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Practitioner Interview

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CDM Smith

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Proposed Questions for Interviews with Water Resources Engineers on Use of Water Resources Systems Analysis in the Engineering Workplace

Prepared by:
Technical Committee on
Excellence in Systems Analysis Teaching and Innovative Communication (ECSTATIC)
American Society of Civil Engineers (ASCE)

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Interview with Kirk Westphal, CDM Smith, September 4, 2014

JOB BACKGROUND

1. What is your current job title?

2. What is/are your roles/activities in your job?

   Types of projects involve water supply planning
   Water basin planning
   Planning integrated resources across jurisdictions
   Legislative problems

3. For how many years have you worked in this role?

   5 years. Doing this kind of work for 13 years.

4. What formal training have you had in systems analysis [If needed, will define systems analysis and provide examples such as use of simulation and/or optimization tools to model, design, plan, and/or manage water resources systems]?

   Master thesis with Rich Vogel. Graduate level course in systems analysis.
   Modeling Boston water supply system.
   Optimization model.

5. If your professional activities have included systems analysis, for how many years have you performed these activities? [This question seems redundant]

   Have had a position doing these things in non-traditional ways for 13 years.

5a. Is this a supervisory/mentoring role?
Staff manager for a while, technical direction on systems analysis and work himself and work with stakeholders.

5b. How many people are working in your group or in systems analysis?
10 people within the firm on a regular basis, can do systems analysis independently, and have been trained in it.

5c. How do you label systems analysis work when talking with stakeholders or other engineers?

The terminology that is used is integrated planning, or integration, even though those terms mean something else to other niches.
He avoids saying it is only optimization, simulation, or uncertainty analysis.
Instead, he focuses on integrated systems across multiple resources, when talking with stakeholders.
Practice involves choosing the right tools to address the problem.
It is much more of a process, instead of a tool.

MORE ABOUT USE OF SYSTEMS ANALYSIS ON THE JOB

6. What work projects have used systems analysis techniques to identify/evaluate/select a design or decision alternative?
Could list 100 projects across country and internationally. Forms and venues are contextual.

One project in Tennessee, south of Nashville.
Master plans for water, wastewater, reclaimed water, stormriver.
All affect river.
Integrated plan for all four utilities.
Systems modeling.
Simulation packages.
Uncertainty analysis.
Impacts on river could be understood.
Workshops with stakeholders. Run model real time.
Any decision made affect the other three, and the river.
Identify stakeholders and objectives and metrics.
Clear consensus on path forward for wastewater and water supply.

Who were the stakeholders?
Utility managers, city councilman, environmental advocacy groups, neighboring water utilities, scientific leadership – PETA, USGS
Nearly unanimous consensus.
Goals were not different, just solutions were different.

Did this change the institutional decision making process?
Permitting was changed after that.
Now they work together more.

7. What systems analysis techniques, software, and/or tools were used?
   Simulation analysis, uncertainty analysis.
   STELLA. Useful because it is very visual.
   GoldSim.
   Multicriteria - Criterion Decision Plus, EVAIX (not sure I got this name correct) (helps move subjective criteria to part of the decision)
   Some in-house code.

8. Have any projects coupled optimization algorithms with external simulation models, simulated system equations within the optimization framework, or used an optimization algorithm available within a simulation model? If yes, what kinds of simplifications were required in the solution approach?
   How do you use optimization?

   Not necessarily coupling. Optimization is seen as a black-box by decision-makers.
   Need to find a solution that is optimal.
   Develop an optimization model off to the side, so know what is the lowest cost can find, or best performance.
   Finds aversion among stakeholders to pure optimization in practice, but useful companion to simulation.
   Embedded optimization within simulation. Powersim.
   San Diego study. Already had a simulation model. Companion optimization model to find how well they were doing with the simulation model.
   A lot of programs have optimization shell around simulation model, so engineers use those.

   Simplifications to go from simulation to optimization?
   Depends on the number of non-linearities.
   Typically linearize the model.
   But the art is to not over-simplify.
   Storage-elevation is not linear, but can be linearized over a small distance.
   Hydraulic equations. Moving water over large distances. Extracting energy from water. Highly non-linear. Difficult to linearize. Choose one or two conditions to optimize over a small bracket.
   Want something that is very simple, to see if you are in the right ballpark.

9. What uncertainty analyses have been used to evaluate designs or decision alternatives? If yes, what assumptions were required? What difficulties (if any) were there in communicating results of the uncertainty analysis to decision-makers?

   It is hard to communicate statistics. It is hard to translate from frequency to probability. If client can process the idea of risk, then he can include it. If the client cannot process these ideas, then he focuses on sensitivity analysis and tradeoff variables. Easy to use simulation to do sensitivity analysis and tradeoff analysis. Provides useful guidance, and easy for clients and public to understand.

Useful in the study of the impacts of climate change. Instead of being predictive and creating probability. Cast a new question – under new conditions what should I be worried about my system? What would be the trigger? If see certain reduction in annual rainfall, need to find an alternative water supply, otherwise, don't need to worry about it.

10. Have projects applied multi-objective decision methods to select a final design or decision alternative? If yes, how was a preferred alternative selected from a set of tradeoffs?

    Formulate solution around objectives – low-cost, entirely reliable. Four or five hybrid grouping of project strategies. Multi-criteria scorecard, rank them, decision is almost known by then, because they've studied it so much at that point. Keep stakeholders involved the whole way, not just at that last step. Scorecard is a way to defend the answer, document the decision.

    USE OF SYSTEMS ANALYSIS IN THE PROFESSION

11. What encourages or limits the use of systems analysis in the water resources engineering profession?
    Constraint is lack of understanding and predilection to use one particular tool. Systems analysis doesn't mean the same thing to other people as it does to us – it's ambiguous, creates doubt in eyes of stakeholder. Wait to hear the question before you choose a tool.

12. What role should systems analysis play in professional practice? [ASKED FIRST IN THIS SECTION]
    Should be ubiquitous. Most useful in front-end of major study that involves multiple resources and jurisdiction. Screen out some of the complexities before detailed engineering gets involved. Also useful in backend of project. Aggregate results from several different tools that have been used and identify response functions that can be used to analyze what's been done.

13. What formal education is needed to use system analysis on a project?

14. What systems analysis skills and techniques should universities teach to prepare new practitioners to successfully join the profession?
    Generally speaking, students don't have the ability to simplify a problem. Being able to simplify a problem so that other people can understand it without doing years of modeling. Students are trained to work with a lot of details in a lot of systems.

    Exposing students to a variety of different tools and approaches. Students are exposed to optimization or simulation, but not both. They have not used scorecard tools that can be used for communicating to stakeholders.

    Students need to know benefits/drawbacks of different tools. Suggest a class project where you divide the class into 3 or 4 groups. Give them a problem, have to solve it using all different tools.

    If someone has been doing hydraulic analysis for 3 years, then it is hard to get them to think more broadly about problems.

15. How can the profession more effectively use systems analysis in the future? [Computers are more advanced, more data available.]

    Has more to do with people than computers. We need to listen to people more. May be answering the wrong question. Make sure you are answering the right question. Talking to people. Not necessarily from scope of project, or contract. Little to do with tools, but interactions with decision-makers needs to improve.

    Case study examples and projects in the classroom to overcome that.

    Every project, force team to write down questions that they are trying to answer.

    Should we have interdisciplinary work to assist with this?
    Good skill would be facilitating. Step back from own biases. Cross-pollination with water quality and economics are the two biggest aspects of field that systems practitioners could really use.