Towards cybernetic buildings: integrated intelligent sensing to create responsive environments

NSF 1951952
Junsong Yuan, University at Buffalo
PG, FY2020

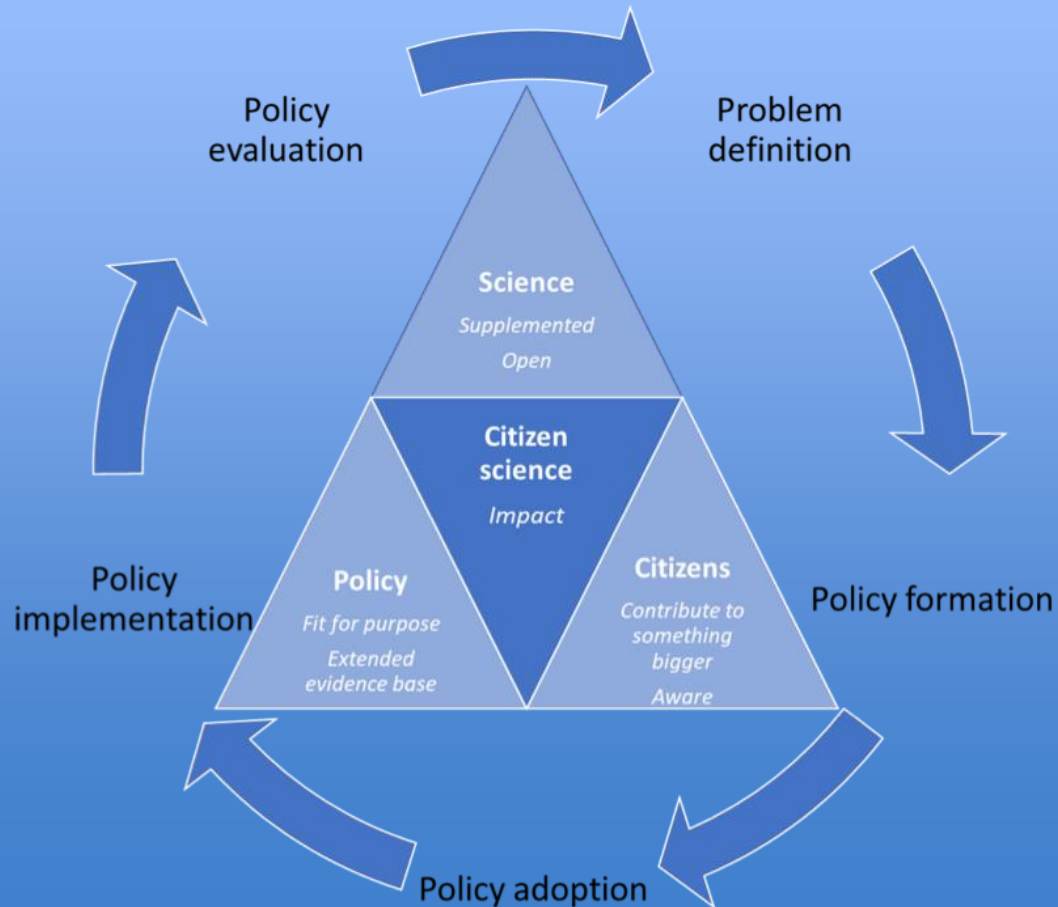| Principal Research Investigators	Buffalo Niagara Medical Campus (BNMC)
· *Junsong Yuan*, PI, *Computer Science and Engineering* · *Edward Steinfeld, Co-PI, Architecture and planning* · *Shira Gabriel Klaiman, Co-PI, Phycology*	• *Jamie Haman Burney, Director of planning* • *Patrick Kielty, Operations Manager* • *Elizabeth Machnica, Director of Community Well-Being* • *Kyria Stephens, Director of Inclusion & Community Initiatives*

Project Overview

Cybernetic Building

Autonomous, Mobile life, Citizen science model

- Policy evaluation
- Problem definition
- Policy formation
- Policy adoption
- Policy implementation

Science
Supplemented
Open

Citizen science
Impact

Policy
Fit for purpose
Extended evidence base

Citizens
Contribute to something bigger
*Aware*

Project Vision

- **Connected communities must contribute to the advancement of a just society for all**
- **A truly smart building should be cybernetic, incorporating feedback for self-regulation toward desirable goals**
- **Integrated platform for monitoring building performance**
  - **Environment sensors**
  - **Human sensors**
  - **Communication systems**
- **Communicate information to building users**
- **Online community to give building users agency**

Project Overview

Use-Inspired Research

- Like the larger community, can buildings accommodate all the needs of a diverse group of people?
- Do intelligent systems benefit the inhabitants of the whole community
- Can marginalized groups who often do not have a say in shaping policy and practices influence building management?
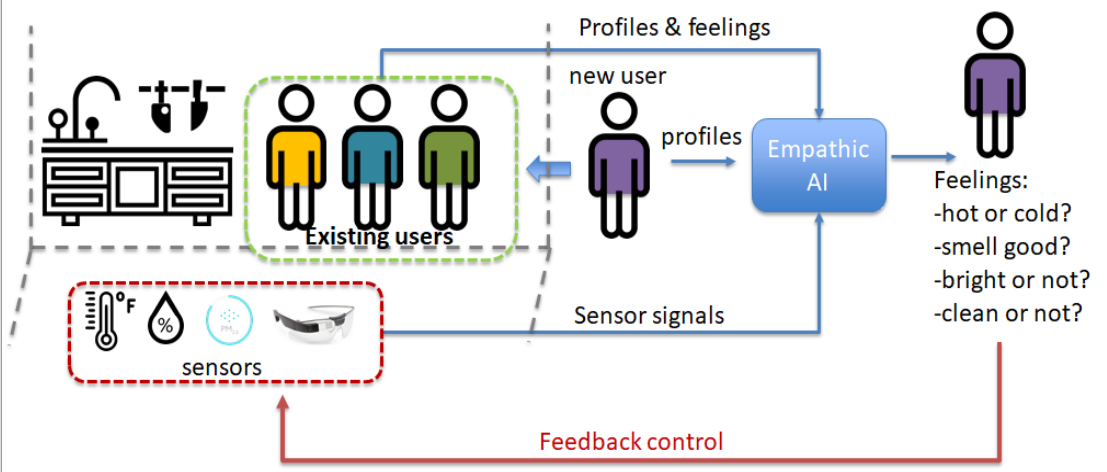

PG Activities

- Develop and test systems in labs
  - Sensors
  - Human survey questions
  - AI prediction algorithms
- IRB approval (ethical research)
- Recruit participants
- Develop and test systems on sites (Innovation Center and home office environments)
- BNMC advises on system features and functions
- Test out prototypes
- Identify other resources and partners

Project Update

Questions	Predicted Accuracy	# ratings
This room is usually too crowded by furniture?	60%	7
It is easy to get around in this room?	73%	7
Comfort rating of this room in the Summer?	67%	100
Comfort rating of this room in the Winter?	64%	100
Humidity rating of the room?	55%	100
How is the noise?	64%	5
How is the temperature?	75%	10

Q2 **Please indicate your work situation by checking the most appropriate box:**

Answered: 38 Skipped: 4

BNMC Innovation Centre
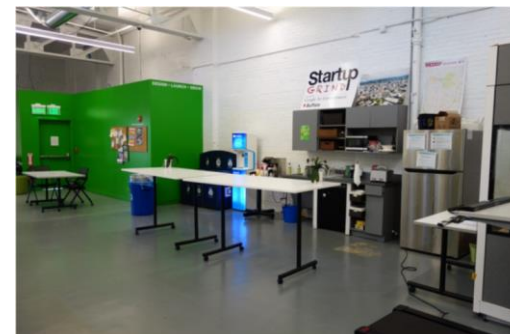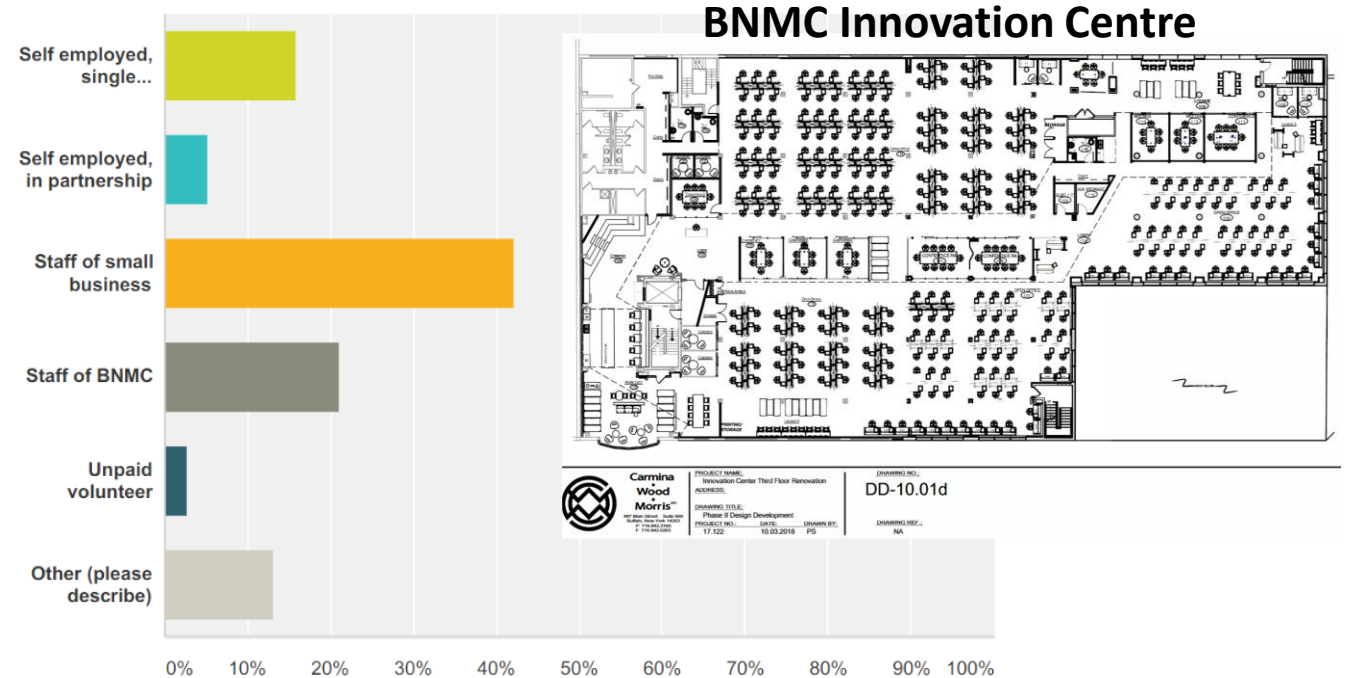
Project Evolution

For users at BNMC

- Affordable – leverage smart phones, commercial AR systems, etc.
- Scalable – easily expanded to other buildings and exterior environments
- Smart – utilize artificial intelligence and leverage human intellect
- Engaging – gamification, social media, etc.
- Outcome oriented– productivity, health, social integration, job satisfaction, etc.

For BNMC Buildings

- Autonomous – avoid reliance on specialized professional assistance
- Mobile life – include traditional and remote working/living environments
- Citizen science model
- Harness volunteer labor of building users
- Engage building users in priority setting and decision making
- Contribute knowledge to building management and development

Anticipated outcomes & success measures for next year

- Milestone 1: building a ubiquitous sensing and computing model to achieve empathic AI and harnessing the volunteer labor of building inhabitants as "citizen scientists"
  - Reduce the cost of monitoring by moving the sensing function from the building to the person
  - provide a "first person" perspective and result in portable and flexible data collection at low cost
- Milestone 2: Building online community at BNMC to communicate building performance information, collecting feedback through survey questions, identifying problems over time
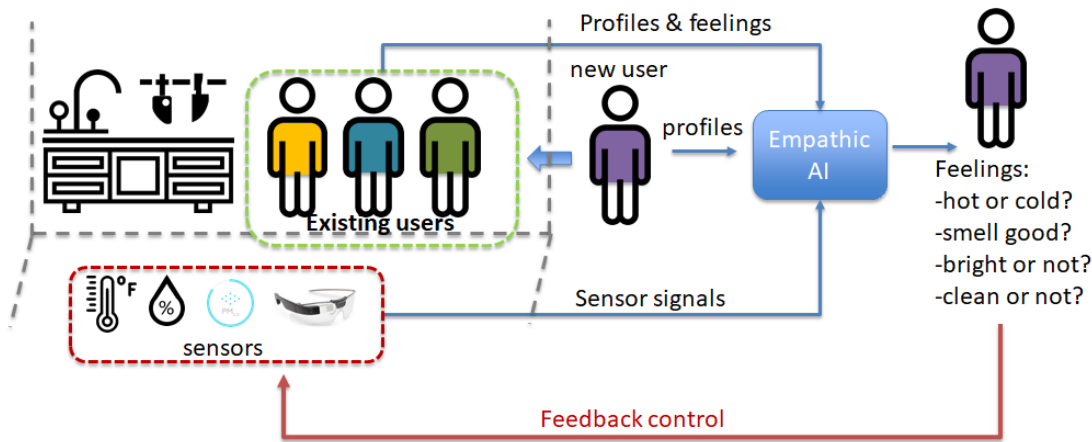 - Help proactive management of building space, schedule, and functions
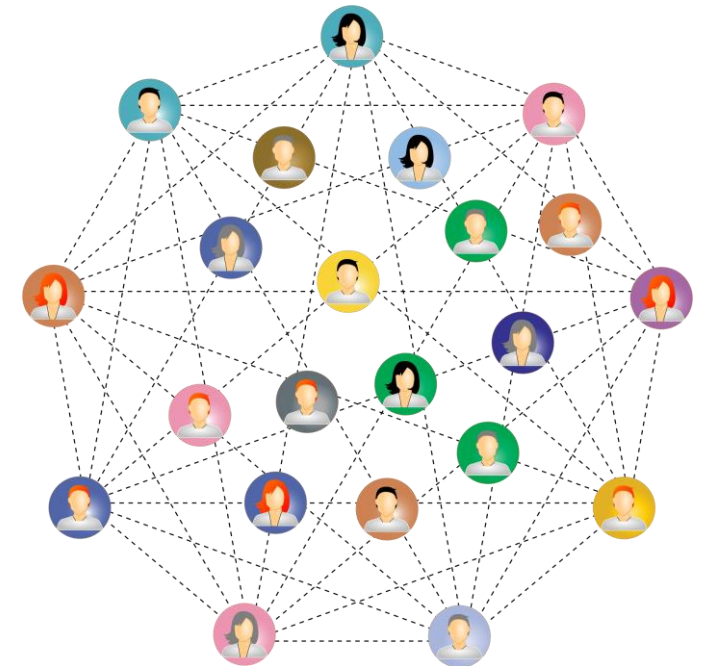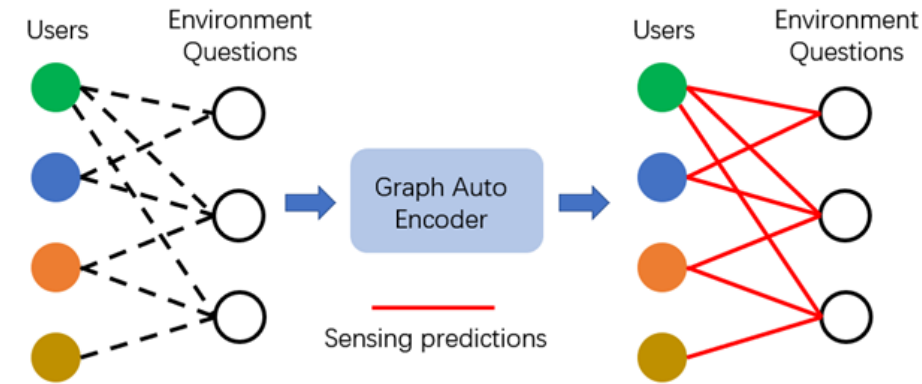
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Cybernetic Building with Empathic AI

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- Communicate information to building users
- Online community to give building users agency

Use-Inspired Research

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PG Activities

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    - Sensors
    - AI prediction algorithms
    - Interactive software
- IRB approval (ethical research)
- Recruit participants
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