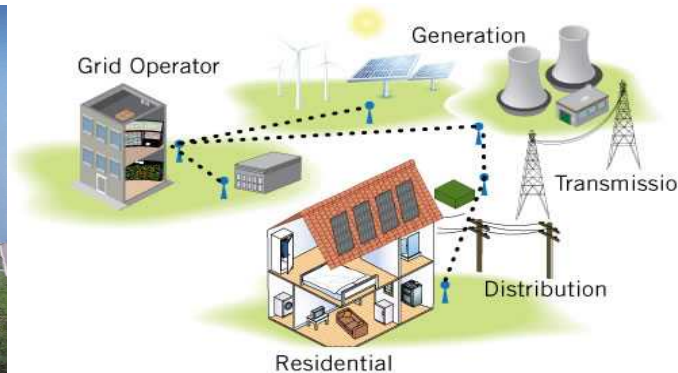


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Defining Expertise in the Electric Grid Control Room

Susan Stevens Adams and Frank Hannigan

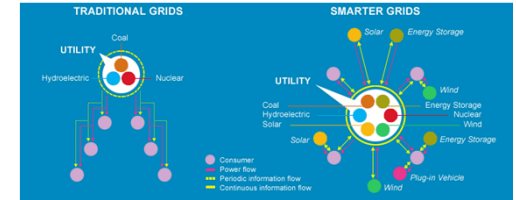
Sandia National Labs and Quantum Improvements Consulting

AHFE conference, 31 July 2016

Distribution Electric Grid Transformation

New smart grid technology resulting in:

- Two-way communication
- More sensors, more information
- Increased use of distributed renewable generation sources
- Better outage management



But, also resulting in:

- More alarms
- Potentially slower operator response time
- Increase in automation (but inverse relationship with situation awareness)
- Profound changes in load management



How will this transformation impact control room operations?

Previous Findings

- Collected data using numerous methodologies with Vermont control room operators
 - Structured interviews, Applied Cognitive Task Analysis, Critical Decision Method
- Found that operator situation awareness is reliant on field crews
 - *How will this situation awareness and mode of operations fundamentally change with increased automation?*
- **Conclusion:** Need to better understand how changes in automation interacts with operator's expertise
 - What are the characteristics of a 'expert' control room operator?
 - Will the characteristics of what defines an expert have to change?



Expertise



- It is agreed upon in the literature that expertise is domain specific
- Varied theories for how to determine who is an expert:
 - Experts must have extensive experience in a domain, but that is not necessarily predictive of expert levels of achievement (Ericsson, 2006)
 - Social acclimation is the agreement of professionals regarding who is an expert in the domain and can be used to determine expertise (Shanteau et al., 2002)
 - The amount of overall experience in a domain needs to be distinguished from deliberate practice (Ericsson et al., 1993)

Data Collection Methodology

- Structured Interviews with individuals from Green Mountain Power
 - 13 operators (8 Rutland, 5 Colchester)
 - Years of experience ranged from .16-37
 - Average years of experience = 15.7
 - 4 different classes of operators (Apprentice, 3C, 2C, 1C)
 - 3 managers
 - 1 HR person
- Interview questions related to years in the field, years in the job, academic experience, training/other experience, and who is an expert at a specific work location



Interview Questions and Answers

Q1. How would you define an expert in your domain?

- Having hands on experience
- Previous field experience
- In-depth knowledge of system
- Exposure to a variety of events



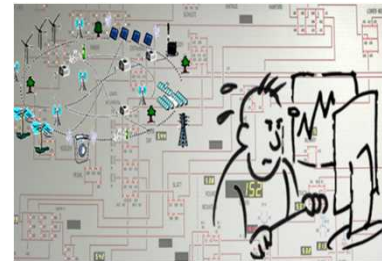
Q2. What are the top tasks associated with being an expert?

- An expert is able to perform complex switching

Interview Questions (con't)

Q3. What are the top qualities or characteristics of an expert?

- Ability to synthesize and correctly respond to a large volume of data
- Ability to remain calm, cool and collected under pressure
- Being adaptable and able to multi-task effectively
- Quickly and efficiently using and navigating system



Q4. Who among your peers do you consider to be an expert and why?

- Experts named had a combination of strong academic or practical experience along with significant time in the control room, with exposure to many events.

Interview Questions (con't)

Q5. How comfortable would you be sketching an area of the subtransmission line?

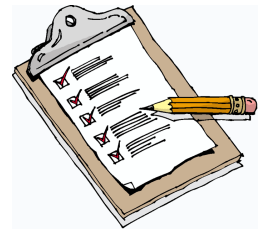
- A 1C would be very comfortable sketching the area
- A 2C should be able to do this before becoming a 1C but it would not be as detailed as a 1C's sketch
- A 3C would not be able to generate a sketch

Q6. Generally, what is SCADA used for and how would a novice use SCADA differently than an expert?

- All operators use SCADA data; a 1C should be able to quickly view and synthesize SCADA data but a 3C will take longer to understand the information.

Interview Questions (con't)

Q7. Describe the testing/assessment required for progressing to 1C.



- Assessments include written and oral portions.
 - Written portions consist of multiple choice, problem solving, schematic drawing.
 - Oral portion gets into more details than the written portion.

Q8. When are you considered an expert (with regard to class/years experience)?

- Average answer = 1C + 4.7 years experience
- Therefore, one is considered an expert after ~7-9 years experience in the control room.

Interview Questions (con't)

Q9. Which skills would and would not transfer to a different control room?

- Skills that would transfer = customer service, fundamentals/principles of electricity, safety knowledge, equipment type knowledge
- Skills that would not transfer = specific system details



Q10. Does management ask the input of 1C operators to determine the readiness of Apprentice/3C/2C to advance to the next level?

- Varies based on manager, 1C operator and control room

Interview Questions (con't)

Q11. What is the difference between a 'basic' understanding vs. an 'advanced' understanding of system knowledge?

- Basic understanding = understanding of how electricity works, basic knowledge of system.
- Advanced understanding = more detailed understanding of system (power flows, voltage levels, what happens when a particular breaker opens), ability to make decisions and perform actions without supervision, writing and executing switching orders on the fly in an emergency situation.

Conclusions and Future Work

- Expertise characteristics for distribution control room:
 - 7-9 years experience in the control room
 - Ability to synthesize large amounts of data
 - Ability to stay calm, cool and collected in stressful situations
 - Exposure to many kinds of events
 - Ability to effectively multi-task
 - In-depth, detailed knowledge of the system
 - Ability to write and execute switching orders (including on the fly during stressful situations)

- **Next steps:** Simulator experiment with expert and non-expert control room operators



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Thank you! Questions?

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