG)
Second draft Report for Comment - July 2011 – NUREG 1934 – EPRI 1023259

‘Test bed’ environment process

1. Identify occupancy group for study focus
2. Collect building configurations for study
3. Identify study parameters
(e.g., selection of tool for assessing safety objectives)
4. Set up building layouts for models

Pre-processing phase

5. Identify safety objectives, safety functions and criteria
6. Select fire scenarios for study
7. Perform the simulations (and for different mitigation strategies, as appropriate)

Performing and analyzing phase

8. Analyze the results in terms of the safety objectives
9. Assess ability of tool to address defined performance issue
10. Conclude by establishing guidelines related to the tool comparison process and its outcome

Post-processing phase

Use of the ‘test bed’ studies

Guidance to use appropriate tool for a given application within the PBD framework

- Not aimed to increase validation domain of tools

- Not aimed to provide fire design scenarios for PBD applications

Because of the scope of the ‘test bed’ studies, participation of world wide fire protection engineers, researchers and regulators is needed

Organization of the ‘test bed’ studies

Pre-processing phase	Creation of a website to present potential study cases of interest and collect the building configurations
Performing and analyzing phase	After agreeing on the fire scenarios to select, each participant performs simulations and upload the results on the website
Post-processing phase	Results are analyzed in common by all the involved participants and the stakeholders in order to conclude on the case study

“Ready-to-use” building layouts for fire protection design purposes

Building configuration generation process

- Step 1 to Step 4 of the ‘test bed’ process
- Input data “pre processing” phase of the case study

Maximum of information regarding the building and its components (structure, contents, systems, occupants) collected mainly from designer files

Objectives:

-different data may be necessary depending on the objectives

- levels of details may be valuable for future use

“Ready-to-use” building layouts for fire protection design purposes

Objectives related to Step 1 to Step 4 of the ‘test bed’ studies

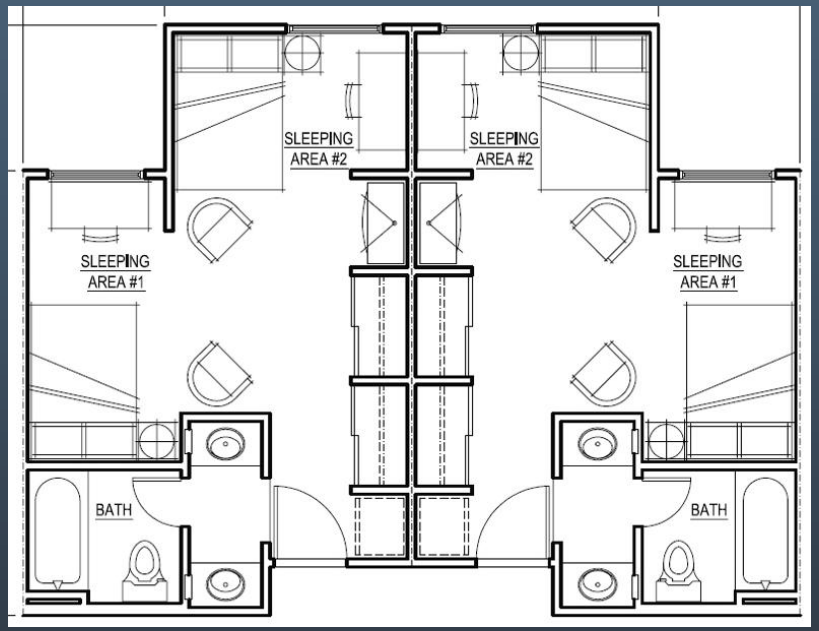
- Get some configurations ready by the end of 2011
- Distribute them to Google group for creation of additional tool input files (evacuation purposes)
- Create the FDS files for these configurations

The Google group participants will also help to:

- Implement Step 5 and Step 6 about the scenarios to set up for the considered building configuration
- Perform the simulation of Step 7

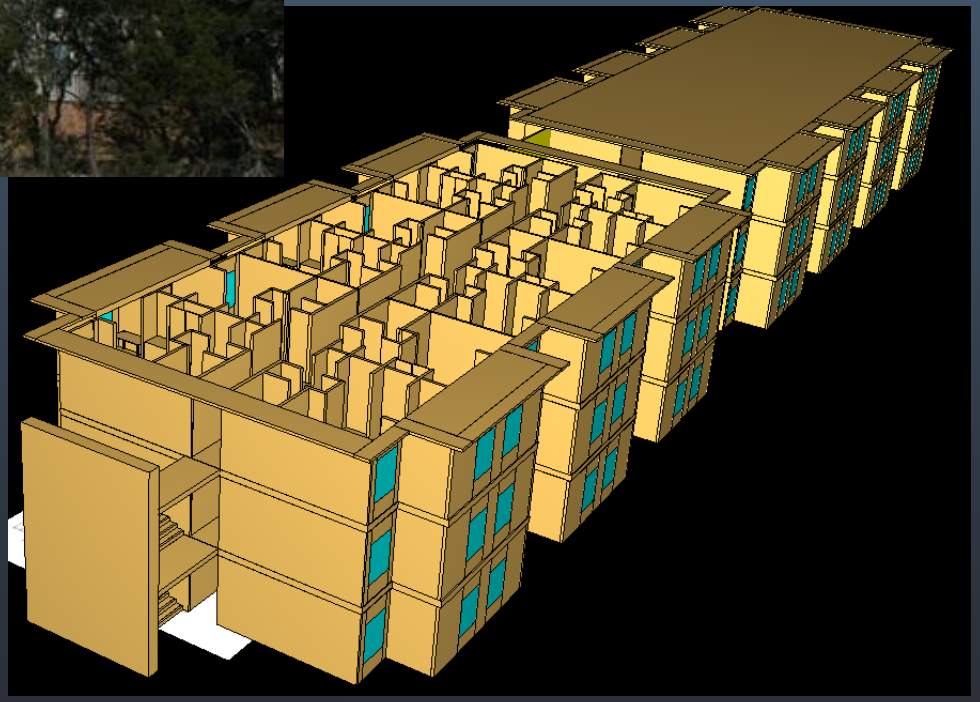
Examples of building layouts

Dormitory: student room layout



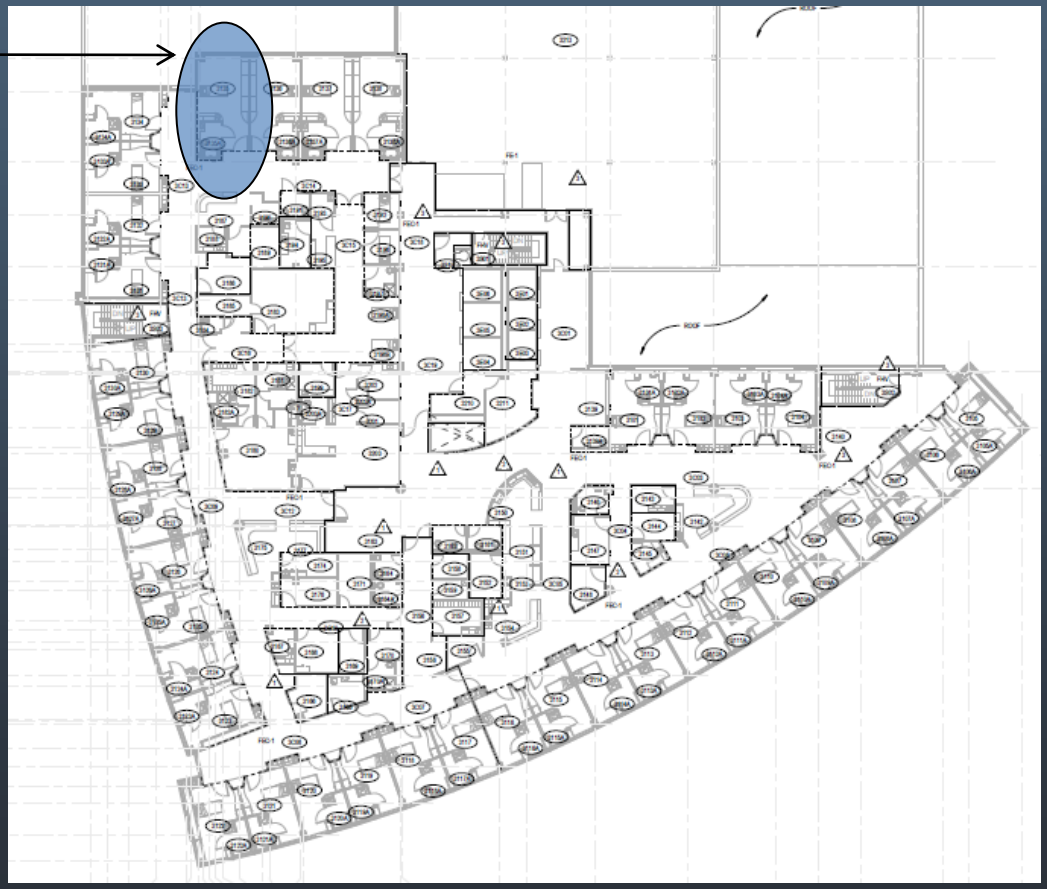
Examples of building layouts

Dormitory: all building layout



Examples of building layouts

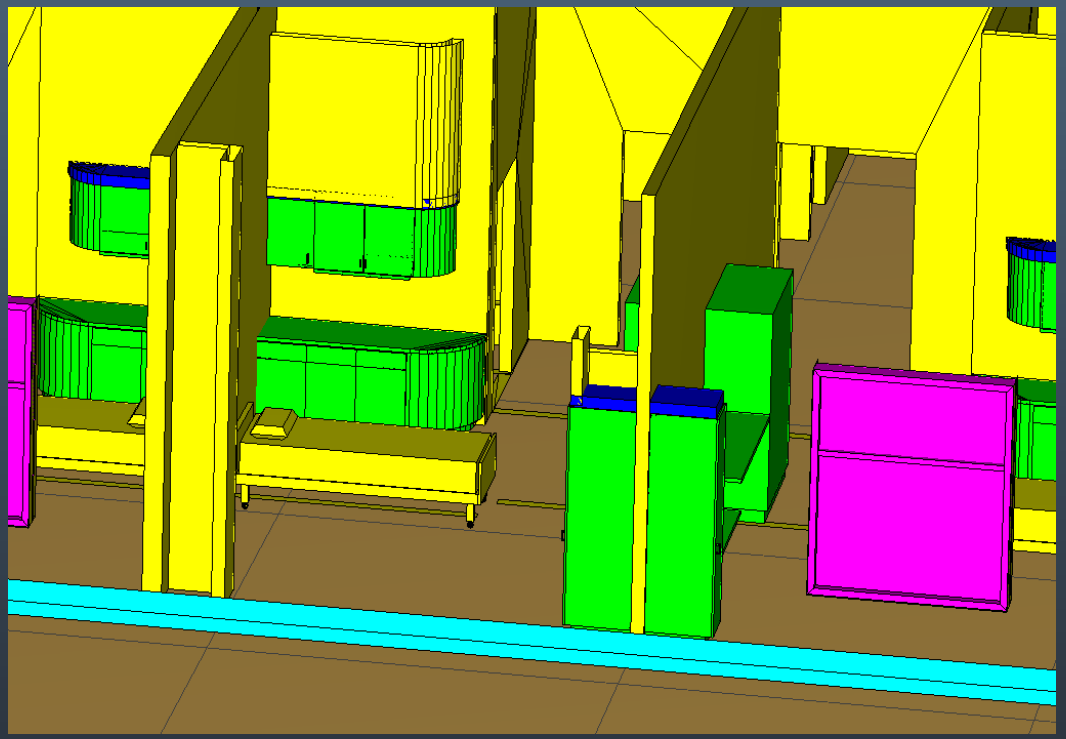
Hospital: patient room floor



Examples of building layouts

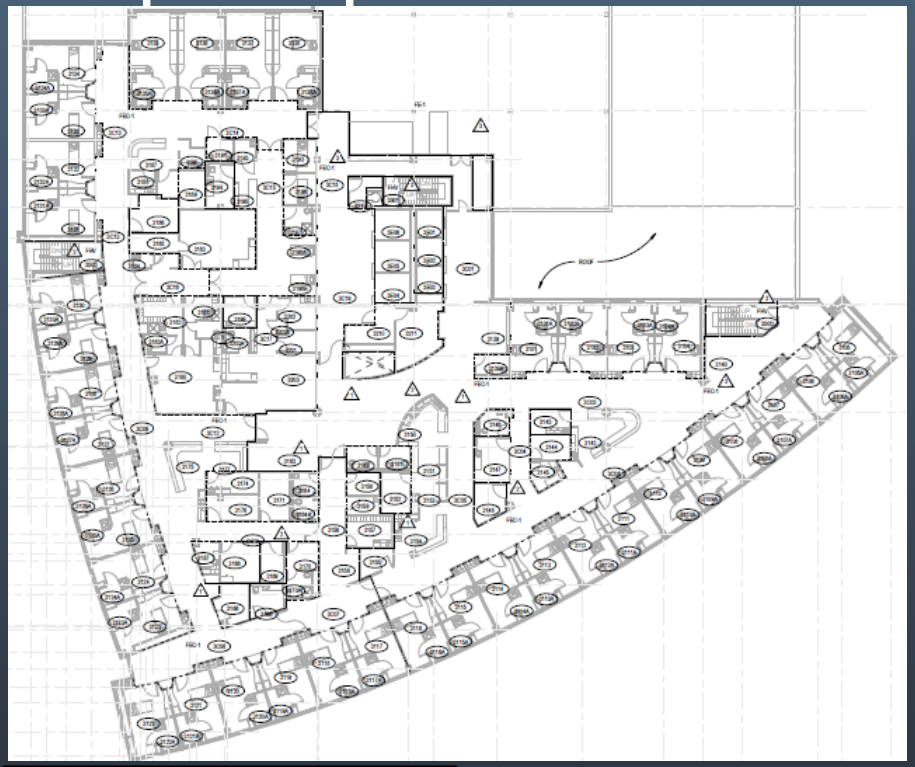
Hospital: patient room configuration

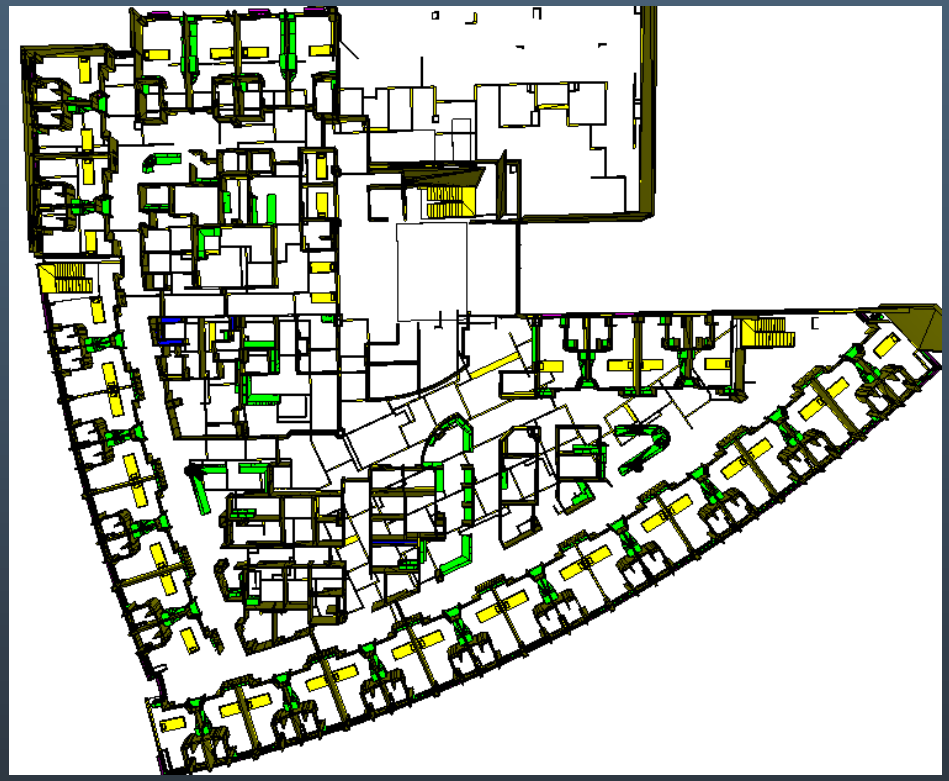
Contents and arrangement



Examples of building layouts

Hospital: patient room floor





AutoCad® files

Revit® files

DXF file usable by PyroSim

FDS input file

“Fuel packages”

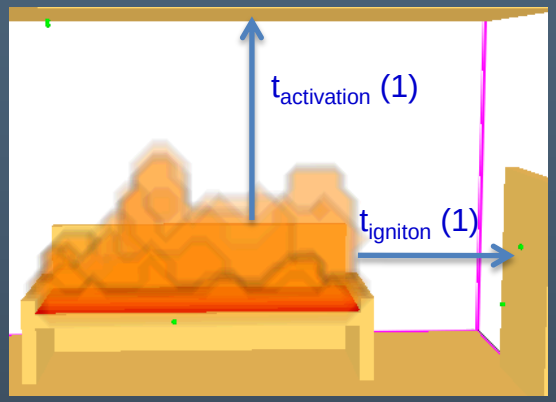
“Fuel packages” are created in order to facilitate the implementation of fire scenarios (Step 6)

- Heat Release Rate curve (lots of available information)
- Smoke and fire effluents (less available information)

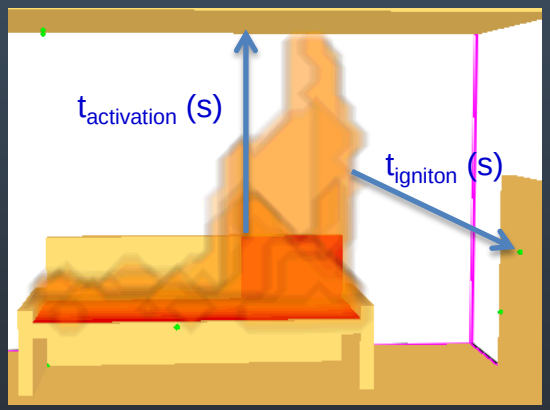
- Database of experiments (one component used for all fire effects tools)
- FDS packages for 3-D fire simulations (for study of influence of detailed description on engineering results)

“Fuel packages” near field and far field analyses

NIST experiment of a loveseat combustion



HRR distributed on 1 area



HRR distributed on several areas

Near field analysis

Activation of heat / smoke detectors

Ignition of secondary fuel item

Highly dependant on the location and the flame characteristics

$t_{activation}$ (1) ≠ $t_{activation}$ (s)

$t_{tgnition}$ (1) ≠ $t_{ignition}$ (s)

"Fuel packages" near field and far field analyses

Near field analysis

$t_{activation}$ (HRR distributed on 1 area) $\neq$ $t_{activation}$ (HRR distributed on several areas)

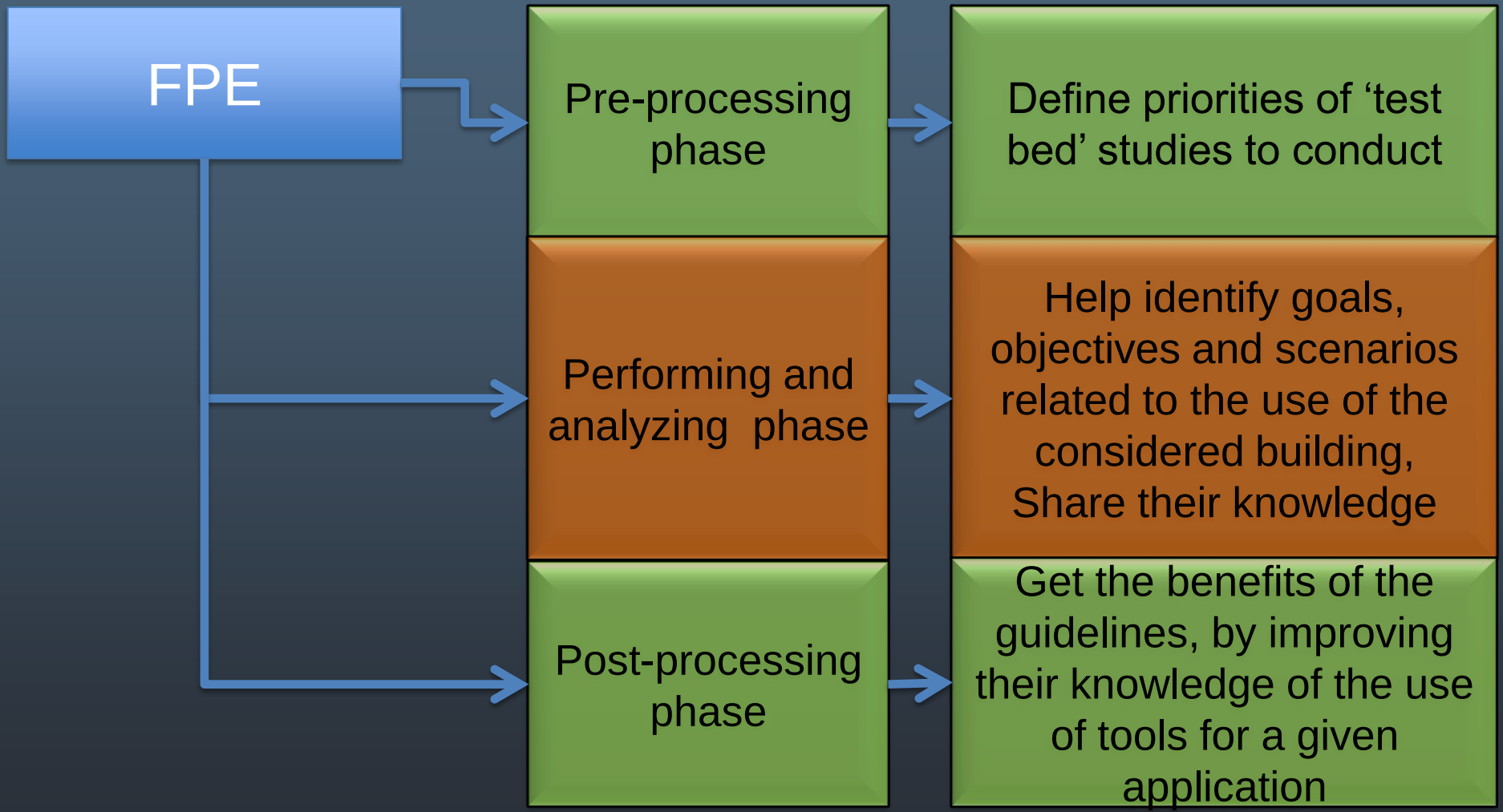
$t_{tgnition}$ (HRR distributed on 1 area) $\neq$ $t_{ignition}$ (HRR distributed on several areas)

Do these differences matter for the overall engineering analysis?

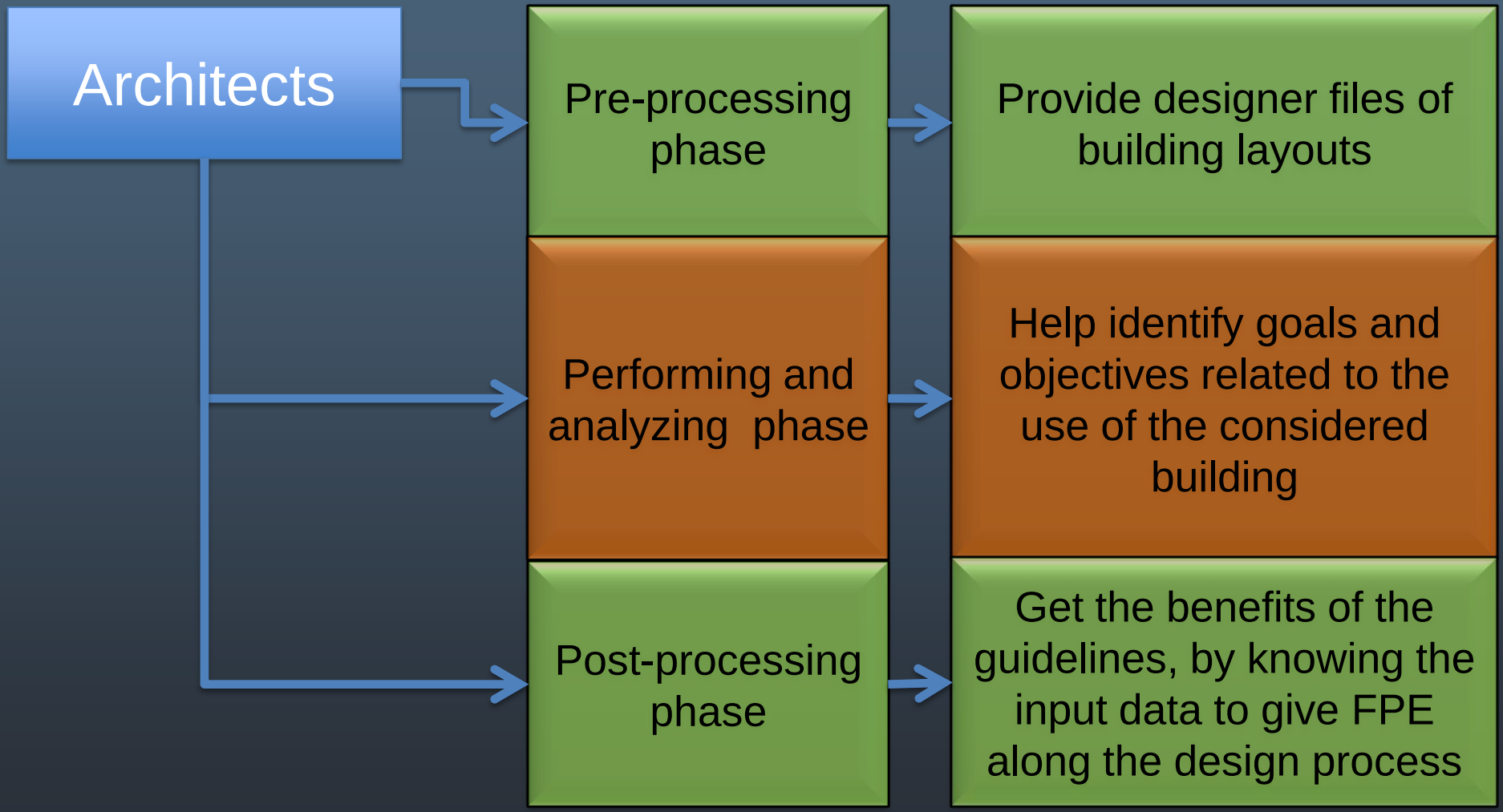
Far field analysis

The level of details required for near field analysis is not the same for far field analysis for smoke transport out of the room of fire origin

Participation in the ‘test bed’ studies



Participation in the ‘test bed’ studies



Acknowledgments

This work is supported by grant 60NANB10D228 from the US National Institute of Standards and Technology

Contact information

Thank you for your attention!

If you are interested in participating, please contact me for further information at

al_alvarez@wpi.edu