THE ESP-r COOKBOOK

Strategies for Deploying Virtual Representations of the Build Environment

The ESP-r Check List

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THE CHECKLIST

14.7.1 Introduction

Working with simulation involves a sequence of tasks by the user, the co-ordination of a diverse set of information and, unfortunately, a good memory for recent actions and decisions as well as an anticipation of subsequent tasks. Experts gain much of their power by their acquisition of skills and strategies to cope with the sequence.

In some places the interface provides opportunities for recording assumptions, in some places it gives warnings to record particular data so that a future task will be simplified. And there are many places where there is no clear indication from the interface about what to do next. The checklist that follows is a summary of *what to pay attention to* and *what to remember to do* when planning and evolving a model.

14.7.2 Planning stage

Gather information about the context of the project such as site details and nearby buildings and ground forms.

- □ latitude, longitude, elevation
- □ urban/rural context (how much of the sky is seen)
- □ scale of the site (how far beyond the building is of interest)
- □ orientation e.g. which way is north, site placement issues.
- □ surrounding buildings and hills (for solar and wind access),
- □ site photographs (to include in the model folder)

Gather information about weather patterns to ensure that the building calibration and assessments identify sensitivity to the climate.

- □ typical and extreme conditions (weeks which may stress the building and weeks when systems are working at part load)
- □ when seasons change (occupant preferences may change)
- □ prevailing wind direction (impacts on heat transfer and ventilation)
- □ duration of extreme conditions (are boundary conditions steady state or transient)

Gather information about the building form and composition from the design team. Depending on the point in the design process a number of assumptions might be required.

- □ plans of typical typical floors (do they indicate materials and section cut lines?)
- □ sections at the core, facade, roof, foundation and junctions (to derive critical dimensions and relationships)
- □ details of facade, spandrels, window and door framing, floor structure, potential thermal bridges
- □ elevations for each facade (to understand if elements repeat) and to help plan how the facade will be

represented)

- □ artists renderings or CAD views (to detect changes in materials as well as design ideas that may be obscured in plans and sections)
- □ photos of the site, adjacent buildings, planning models

Gather information about how the building is likely to be used and the occupants of the building.

- □ requirements for environmental controls (for each type of room use), short list of possible system types
- □ information on likely room uses (number of people, diversity)
- □ short list of possible lighting types
- □ short list of likely small power loads and their diversity
- □ information on alternative building uses (future-proofing)

Gather a short-list of likely candidates for building composition (in preparation for what-if questions).

- □ materials - review the current databases, identify gaps in the material types,
- □ identify unique materials to be added
- □ constructions - review the current databases for exact and close matches to the needs of the project
- □ define new constructions required or place-holder constructions to be updated later.
- □ optical properties - glazing manufacturers may require time to supply the details needed by simulation
- □ review current databases for exact and close matches and identify where new items are required
- □ operational characteristics of blinds - blind control may be an issue for the building.
- □ types of windows and how they might be operated may be issues for control as well as for flow networks.

Talk to the design team about what they think is important in their design. Check beliefs or assumptions about how the building will work that may need numerical confirmation.

- □ schematic sketches can give clues as to how they think buildings work
- □ design meetings may include discussions of performance which can be tested
- □ design meetings typically include *what if* questions that may need to be confirmed by simulation
- □ design meetings may include clues as to future concerns which may need to be assessed (early warning)

There may be a similar project in the model archives that can provide indicators of successful simulation approaches.

- □ approaches taken in the past (size of team, sequence of tasks)
- □ performance issues dealt with
- □ skills required via staff or via consultant
- □ resources required (is the past a good indicator of current productivity

- ☐ was the past project in budget
- ☐ outcomes of the project (are similar deliverables appropriate)

Consolidate the available information and create a work plan for the current project.

- ☐ sequence of work tasks (critical path bottlenecks)
- ☐ assign staff to tasks and plan for alternatives in case of sickness
- ☐ identify points where interactions with the design team should be scheduled

Plan the simulation model(s) taking into account the issues that needs of the design team, the available staff and the pace of the design process.

- ☐ scale of the model (whole building or selected portions)
- ☐ level of detail required in various portions of the building for current and future design issues
- ☐ number of design variants, relationship with the base case, schemes for managing model evolution and creation of design variants
- ☐ identify analysis domains to be included in the model and expertise required to work with these domains
- ☐ identify which consultants may need to be on-call for the project

Sketch the model composition, iterate as required to arrive at a consensus of the model composition and form. Iterate on alternative approaches.

- ☐ record critical plan and elevation co-ordinates
- ☐ identify zones (use tracing paper or virtual overlays of the drawings)
- ☐ identify where geometry can be abstract and where detail is necessary
- ☐ decide on a naming scheme to use for zones and surfaces (take into account whether the building orientation is a design variant)
- ☐ gather documentation to be included in the model

Record ideas and patterns related to how the building is used and the temporal nature of occupants and lights and small power loads.

- ☐ occupancy patterns for each day type and zone or room use
- ☐ identify common patterns, consider creating an operations file for the pattern folder or creating event profiles for later use
- ☐ sketch the patterns of control for each day type and zone or room use
- ☐ identify common patterns, consider creating initial generic control loops which can be copied and adapted to specific requirements

Identify where additional thermophysical resolution is needed or additional solution domains will be needed

- ☐ solar distribution in rooms - diffuse distribution or calculated distribution
- ☐ solar shading devices
- ☐ radiant exchanges in rooms - area/emissivity weighted or calculated view factors
- ☐ air movement between rooms - scheduled or dynamically

calculated

- □ infiltration - scheduled or dynamically calculated
- □ facade controls - always closed, user controlled, automatic controls
- □ system component networks - sketches of component layouts, research into the attributes of components
- □ controls applied to system components - sketches of control logic, review of other models using similar controls
- □ electrical power networks - sketches of component layouts, research into the attributes of electrical components
- □ agree on a naming strategy for entities in networks

Identify future model variants, plan how and when variants will be created, how model variants will be identified and what dependencies might need to be resolved.

- □ identify design issues requiring model variants (e.g. *what if partitions are heavy weight rather than light weight*)
- □ for each type of model variant confirm an approach (e.g. use model variant facility, copy model folders, archive and evolve current model)
- □ naming schemes and documentation needed to support model variants
- □ file management strategies and archival strategies

Plan the assessments to be carried out - what will be measured, what periods should be assessed, what format should performance data take and if data recovery should be automated.

- □ assessments for model calibration
- □ assessments for establishing peak and capacity issues
- □ assessments identifying building performance at part-load
- □ production assessments (seasonal or annual)
- □ search for scripts used in past projects (and test them to confirm they still work)
- □ review reports generated in past projects, define what reporting is appropriate for the current project
- □ assign staff to check model details
- □ assign staff to check performance patterns
- □ identify issues where outside/expert assistance is required.

Identify relevant data from prior work which can be imported into the project

- □ ensure the data is available to relevant staff
- □ confirm if a past model can be adapted for the current project
- □ confirm if database entries used in past projects can be imported

14.7.3 Review stage

Before creating the model, the simulation team should review the information collected and the evidence of past projects and the needs of the current project. Update the work plan and arrive at a consensus for the model creation phase.

- ☐ agree level of geometric detail
- ☐ agree level of thermophysical detail
- ☐ agree patterns of occupancy, lighting, small power
- ☐ agree calibration and production assessment regimes
- ☐ agree the characteristics of what will be measured during the simulation
- ☐ agree what else needs to be measured to limit risk of unintended consequences

Plan the sequence of tasks related to zone creation and attribution.

- ☐ define the order in which the zones will be created
- ☐ fine-tune zone details to allow re-use of typical components
- ☐ identify which rooms can be generated via copy operations and how much attribution can be given to zones prior to such operations
- ☐ identify if zones can be defined via *click-on-bitmap* or by import from CAD or by dimensional input.
- ☐ identify the initial shape of each zone (rectangular box, floor plan extrusion, general polygon enclosure) and what transforms will be needed to adapt the initial enclosure shape
- ☐ identify rotations and transforms to be applied to the building to bring it to site alignment (and when to apply the transform)
- ☐ decide if the internal clutter in zones (furniture, storage) is thermally important

Establish control relationships with systems, flow networks, and zone controls with thermal zones

- ☐ confirm thermal zones match resolution of flow network nodes
- ☐ plan locations of boundary nodes for flow networks
- ☐ identify approaches for representing floor heating systems or chilled ceilings

Generate a todo list for each of the zones so that all aspects of the model and state of model attribution and networks can be checked for completion

- ☐ zone geometry complete
- ☐ surface attribution (names, composition) complete
- ☐ model topology checked and each surface with correct boundary condition
- ☐ shading obstructions created
- ☐ shading and insolation calculations completed or updated
- ☐ heat transfer coefficient regimes defined
- ☐ MRT sensors defined in zone
- ☐ surface to surface view-factors calculated or updated
- ☐ lighting zones and controls defined
- ☐ air flow schedules for zone defined
- ☐ casual gains for zones defined
- ☐ documentation of zone schedules
- ☐ zone construction files created or updated

14.7.4 Model creation

And now the dance with the software begins. According to the *Cookbook* procedures users will typically being with site information and then proceed to update and configure databases in order to have available these entities before zones are created.

- ☐ enter the registration phase and define site details
- ☐ copy images into the model `images` folder and associate images with the model
- ☐ start the project log file
- ☐ populate the model `doc` folder with relevant documents
- ☐ populate databases with entities to be used in the model
- ☐ create placeholder database entries (for later updating) and note this in the project log file
- ☐ archive the model folder
- ☐ using the planning sketches create zones or import data from CAD tools
- ☐ attribute zones and surfaces according to the plan
- ☐ make periodic archives of the model as it evolves (goal is to never loose more than 15 minutes work)
- ☐ mark completed tasks on the todo list
- ☐ create a model QA report, print it out and review in conjunction with the wire frame views of the model and the initial planning sketches
- ☐ establish or re-check the model topology until all surface boundary conditions are known
- ☐ create a model contents (QA) report and review details to ensure that the surface names, composition and boundary conditions are coherent.
- ☐ after surfaces are fully attributed create the zone constructions based on the surface attributes
- ☐ if there are optical controls add them
- ☐ using the planning sketches and documents create zone schedules, make use of event profiles or existing operation/pattern files where possible
- ☐ document the schedules
- ☐ create a new model QA report, print it out and review the schedules against the planning documents
- ☐ make an archive of the model prior to increasing model resolution or performing global transforms and rotations
- ☐ rotate and transform the model if necessary
- ☐ confirm the new orientations and position
- ☐ perform shading calculations if necessary
- ☐ calculate surface view-factors if necessary
- ☐ create a new model QA report, print it out and review the additional resolution sections of the report
- ☐ making reference to the planning documents, define the sets of simulations to be performed via the Integrated Performance View interface.

- ☐ have the model checked for consistency, pass the model and the model contents report
- ☐ correct issues found during the model checking

14.7.5 Model calibration

At this stage it is essential to check that the model is syntactically correct and the performance of the model has some credibility. The initial stage should be done with the building without environmental controls

- ☐ choose a transition season week and run an initial assessment of the model
- ☐ confirm how well the building works without mechanical intervention and the temporal nature of the response to changes in climate and in changes in occupancy patterns
- ☐ make a note of any hours when the building performance is close to acceptable without environment controls
- ☐ add in environmental controls and any control related to networks in the model
- ☐ generate a QA report and focus on the control section and the planning documents and sketches for control
- ☐ run short period assessments starting with the transition season, to confirm that the control is functioning properly at different times of the year
- ☐ referencing the planning documents, investigate each of the performance indicators of interest to the design team
- ☐ investigate each of the second set of performance indicators related to unintended consequences
- ☐ run assessments at a shorter and a longer time-step to ensure that predictions are not sensitive to your initial choice of simulation time-step.
- ☐ make an archive of the model (results files are optional)
- ☐ make a second pass with the results analysis module to capture the graphs and generate tables and reports which identify issues to report to others in the design team
- ☐ present initial findings to others in the team
- ☐ have the model checked for consistency, confirm that the initial plan for assessments is still appropriate
- ☐ distribute the model for others to test and update the model to reflect their suggestions
- ☐ update the model log

14.7.6 Model assessments and understanding

The production cycle has an initial focus to implement the planned assessments and recover the planned performance indicators. This is also a good time to divert some of the teams focus on interactive explorations looking for opportunities to enhance performance and as a second pass looking for critical performance failures or issues with the model.,

- ☐ relocate the model to a compute server if available and re-run selected tests to ensure the model was transferred correctly

- □ if production work is automated, prove the script, document the logic of the script
- □ begin production runs
- □ inspect reports as they are generated to identify any production stage errors
- □ have a team member continue with interactive explorations of performance, scanning for unintended performance patterns
- □ scan predictions for performance patterns that indicate options for improving the building design
- □ if possible work interactively with the design team to present current findings and to allow drilling-down into the data for clarification
- □ if what-if questions are raised identify whether the current model can address the issue or if a model variant will be necessary

14.7.7 Project review

While information is fresh discuss the project with the team in terms of how well the work confirmed the initial planning goals.

- □ update the model documentation with assumptions and reasons for the various model configuration files and assessments and reports
- □ document the resources used in the project
- □ document issues that caused problems in the project
- □ check the contents of the model folder for files which are no longer relevant
- □ archive the model (results files are optional)