2017 International Radiance Workshop

Integrating Radiance with OpenStudio's Parametric Analysis Tool

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Obligatory Eclipse Photo! [LAT 39.98, LON -105.24, MAG 0.94, FBL 76]
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- The Radiance community at large; you are all an inspiration to me

[In addition, several features of the Radiance Measure were developed for work under the Wells Fargo Innovation Incubator (IN^2) project.]
Agenda

- Existing work
  - OpenStudio Analysis Framework (OSAF)
  - The OpenStudio Measure Framework
- Case Study, Part I - The Problem
- OpenStudio Radiance Measure - The Solution(?)
- Case Study, Part II - Application
- Conclusions/Next Steps
Existing Work
OpenStudio & Measures

- Integrated application suite, SDK, and API for parametric building energy modeling
- Model/API for building energy modeling
- Application, SketchUp plugin, Parametric Analysis Tool (PAT)
- Ruby-based API for model generation, manipulation, and reporting

OpenStudio Analysis Framework

- Containerized (Docker) OpenStudio instance (and many helper programs) for large scale analysis using OpenStudio and measures
- Spreadsheet-based problem generation, supporting advanced analysis problem generation and sampling (Morris method, LHS, et al.)
- Parametric Analytic Tool (PAT v2.0) Released
Case Study, Part I

[Da' Problem]
Technology Evaluation

- Investigate energy savings and glare control potential via "climate sweep"

- Large scale analysis of the product prototype on multiple, exemplar, commercial building types and climate zones

- Use Radiance to calculate Dynamic Daylight Metrics and account for spatial, climate-based daylight distributions (DA/cDA/UDI)

- Compare energy savings and daylight metrics of study building models with and without product installed
Meanwhile, in OpenStudio...
Meanwhile...

Tedious Model Creation

- No automated way to add daylighting objects to models
- No ability to model shading controls (i.e., no dynamic windows)

Limited output

- No daylight metrics

Limited batch processing

- Radiance Implementation "glued on" to OS GUI:
- Batch processing only via command line
- **No Access** to Measures, PAT, Spreadsheet, OS-Server [this is lame]
Previously...

IDEAKit
Climate Sweep

Suboptimal Cluster Computing Resource

- Three (3) Macbook Pros
- Coffee
- Comfy Chair
- Dog (moral support)

Job creation, queuing, results collation and processing all performed by one (1) human (not shown).
Previously...

IDEAKit
Climate
Sweep

Manual model generation + Manual process
distribution and management = Lean dataset

- 2 building types
- 2 climate zones
- 4 Daylighting ECMs, but very coarse sampling
#TODO

- Support Shading Controls
  - Switchable Glazing
  - Daylight Redirection Devices
  - Traditional (e.g. blinds, shadecloth)
- "Measureize" the existing Radiance workflow
  - Radiance can leverage entire OpenStudio ecosystem
- New measures to add daylighting elements to model automatically
Measurification of the Radiance Workflow
Oh man, it was super hard! Look:

```cpp
class RadianceMeasure : OpenStudio::Ruleset::ModelUserScript
```

- The OpenStudio API offers a macro* class for easy script generation within the OpenStudio application ecosystem

*Some folks call 'em macros, or scripts. We call 'em measures (mmm-hmmm).
Radiance Measure

Radiance simulation workflow can be applied via OpenStudio Application:
Radiance Measure

...or via the Parametric Analysis Tool:
New Radiance Functionality
Support for dynamic windows in OpenStudio

Complex fenestration with bidirectional scatter distribution functions (BSDFs)

- Blinds
- Shadecloth
- Daylight Redirecting Devices

Dynamic glazings via multi-pass Radiance runs

- Traditional Radiance materials *glass* and *trans* materials
Generate sensor views of models, with Radiance
Generate "debug images" of each window group
Calculate daylight illuminance per window group
Case Study Part II
IN2 Climate Sweep

Proving ground for Radiance Measure

- Broke OpenStudio Server
  - Data merges overran available memory
- added silly hacks to git'er done, e.g.:

```python
# check for number of rmtxop processes
def merge_count()
    return `pgrep rmtxop`.split.size
end

... while merge_count() > 2
    puts "waiting in rmtxop queue..."
    sleep(5)
end

rad_command = "dctimestep output/dc/#{wg}.vmx \ annual-sky.mtx | rmtxop -fa -c 47.4 120 11.6 - \ > output/ts/#{wg}.ill"
exec_statement(rad_command, runner)
```

- Still broke server
  - Output overran available storage
- Ultimately had to reduce the parameter space
  - 1 building type (Small Office)
  - 16 climate zones
  - base case/lighting controls/shading controls (SmarterShade)
Conclusions, Benefits, What Have You
Benefits

Wells Fargo IN2 Project

- Determined ideal use cases for product
- Verified pre-existing concerns WRT ultimate energy efficiency potential

NREL

- Vastly improved the Radiance integration within OpenStudio
- Added functionality
  - Works with other measures (e.g. in a parametric matrix)
  - PAT
  - OpenStudio Spreadsheet
Conclusions

"Just because you can, doesn't mean you should."

hey Ry, I need some stats
wondering how many simulations you are doing these days
for your COMSTOCK work, et al.
just rough numbers

Tue, 4:02 PM

H
I'll be running a 20k test later this week. Residential
runs 350k for a single national scale run. Each EXM
gets its own run. I'm not sure what my number will be
yet. Probably 1 million, although I'll most likely
segment those runs by census region or division.
A big ass residential run now clocks in at 20 mil sims.

Henry • Tue, 6:04 PM

Perfect, thank you!!

Tue, 6:31 PM
Conclusions

Running Radiance on an entire building, at a resolution to support complex fenestration devices AND dynamic daylight metrics, is intractible:

- Not enough time
- Not enough memory (RAM)
- Not enough storage

And "the cloud" is of little help; it just masks the mountain.
Next Steps

Give users ability to:

- Tag spaces (or groups of spaces) for Radiance analysis
- Apply shade & lighting schedules from exemplar spaces to similar spaces

Add new measures for:

- Simple reporting of static data
- Interactive data browsing and manipulation (e.g. sensor setpoint optimization)

What Else?

- Many presentations this week have illustrated these issues remain
- Any Takers?
  - Partnerships?
    - Bueller?
    - Bueller?!
The good news...
New Radiance Packages [Windows too!]
Questions?

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[thank you. [:]]