

Open Web Tools and OpenStudio

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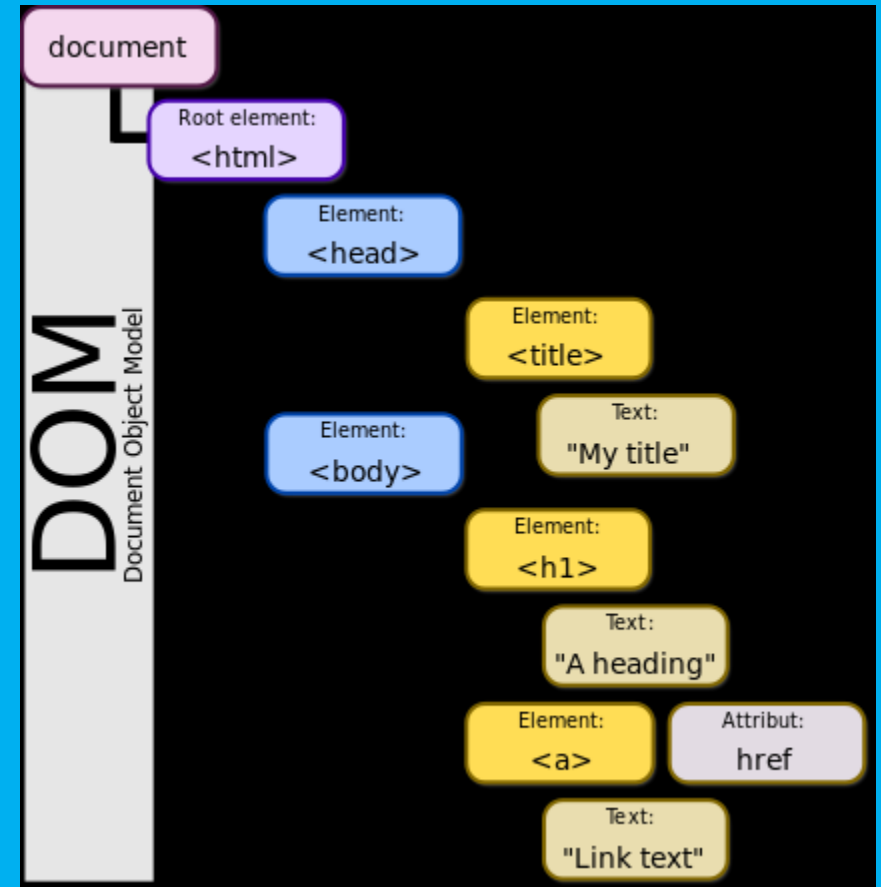
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Outline

- ***Understand D3.js terminology and uses***
 - Background on d3.js
 - SFO lobby thermal analysis
 - Hydra
 - Pollinator
- ***OpenStudio API – How it we've used it, learning resources***
 - OpenStudio as an API for EnergyPlus
 - Measures
 - Command Line Interface
- **Open Tools / Open Problems**

Web Languages

- Document Object Model (**DOM**)
- DOM interprets HyperText Markup Language (**HTML**) as a *tree*, each piece is an *object*.
- Javascript “the language of the web” can interact with these nodes – move them around, change text, etc.
- Scaled Vector Graphics (**SVG**) – XML format that contains instructions on how to draw graphics



Data-driven-documents - D3.js – by Mike Bostock

- A nifty library to bind data to objects in the DOM, including SVG objects
- Size, shape, and color objects based on data

```
1 <!DOCTYPE html>
2 <meta charset="utf-8">
3 <title>Bar Chart Example</title>
4
5 <script src="https://d3js.org/d3.v4.min.js"></script>
6
7 <body>
8   <p id="chart">Example Bar Chart</p>
9 </body>
10
11 <script>
12   var data = [2,3,5,7,11,13]
13
14   var svg = d3.select("#chart").append("svg")
15     .attr("width",800)
16     .attr("height",400);
17
18   svg.selectAll("g")
19     .data(data)
20     .enter().append("rect")
21     .attr("transform", function(d,i){ return "translate(0," + i * 20 + ")" });
22     .attr("width", function(d){return d*30;})
23     .attr("height", "12")
24     .style("fill", "green")
25 </script>
```

D3.js examples

NYTimes buy vs. rent calculator

<https://www.nytimes.com/interactive/2014/upshot/buy-rent-calculator.html>

SFO Administration Building Lobby

HydraShare

<https://hydrashare.github.io/hydra/>

Pollination

<http://honeypatch.github.io/pollination/index>

ewpmap, epwvis

<http://www.ladybug.tools/ewpmap/>

<https://mdahlhausen.github.io/epwvis/>

OpenStudio API

- OpenStudio is an **A**pplication **P**rogramming **I**nterface (**API**) for EnergyPlus
- Casts EnergyPlus items as objects, with associated values and methods
<https://www.openstudio.net/developers>
- OpenStudio measures are ruby scripts that make changes to a model, available on the **B**uilding **C**omponent **L**ibrary (**BCL**). <https://bcl.nrel.gov/> (e.g. change lighting power density, add whole HVAC, LEED baseline)
http://nrel.github.io/OpenStudio-user-documentation/getting_started/about_measures/
- Has built-in support for data analysis and cloud-simulations through OpenStudio server
- Run / report simulations through the command line
- These are accessible through a **G**raphical **U**ser **I**nterface (**GUI**) in the form of the OpenStudio App and **P**arametric **A**nalysis **T**ool (**PAT**)

OpenStudio API example

Title 24 Codes and Standards

- Demonstrate savings for measures across multiple building types and 16 California climate zones
- Made OpenStudio measure to calculate Time Dependent Valuation (**TDV**)
- OpenStudio command line interface with simple ruby scripts to run and read results for multiple building types in all climate zones

OpenStudio API

Where to go for help:

<https://www.openstudio.net/>

<https://unmethours.com/>

<https://unmethours.slack.com/messages>

Open Tools

Projects shown today are open source and built with open tools

- D3.js
 - OpenStudio
 - Building Component Library
 - Github (<https://github.com/>)
-
- + Share-alike
 - + Other people contribute to code
 - + Good for under-resourced industry
-
- Monetize / recoup development costs
 - Differentiate services

Open Problems

What can we do with better/faster tools?

- Answer different questions
- Faster turn-around to designers / engage earlier, often
- Decision makers (architects) experience gap vs. experts (engineers)
- More confidence in results, account for uncertainty
- More projects

Generic Model Input/Output / “Data Munging”

- Revit / Arch geometry to energy models, gbXML
- Drawings / Specifications to model parameters
- Building code checks / LEED
- Standard Reporting

Future of modeling software

- Infiltration / natural ventilation / airflow / pressure networks
- Occupancy/Plug load integration in models
- Radiant systems / loads / comfort
- Controls integration

Questions?

Skillsets

General purpose scripting / object-oriented programming

- Web languages (HTML, javascript, D3.js)
- Ruby / Python
- Software control / Git

Statistics and Data Science

- Python pandas, R
- Regression methods, machine learning methods
- Sampling, uncertainty, monte carlo methods

Choosing a language for your project

I want to:

- Simple stuff, e.g. parse a bunch of files → Python, Ruby
- Execute a bunch of commands → Bash/Shell script
- Write an OpenStudio measure → Ruby OpenStudio API
- Write a web application → Javascript, CSS, PHP, Python, Ruby
- Make a web visualization → d3.js (javascript)
- Make a 3D web visualization → three.js (javascript)
- Work with applications (e.g. Revit, Unity) → C#, Visual Basic .Net
- Run a bunch of statistics on my data → R, Python with pandas package
- Do lots matrix calculations → C++
- Write Apps for smartphones → Objective-C, Java, C++

Online Resources

- Most popular programming languages:
 - http://www.tiobe.com/tiobe_index
 - <http://githut.info/>
 - *** Just because a language is popular doesn't mean it is a good fit for your task!!!
- Programmer competency matrix:
 - <http://sijinjoseph.com/programmer-competency-matrix/>
- Programming resources:
 - https://wiki.lesswrong.com/wiki/Programming_resources
- Google, StackExchange

Bio::Mathew Dahlhausen

Matthew Dahlhausen is an Energy Modeler with Integral Group, Inc. He is the team's expert on OpenStudio, parametric modeling, scripting, data analysis, and data visualization with web tools. In addition to his work, he is pursuing his doctorate in Mechanical Engineering at the University of Maryland, focusing on building energy model calibration. He holds an M.S. in Architectural Engineering from Penn State, and a B.E. in Environmental Engineering from Dartmouth College. He has authored or co-authored several papers in the field.