SUSTAINABLE DATA COMMUNITY FORUM

Presentation notes from the Sustainable Data Community Forum: Discussion by a community of experts committed to gathering, disseminating, and promoting the sharing of sustainability data.

Chicago, IL
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Sustainable Data Community Forum – Thursday, July 18

Opening Remarks

Aimee Buccellato

Assistant Professor, University of Notre Dame School of Architecture

The impetus for the Green Scale Research Project was an attempt to compare the performance of traditional building materials and methods against modern materials and methods. We need data to make that comparison. While the data exist, they are inaccessible to the point of being unusable: the data are widespread, unorganized, and not readily incorporated into a single workflow.

The success of the Green Scale Research Project is dependent on linking these heterogeneous data and delivering them to researchers, and ultimately, practitioners.

While the GSRP is focused on comparing a specific component of building design and activity, it is logical that an entire building's initial environmental impact and life cycle performance could be analyzed using Linked Open Data.

Currently, multiple building sustainability assessment methods and standards exist, but no single researcher or practitioner has the resources to verify that a given method or standard does, in fact, achieve the highest performing sustainable building possible for a given situation.

Our challenge then, is to develop a strategy for gathering, organizing, and delivering sustainability data to researchers and practitioners. Our approach to this challenge will be guided by the following questions:

- What is the framework that is needed to enable us all to access and utilize the data that exists?
- Where *is* the data?
- How is the data collected?
- What tools are available to generate, source, organize, and deliver data?
- **What actions will we, the Sustainable Data Community, take to realize a sustainable building design and delivery approach based on data-driven judgment?**

Dr. Charles Vardeman

Center for Research Computing, University of Notre Dame School of Architecture

We are familiar with the internet, or the "World Wide Web". On the internet, pages—quite literally, documents—are linked to one another. These documents are often quite interactive, but they are ultimately documents. Simpler still, the internet links things.

Compare this to the Semantic Web that links *concepts*, as opposed to finite things. Using ontologies based on RDFs (Resource Description Framework), we can link data by concept.

For example, we can structure an ontology for the concept of our friend, Mary. Once we declare that Mary is a person first, and a female second, the Semantic Web can understand that the concept of "Mary" is a female person, and further, that the concept of "female" is a type of person.

The identification and organizing of concepts associated with data allows links to be created among disparate and heterogeneous data. Without the Semantic web, human judgment would be required to connect and reconnect innumerable data points; **Without the Semantic web, gathering, organizing, and delivering sustainability data to researchers and practitioners for the sake of designing and delivering the highest performing sustainable buildings, would be impossible.**

This workshop will begin to identify ways in which the Semantic Web can support sustainable design, and what this community will do to harness and leverage its power.

END OF "OPENING REMARKS"

Architecture/Industry – Shahin Vassigh

Shahin Vassigh *- Associate Professor, Florida International University, Department of Architecture; Co-Director, Environmental Technology Lab*

How do we *build* a more sustainable future? It is not enough to know past facts. We must be able to forecast an image of the future using data from the past. Further, we must be empowered to act towards realizing that future. Accessible, organized, and relevant data is the resource that will empower us to build a more sustainable future.

The effects of building and development are as numerous and far-reaching as the components of building and development themselves. If we are to make progress toward true sustainable building and development, we must possess the data with which to evaluate each component and its effect on short term and long term performance.

The following identifies the components of building and development activities, the data required to inform them, and the tools that will manage this data in such a way as to capture synergistic opportunities to benefit all stakeholders of the building and development process.

Building Scale – Climate Change Challenges

- Building Scale
    - Energy Use
        - Function and Form
            - Data: Readily Accessed
        - Climate, Site , Orientation
            - Data: Readily Accessed
        - Climate Control Systems
            - Data: Lacking tools
        - Envelope and Materials
            - Data: Lacking tools
        - Technology and Energy Resources
            - Data: Comprehensive database needed
        - Construction Type & Schedule
            - Data: Comprehensive database needed
    - Carbon Footprint
        - Embodied Energy
            - Data: varied, and disparate
        - Embodied Water
            - Data: varied, and disparate
        - Recycle Content
            - Data:
        - Waste Disposal Methods
            - Data:
        - Operational Energy
            - Data:
        - Operational Water
            - Data:

- Resiliency
  - Function and Form
    - Data
  - Location, Site, Climatic Conditions
  - Structural and Foundation Systems
    - Data: What are the systems to resist the forthcoming results of climate change?
  - Construction Type
- Water and Soil – Data specific to Architect and LA
  - Building Function
  - Location and Topography
  - Landscape
  - Waste Management and Soil Erosion and Water Quality

- Data Requirements:
  - Comprehensive Build Material Database
  - Climatic Data with **Future Projections**
    - Current data is historical, rear looking
  - Reliable Energy Performance Data
    - No existing database showcasing how accurate a “sustainable” ranking is?
    - What are our model buildings to use?
  - Expanding Geographic Information System
- Analysis Simulation Tools – many, but disconnected and disparate; we miss “synergistic benefits”
  - We need tools to help us decide the how to build sustainable buildings
  - 3D and BIM
  - Thermal
  - Energy
  - Structural
  - Acoustics
- Data-Driven Outcome
  - Sustainable and Resilient Design Alternative Strategies
  - Post-occupancy Evaluation
    - Critical
    - Direct feedback to improve future efforts
  - New Guidelines, Codes, and Strategies

Community Scale– Climate Change Challenges

- Land Use and Zoning
  - Re-evaluation of Zoning Maps
  - Protection of Vacant Land
  - Promoting Infill Construction
- Landscape Systems
  - Changing Plant Habitation
  - Permeability and Changing Soil Conditions
  - Water Management
    - Data must be made accessible to designers
    - Missing synergistic opportunities
- Storm Runoff Flooding

    - Urban Runoff
    - Runoff Pollution through Impermeable Materials
    - Ground Surface and Flooding
- Data Requirements:
    - New Zoning Maps
    - New Flooding Maps
    - Runoff Contamination Sources Data
    - Integrated Data on Plant Habitation Changes
- Analysis and Simulation Tools
    - Simulation of Alternative Zoning
    - Simulation of Storm water Runoff Impact
    - Simulation of Plant Habitation Changes
- Data-driven Outcome
    - Sustainable and Resilient
    - New Pattern of Community Dwelling and Occupancy
    - New Guidelines, Codes, Strategies

Regional Scale

- Energy Systems
    - Generation
    - Transmission
    - Distribution
- Sea Level Rise
    - Aquifers and Potable Water
    - Flooding and Available Land
    - Impact on Ecosystems
- Water Systems
    - Increase Variability
    - Increased Risk of Flooding
    - Diminished Water Quality
- Transportation Systems
    - Threatened transportation Infrastructure
    - Decreased Reliability and Safety
    - Alternative Transportation Systems
- Data Requirements – see previous
- Analysis and Simulation – “extreme events” analysis
- Data Driven Outcome – see previous, sim.

END OF “ARCHITECTURE / INDUSTRY”

Data-Driven Approach to Architecture – Ryan Smith

***Ryan Smith** – Associate Professor, University of Utah, College of Architecture and Planning; Director, Integrated Technology & Architecture Center (ITAC)*

Ryan Smith first presents some current projects that he and his team are working on. These projects are examples of the practical application of data in building design, construction, and operation.

Next, he discusses the current relationship between Data and Architecture.

Finally, he discusses how a data-driven approach may take shape, and what are the barriers standing in the way of its realization.

Introduction: Current Projects

- Energy modeling software comparisons
- Market-rate housing and energy performance – evaluating the success of these housing projects.
- Which green rating program is most aggressive?
- Solar shading performance examined
- Life-Cycle Accounting
- Leadership in Collaborative Architectural Practice

Why do we need data for architecture?

- “If you can’t measure it , you can’t manage it” –Peter Drucker
- “Not everything that can be counted counts, and not everything that counts can be counted” – W. Bruce Cameron

- Architecture is a Profession (SOCIETY)
- Architecture is a Service (CLIENT)
- Architecture is a Business (DISCIPLINE) – must be solvent

What do we use it for in architecture?

- Building Statistical Data
    - Design
    - Specification
- Operational Performance
- Construction Performance
- Functional Performance Data
    - Sales
    - Healing
    - Learning
    - Productivity
- What is the relationship of the above data with the Contextual Data (Situational, Organizational, Technological)

Who collects the data?

- University of Bath ICE Database

- Companies (e.g. 3Form, others)
- Trade Associations (e.g. AIA, NIB?, BRICK)
- Government (e.g. NREL)

How is it collected and used? What are the barriers?

If architecture is for making buildings,
And buildings are products,
Then apply product performance theory:

Buildings are custom site-produced products, with significant input from the customer:

High customer input defines Architecture as a service profession, and renders production efficiency low—the feedback is introduced during the design and delivery stages as opposed to the conceptual and planning stages.

When should you be getting data? Heavy post-occupancy, and heavy pre-process streamline Process and generate greater profits.

What are some professional models of firms collecting data pre and post?

- Arup Model: We are so big; our huge cash-flow enables it.
- Kieran Timberlake: We make it a point of our practice to re-invest in research. 10%
- Partner Universities with Industry: Knowledge transfer partnerships—company supports PhD student to answer a specific question
- "Hey let's lobby the government for research money"
- Stealth! Off the clock, at lunch, etc.

Currently, there's a scramble to model and analyze during the process. This is inefficient. There should be a data-driven library of best solutions.

Barriers:

- Scale
    - SME's (small medium enterprises)
    - $2T Industry
    - Participants need boundaries – when do we stop measuring?
- Diversity
    - Project types
    - Location and values

  - Specialization
- Competition
  - IP
  - Volatility (worse performing second only to the airport industry)
  - Low expectations: owners, codes, gov't regs, self, discipline WE DON'T DEMAND ENOUGH FROM OURSELVES
- Culture
  - Architecture as Art
  - Basic VS. Applied Research
  - Quantitative vs. Qualitative Research
  - Productive Narcissist (the artist who can solve all the problems and doesn't need data, thankyouverymuch)

Ultimately, we will benefit from a data-driven approach to architecture informed by an understanding of the unique service-industry-meets-product-delivery dichotomy of the architecture discipline.

<u>END OF "DATA-DRIVEN APPROACH TO ARCHITECTURE"</u>

Practicalities of Pursuing Sustainable Architecture – Duane Carter

***Duane Carter, LEED AP –** Architect/ Sustainability Group, Solomon Cordwell Buenz Board President, Foresight Design Initiative*

Duane Carter discusses how data supports and affects the practical approaches to achieving sustainable design. Further, he evaluates the sources, quality, and accessibility of the data, and introduces potential future considerations for the profession.

How do architects use data?

- Programming
  - Use volumes/patterns
  - Data on users/communities
- Benchmarking
  - Energy
  - Water
  - See Shahin's presentation
- Other Performance Factors

Where are we getting this data?

- Usually indirectly – through codes, tables, manufacturers, etc.
- Climate data
- Energy Use benchmarking/goal setting
  - Energy Star – individuals/user driven
  - CBECS – survey of commercial buildings, gov't driven
  - EIA Publications – typical energy usage
- Research reports
  - E.g. daylighting
- Post Occupancy – firms could sell this activity?
  - Sensors—who pays for sensors? What's the return on the investment?
- GIS Data – uncovering building sites for developers.
- Mining other sites
- Automation using real time data

What are the Problems with this data?

- Not easy to find and use
- Fragmentation
- Don't know the context
- Not much granularity to data
- Not graphic – "Architects are kind of like children"
- Secondary nature raises suspicion (is it up to date? Gathered accurately? Etc.)

USGBC

- Have data on several hundred buildings related to LEED credentials
    - Helps evaluate LEED and non-LEED, but begs for granularity
    - Disclosure ordinances unique from LEED identify successes and failures.
- Considering a system of recertification – allow LEED to certify *performance*, not just a snapshot in time
- Dynamic Plaque showing performance

Where can little pieces of data go?

- If architects are doing research on their own, how can we facilitate crowdsourcing?
- Some larger firms with greater resources often publish data.

Municipal Disclosure Ordinances:

- New York
- San Francisco – energy audit required
- Austin
- Are they isolated or combined? Isolated; and what are they asking for? Are the outputs standardized? That might facilitate formulation? Architecture 2030 is working to develop such a model of districts.
- Comparing data – how do we know we're comparing apples to apples.

END OF "DATA APPLIED TO ARCHITECTURE"

SolarShoeBox Energy Simulation Software – Troy Peters

Troy Peters, RA, LEED AP *– Associate Professor, Wentworth Institute of Technology, College of Architecture, Design, and Construction Management*

Problem: Too difficult, too time consuming to learn building simulation software.

Solution: Building simulation software should be made easy to use, and should be used at the earliest stages of design.

SolarShoeBox delivers visual instant input to basic building shape and orientation, after which you can export to a more fine-grained modeling tool.

"If you can make it green, then you win!" Gameification of the process engages more users.

END OF "SOLARSHOEBOX ENERGY SIMULATION SOFTWARE"

Life Cycle Assessment – Kate Simonen

***Kate Simonen, RA, PE** – Assistant Professor, University of Washington, Department of Architecture; Principal, Operation Architecture; Director, Carbon Leadership Forum*

Kate Simonen offers a primer on Life Cycle Assessment, introducing the three phases of LCA (Construction, Use, and Demolition) and dividing the energy use of a building into "Operational" and "Embodied".

She goes on to discuss Environmental Product Declarations (EPDs) and their potential effect on LCA and building design/material specification.

As it relates specifically to the Data Community, LCA (especially the EPD component of the process) is dependent on gathering, organizing, and delivering a vast quantity of data.

Operational energy:

- 80% of total impacts
- As they are reduced, the embodied impacts become more significant

Embodied energy – EPD:

- How you write the standard affects the result (consider gas mileage)
- Challenges:
    - Product Category Rules require development:
        - There are many that must be developed
        - Development takes time and money
        - US market driven = confusing; Europe and Asia, EPD programs are gov't run.
        - Global/regional standards compete
    - Availability and accessibility of Data
        - Data incomplete-missing key processes
        - US data not verified
        - No US money to maintain
        - No US money to expand
        - Best data from Swiss or privately held
    - Comparing EPDs
        - Much data based on industry average
        - Not common to publish range
        - Variability within a product may be more than difference between products—how significant is one EPD number versus another?
        - Business-to-consumer reports can help: defines what a metric means, and its sensitivity.
    - Whole Building Assessment
        - Estimating material quantities
            - Some tools estimate them, but how?
        - Establishing LCA data
            - Data is held by diverse sources: engineers, contractors, subcontractors
        - Availability of data
        - Average data doesn't capture variation
        - Tools

        - Athena Impact Estimator
        - GaBi
        - SimaPro
        - eTool
        - Low Carbon Building calculator
    - Does doing LCA really lead to improvement and design? Comparing construction options
    - **Most effective use of time: develop overarching standards for US building products.**
    - **In the near term, comparing EPDs will be difficult.**
    - Heterogeneous data – Athena makes heterogeneous data comparable; however, Athena is not linked to energy modeling so you can't compare trade-off between embodied energy and operational energy.

END OF "LIFE CYCLE ASSESSMENT"

Incorporating Dynamic Data within LCA – Melissa Bilec

Dr. Melissa Bilec *– Assistant Professor, University of Pittsburgh, Swanson School of Engineering; Director, Construction Management Program and Green Construction Program; Assistant Director for Education & Outreach, Mascaro Center for Sustainable Innovation*

Br. Melissa Bilec continues the LCA discussion by posing the following questions:

- How do we incorporate dynamic data into our energy models?
- How can LCA analysis be made more dynamic?
- Why should we incorporate Internal Environmental Quality into LCA?

Dynamic LCA

How can we pair the systems level performance with the personal experience in the building?
Shortcomings for LCA for buildings:

- Static, one-time snapshots
    - Ignores dynamics of the use phase
    - Assumes year 1 status quo until end of life
    - Ignores changes in the environment and economy that occur during a building's lifetime (often 50+ years)
- **BUILD (Barriers, Understanding, Integration – Life cycle Development Mascaro Center**

Whole-building IEQ:

- External Impacts:
    - Some LCA categories do not exist
    - Some are hard to capture
- Internal Impacts:
    - If you don't incorporate the IEQ, then you miss a lot of performance factors.
- Challenges:
    - Data Collection:
        - Building Automation System for HVAC data: airflows, temperatures, pressures
        - AirCuity OptiNet IAQ sensing system: CO_2, TVOC, PM2.5
        - Electrical panel meters (application specific: lighting, misc; by location)
        - See slide show: /
    - LCA should move to Dynamic + Indoor, versus the current Static.
        - US standardized EPDs
        -

Are we on the right path to creating better building?

[Notes missing]

Are we creating unintended consequences?

[Notes missing]

<u>**END OF "INCORPORATING DYNAMIC DATA WITHIN LCA"**</u>

Expected vs. Actual: Occupant Data Guiding Future Design – Dr. Kyle Konis

***Dr. Kyle Konis, AIA** – Assistant Professor, University of Southern California, School of Architecture*

Dr. Kyle Konis refers to the San Francisco Federal Building case study to discuss the following:

- Unintended consequences stemming from uninformed design decisions,
- IEQ,
- User-generated data, and
- Methods for gathering, organizing, and delivering data.

Field Studies

- Clear statement of design intent
- SF Federal Building
  - Comfort:
    - Anticipated daylighting is less than expected
    - Building overall performs well for solar gain, but actual node performance varies. As a result shading was introduced to lower heat gain, but at the sacrifice of daylighting
  - Behavior:
    - Is building management willing to operate in line with building intent
    - Will end users accept and support design intent and use accordingly?
- Tools to use
  - Field experiments lack accuracy/control of lab experiments
  - Unique tool developed:
    - How do we support interaction and use of the tool?
    - Is it clear why they are using the devices?
- Conclusions of SF Federal test:
  - The devices meant to diffuse light actually were the worst offenders for discomfort
  - We could benefit from a more accessible tool to log subjective reaction:
- Location-aware Mobile Survey Mechanism
  - Mobile
  - Low cost
  - Scalable
  - Ubiquitous
  - Countable
  - _
  - _
  - _

Goals RE: Energy Problem

- Base Load Reduction
- Peak Load Reduction:

    - Tool helps better understand how building applicants actually respond to changes in IEQ.
- Strategies:
    - Manipulation of Thermal Zone
    - Demand controlled ventilation

Why not use existing Energy Information Systems?

- Lack of Systematic Mechanism for Acquiring and Integrating End-User Feedback
- Low Resolution Physical Sensor Infrastructure
- Inability to sense occupancy
- [Notes Missing]
- [Notes Missing]

End-user Acceptance

- First, adopters.
- Then, end user acceptance,
- Then learning and disclosure
- Targets
    - Overcooling
    - Over-ventilation
    - Over illumination

END OF "EXPECTED VS. ACTUAL: OCCUPANT DATA GUIDING FUTURE DESIGN"

Adjusting the Approach to Understanding "Energy Performance"
Kristen Parrish

Dr. Kristen Parrish *– Senior Sustainability Scientist, Global Institute of Sustainability at Arizona State University; Assistant Professor, School of Sustainable Engineering and the Built Environment*

Dr. Kristen Parrish acknowledges a specific approach to understanding energy performance, frequently taken by builders and operators. She offers the example of the **Building Energy Dashboard** and how the construction community considers data:

Energy Management

Design, **Build**, Operate: There is benefit to feedback in this loop which is typically considered feed-forward.

Data, Synergies, Metering

Plan, Do, Check, Act – ISO standard requires a lot of data

What is Energy Performance? Energy Intensity, Energy Use, Energy Consumption, Energy Efficiency, Other

We have to move from "You're not doing as bad" to "You're doing this X well"

BEST Center – Building Efficiency for a Sustainable Tomorrow NSF National Center for Building Technician Education

END OF "ADJUSTING APPROACH TO UNDERSTANDING 'ENERGY PERFORMANCE'"

South Bend, IN: Data-Driven Decision-Making – Jitin Kain

Jitin Kain – Director of City Planning, City of South Bend

Jitlin Kain discusses South Bend's data-driven approach to decision-making, and the overarching question multiple disciplines face: *How do we make sense of heterogeneous data from multiple, disparate sources?*

City goals:

- Basics are easy
- Good Governance
- Economic Development

Guiding Principles

- [Missing Notes]
- [Missing Notes]
- [Missing Notes]

City has the Energy Office tracking energy consumption and usage throughout South Bend. Types of data include:

- Economic Development Data
- Energy Data
- Infrastructure Data
- Environmental Data
- Demographic Data

Project: Clean River

- Smart Sewer System prevents combined sewer overflows
- Sensors report to a central hub which directs runoff efficiently

Accessibility and Dissemination of Data

- Not everyone is on the internet!
- For our purposes, we must rely on a multitude of data collection methods

Project: Code for America (building code inspections)

- Code Enforcement Dashboard
- LocalData
- Procure.io

Community Data Infrastructure

- MetroNet:
- 50 mile fiber optic network
- Unlimited bandwidth and speed

Challenge: How do we make sense of various data from various sources?

END OF "SOUTH BEND, IN: DATA-DRIVEN DECISION-MAKING"

Greater BIM Adoption to Support Data-Driven Design – Shelley Simon

Shelley Simon, AIA, LEED AP – Principal, Beardsley Design Associates

Shelley Simon discusses how BIM is changing the industry, but suggests that the industry is not yet leveraging its power to pursue sustainable design.

Simon also identifies the practical barriers (buy-in, understanding, cost) associated with pursuing and achieving sustainable building design.

Beardsley Design Associates

Typical A/E Firm Design Process – 60 Person A/E firm

How are the sustainability decisions made within the design process?
In creating high performance buildings, what data do we use, and how do we access that data?

Contractors are beginning to understand the shift from drawing to BIM.

Modeling allows us to build virtually, yet we are still beholden to the schedule and client needs. Decisions are being made in parallel with our model, but we would love to see integration in some form.

Decisions are frequently made by first cost analysis. With better more accessible data, we could potentially better motivate clients to make the best decisions.

What else needs to happen?

Assessment, evaluation, and response loop

Coopetition vs. competition in the industry

Development of value proposition, including commitment to life-cycle cost-benefit analysis and cost of design services

Education / mainstream acceptance

END OF "GREATER BIM ADOPTION TO SUPPORT DATA-DRIVEN DESIGN"

Sustainability and the U.S. EPA – Danielle Potts

***Danielle Potts** – ORISE Fellow, Green Historic Preservation, US Environmental Protection Agency, Region 5*

Danielle Potts reports on the ways that sustainability is pursued under the mission of the U.S. EPA to "Protect Human Health and the Environment"

Legacy cities

- Cities with a historical manufacturing base
- Distressed city budgets, low tax base, blight
- Strategic Development to revitalize community

Need:

- Quantify economic and social benefits of Green Infrastructure Projects
- We don't have a framework to manage/approach that data.
- We don't have an operational/implementation model for after gaining that data.

Current Activities:

- Regional Communities Initiative: Northwest Indiana
    - Leverage Existing Assets
    - Improve Quality of Life
    - Quantify Economic Development Impacts and Public Health Benefits
- EPA is at the earliest stages of this work. Interested in strategies and frameworks for data management and implementation.
- Green Historic Preservation Work:
    - Building re-use is easily understood as being valuable and sustainable.
    - From a building performance side, we need case studies to prove that preservation is sustainable in the long term.
    - Preservation Green Lab Report
- EPA resources:
    - www.epa.gov/datafinder
    - www.epa.gov/sustainability/docs/framework-for-sustainability-indicators-at-epa.pdf

END OF "SUSTAINABILITY AND THE U.S. EPA"

All (Data) Things Considered - Randy Deutsch

***Randall Deutsch, AIA, LEED AP** – Associate Professor, University of Illinois at Urbana-Champaign School of Architecture, Managing Principal/ Design Director, Deutsch Insights, Inc.*

Randy Deutsch highlights areas where the AEC industry and Big Data are merging (or would benefit from merging), and poses questions to guide progress toward leveraging data in the architectural process:

- AEC Industry is the last to use data—WHY?!
- What's driving data use in other industries?
- Why is this happening now as opposed to 2010? 2008? Etc.
- What's the business case for incorporating data into our industry?
- Design professionals have a competitive advantage working with the data.
- How will architects adapt to working with quants?
- Do we need to modify architectural curriculum?
- Can data be crunched into a form that can be analyzed by non-experts?
- Where does judgment come in? Data must be translated into an insight.
- How can we ensure our data is high-quality? Can we legally allow others to rely on the data in our models? Can we guarantee that data? Who is liable?

END OF "ALL (DATA) THINGS CONSIDERED"

Campus Energy Consumption Known-Unknowns – Dr. Rachel Novick

***Dr. Rachel Novick** – Education and Outreach Program Manager, Office of Sustainability, University of Notre Dame*

Dr. Rachel Novick discusses the challenges in generating and evaluating operational data, and the challenge of implementing change within a large organization.

Goals:

Reduce emissions
Responsible resource usage
Improve outreach and education

What we know:

Energy:

- Electricity meters read manually once a month, one meter per building
- Steam metered at plant; per building use estimated based on GSF and type
- Chilled Water metered at plant; per building use estimated based on GSF and type
- Current Fume hood % open data can be viewed on CBAS

Water:

- Domestic water metered at sanitary sewer pipe leaving campus
- Irrigation water calculated by subtracting domestic water from well meter total
- Hot water metered at plant

Materials:

- Limited data on building materials
- No end-of-use policies

Building Design:

- Input at 50% design development documents

What we wish we knew:

Energy:

- Real time metering, sub metering by section or use
- Real time metering of steam building level
- Real time metering of chilled water at building level
- Fume hood trends stored and alarms generated

Water:

- Domestic water metered at building level
- Irrigation system records water output
- Hot water metered at building level

Materials:

- Inventory of building materials and items installed
- Take-back programs for building materials when they are no longer usable

Building Design:

- Input at conceptual stage. Current input is requested well into Design Development

END OF "CAMPUS ENERGY CONSUMPTION KNOWN-UNKNOWNS"

Thesauri and Linked Open Data – Robin Johnson

***Robin Johnson** – Editor, The Art & Architecture Thesaurus (AAT), Getty Research Institute*

Robin Johnson discusses "The Getty Vocabularies: Valuable Tools for Art Information Management in the Age of Linked Open Data," specifically addressing the following:

How is Linked Open Data used, and how can it support various subject foci.

What are The Getty Vocabularies

Structured, multi-lingual vocabularies that allow user to Discover, link, access, retrieve, research, catalogue, index

Art and Architecture Thesaurus (AAT)

Global scope

Grows through contributions from global user community

Union List of Artist Names (ULAN)

Artists

The Getty Thesaurus of Geographic Names (TGN)

[Notes missing]

Data-sourcing

Loading data from NGIA

The Cultural Objects Name Authority

[Notes missing]

Conclusion / Take-aways

- One of the most powerful potentials offered by web technology is the ability to electronically link related resources
- AAT is moving to the Linked Open Data Cloud
- Goal – data from different sources collected and queried.
  - How? Relationships:
    - Equivalence Relationships
    - Hierarchical Relationship
    - Associative Relationship

<u>END OF "THESAURI AND LINKED OPEN DATA"</u>

The Semantic Web and Internet of Things – Michelle Cheatham

***Michelle Cheatham** – Graduate Research Assistant, Wright State University, Department of Computer Science and the Ohio Center of Excellence in Knowledge-enabled Computing (Kno.e.sis)*

Michelle Cheatham expands on Dr. Vardeman's Opening Remarks regarding the Semantic Web.

The following provides examples of the Semantic Web in action, and discusses how ontologies can be applied to various activities and processes.

The Semantic Web

How do you tell the computer that two *different* terms *mean* the same thing?

Today's Web – requires background knowledge and language:

- Links between web pages
- Understanding requires natural language processing and background knowledge
- Content and Presentation are mixed
- Tags include "table", "heading" and "font"

The Semantic Web:

- Links between concepts (data)
- Understanding requires following links and reasoning over logic formalisms
- Content and Presentation are distinct
- Tags include "subClassOf", "sameAs", and "disjointFrom"

Why is this a big deal?
Rather than stand-alone databases, we can take advantage of all the databases to empower new and better ideas and applications.

The Internet of Things

Everyday things have an Internet presence. Ubiquitous computing allows extensive measurement/data collection.

Enabling technologies like RFID tags, EPC, and embedded sensors

Case Studies:

- USC's campus has over 170 buildings with 50,000 sensors; data is published as RDF triples; semantic-aware complex event processor is used to dynamically respond during peak load periods; Queries such as "Alert me when the space temperature in a non-occupied meeting room is lower than the green building temperature"; Semantic layer enables easier, wider applied use

- Dublin, Ireland traffic congestion remediation. Ontologies and RDF wrappers allow recognition of similar but not identical causes—previously, computer could only recognize problems that were EXACTLY the same as before.
- Christopher Alexander and Architectural Design Patterns – encoding best practices for typical design decisions. Ontology design patterns exist for the same purpose

Research Trends:

- Model new domains
- Handling heterogeneous data
- Adding semantic layers to existing data mining, machine learning, and reasoning systems

END OF "THE SEMANTIC WEB AND INTERNET OF THINGS"

Twenty Questions – Dr. Charles F. Vardeman

We should consider developing Twenty Questions to guide future discussion and work regarding data applied to sustainable building:

"20 queries" 5 questions is not enough; 100 would result in a lack of focus. The community should develop 20 questions to guide the next phase of work.

Utility in developing formal ontologies. They require more work up front, but you save time and money in the long run, and facilitate new data entry in the future.

How do we enable the long tail for sustainability data? It has already begun—the internet of things.

Complete the loop—support the community interested in sustainability data.

[Question development continues post-forum]

END OF "TWENTY QUESTIONS"

END OF DAY 1

Sustainable Data Community Forum – Friday, July 19

Network Science and Applications – Dr. Tracy Kijewski-Correa and Dr. David Hachen

Dr. Tracey Kijewski-Correa, PE (co-PI) *– Leo E and Patti Ruth Linbeck Collegiate Chair and Associate Professor, University of Notre Dame, Department of Civil & Environmental Engineering & Earth Sciences; Director, DYNAMO Lab – ND*
Dr. David Hachen (co-PI) *– Associate Professor of Sociology, University of Notre Dame, College of Engineering; Co-Director, Interdisciplinary Center for Network Science and Applications (iCeNSA)*

Dr. Kijewski-Correa and Dr. Hachen introduce the power of Virtual Organizations, and discuss how they can be successfully formed and operated.

Virtual Communities

- How are they formed? Ad-hoc or concerted sponsored effort.
- Group whose members and resources are dispersed geographically yet who function as a coherent unit through the use of **cyberinfrastrcutre**
- Both have to be designed with sensitivity to group structure and goal
- Why? Sharing in real time to conquer problems that are too great for an individual; ultimately sharing can make you more competitive.
- Incentives and value proposition – must be well understood and implemented to keep participants engaged
- How do they function? Computational enhancement is key tool. Bigger, faster, stronger computers facilitate.

4 Dimensions of Sharing for VOs

- Shared human resources
- Shared hardware
- Shared software
- Shared knowledge

How do you do it? How do you get everyone to share their toys?

- Why *would* I share my toys?
    - Mutually beneficial – value proposition to each/every individual
    - Greater good
    - Competitive advantage
    - Best way to grow your piece of the pie is to grow the pie: Co-opetition (Adam Bradenburger)
- Needs for success:
    - Flexibility and interoperability

Beyond the VO

Examples:

- Nanohub.org (National Science Foundation)
- Biomedical Informatics Research Network (National Institute of Health)
    - Liability and security of information
- NEEShub – network for earthquake engineering simulation (NSF)
    - Structural engineering sharing with open management

  - Data management structure protects IP by strategically exposing/rolling-out data
  - Liability issue is also addressed successfully

What about grass roots VOs lacking government funding? Examples:

- When you put something out that the design professional needs.

Best cognitive model is the crowd. Really?! Yes. *The Wisdom of Crowds*

- Ex: Wikipedia
  - Well-established policies
  - Verifiable against reliable source
- GalaxyZoo.org
- It's a ubiquitous sensor network
- Open Street Map
- **Crowdsourcing.org**

Ubiquitous Sensing from Humans

- "Sensor" can decide when to act
- Non-engineers police infrastructure
- Disaster relief efforts better directed
- Non-experts can quickly be trained to support.

Establishing a Successful VO

Technology Adoption Life Cycle

- *Crossing the Chasm*
- Value Proposition:
  - What is the need? What is the limitation of current state-of-the-art?
  - Preferred mode of operation – align with current workflow.
- Community Culture
- Community buy-in (check slide)

How do you transform your data to impactful decision making?

- Data, data artifact, knowledge, decision making

Community, Social Science, Computer Science

Outliers of the crowd need an incentive. **Innocentive.com, Challenge.gov** Welcoming knowledge regardless of its source

3 Challenges in Creating Successful VOs

1. How do you build a community of diverse and dispersed yet engaged contributors?
   a. Build upon existing communities
   b. Compile lists using existing directories and networks
   c. Leverage social media
      i. Website (place to DO)
      ii. Blog (place to BROADCAST and DISCUSS)
      iii. Twitter (place to BROADCAST and DISCUSS)
   d. Facilitate participation: Open information, adequate guidance, and examples for use
   e. Facilitate participation: "chunk up" larger tasks (assembly line approach), allows users to choose actions in line with their skills/knowledge

2. How do you motivate these participants?
    a. Moral
        i. Creating a public good, being part of a change movement
        ii. Community/Social standing; relative standing
    b. Instrumental
        i. Money
        ii. Satisfaction
        iii. Personal growth, competitive advantage
        iv. Use of a public good
3. How do you aggregate a large number of contributions and assure their trustworthiness?
    a. When?
        i. At submission?
        ii. At time of use?
    b. How?
        i. Crowd-source review
        ii. Experts review
    c. Contributions must be complete
    d. Requirements for submissions and contributions must be clear (set expectations)

Distributed work is self-guided:

- People choose what and when to contribute. How do you facilitate engagement?

Crowd can contribute, evaluate *and* disseminate.
Closing questions (see slide show):

- Engagement:
    - How will people learn about the VO
        - >
        - >
    - What will they learn when they discover VO?
        - >
        - >
- Framing the Value Proposition
    -
- Quality Assurance:
    -
- The current Situation:
    -
- Membership Structure:
    -
- What do we want to know?
    -
- How to even begin?
    - **Find a seed—find a case study for which you can demonstrate a value proposition. Find a problem—demonstrate the value proposition**
    - Have it be something for which you already have data

CSDR-ND Session II: The Mechanics (Dr. Charles Vardeman, Dr. David Hachen, Dr. Tracy Kijewski-Correa)

[Notes Missing]

Moderated Discussion: How Do We Build This Community? – Natalie Meyers

Natalie Meyers (co-PI) - Digital Librarian, University of Notre Dame, Hesburgh Libraries

To move forward:

- Discover common needs
- Identify a common set of shareables
- Implement and use a shared compute infrastructure portals

Questions:

- What is the measure of uncertainty to the data?
- What are the contractual relationships that inhibit data transfer? Consider BIM; cost information is not included because contractors will lose a competitive advantage.
- How interoperable do we need to be?
- What data do we really need? What is our scope?
- Was designer intent achieved? What is the user response? How do we get both of these data?
- What is the impact? Some people will do good, while others may try to do evil.

Barriers:

- How do you avoid political/invested bias? Include everyone
- How do we build trust? Inclusivity and anonymity. Early innovators are key as well.
- Legal liability - anonymity
- Too big, diverse - _____
- Motivation – dependent on players
- What are the problems/cases to illustrate value
- How do we trust the data now:
  - Prescriptive methods
  - Software model with name-brand, significant investment
  - Who is policing how "sustainable" a design is?
  - Who are the experts in sustainable design? What does it take to be an expert?
- There are very few data sets that we can trust right now
- Levels of sensitivity for data.

What can we share now?

- Do we start with something small—e.g. embodied energy?
- Existing virtual organizations
  - CBECS
  - Conduit
  - Open EI?
  - Modelica

- What data already exists?
- What in-house data do we have?
  - Notre Dame data
  -

Wish list:

- Grading/evaluation on data reliability
- Type in "Chicago, residential, green design": database of illustrated precedents.
- Data disclaimer? Third party validation of data?
- Rating system
- Data can be used with existing tools (what are the existing tools)
- Make them fun to use/engaging
- Templates for sanitizing data. Easy to submit data; requirements are clear; and then easy to evaluate.
- Integrative framework – sustainability is a multi-headed beast
- Ways to turn data into useful input (visualization, allow for judgment—understanding stakeholders goals about which they will make judgments)
- How can a greater academic network—including students—populate data? Seeding the movement with students can help engrain value for data within the next generation.

Closing Remarks / Forum Takeaways

Mission:

What ways would you like to continue this? **Develop a mission statement**. What are the immediate and specific problems we are trying to solve with this data?

Build a community of practitioners. A hub for architects and engineers to access tools.

Create a seed database to see if it has legs. Who is willing to provide data for this hub? Identify the pools of data to which we can contribute.

Who are the stakeholders in the design process and where is their pain? How can data alleviate pain?

Open channel of communication to seed our direction, after which activity is noded?

Format to promote that repository: box? Googlesites?

Center for sustainable energy provided seed grant enabled this meeting. Expected follow-up: become a center for this work, multi-institutional.

Share and get feedback from professional network.

END OF SUSTAINABLE DATA COMMUNITY FORUM