Best Practices in Service Restoration

Discussion document

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Management
Consulting, LLC
Consultants to the Utility Industry

Agenda

- Sources of Lessons Learned
- Lessons Learned from audits
- The case for better decision support tools
- Observations and Key Questions

There has been no shortage of sources for lessons learned

Selected Sample of Events

Company	Event Date	Type	Regulatory Response
Entergy Gulf States (TX)	Jan 1997	Ice Storm	Audit, Fine, Get Well
Com Ed, Con Ed, PSE&G	Jul 1999	Heat waves	Audits, DOE POST, Get Well
Indianapolis Power & Light	Jul 2001	Thunderstorm	Audit, Fines, Get Well
Duke Energy, Progress Energy	Dec 2002 Feb 2003	Ice Storm	Audits, UG Study, Get Well
Many companies in Northeastern North America	Aug 2003	Blackout	Congressional study, suits, new NERC rules, etc.
PHI (Pepco, Delmarva)	Oct 2003	Hurricane Isabel	Assessment, UG Study, Get Well
PacifiCorp (Utah P&L)	Dec 2003	Snow storm	Audit, Get Well
FPL, Progress, Southern	Aug-Sep 2004	Charley, Frances, Ivan, Jeanne	Rate recovery proceedings
Entergy, Southern, Progress, SCANA, FPL	Jul-Sep 2005	Dennis, Katrina, Ophelia, Rita, Wilma	Congressional hearings…
Con Ed – Westchester Con Ed – Northwest Queens	Jan, Jul, Sep Jul 2006	Wind storms Heat Wave	Audit…
Ameren	Jul 2006	Wind storm	Audits in IL & MO…
Puget Sound Energy, Seattle City Light	Dec 2006	Wind storm	Audit, assessment…

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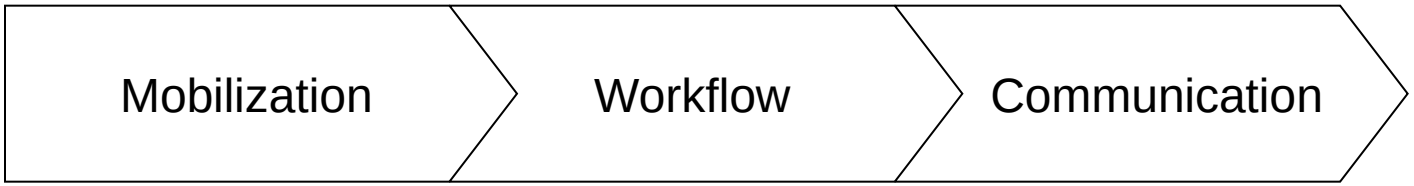
Effective major event restoration requires multiple process skills



- ICS Activation
- Predicting/assessing storm damage
- Predicting/tracking resources needed
- Mutual assistance
- Logistical support
- De-mobilization

- Trouble analysis
- Trouble dispatch
- Wire watch
- Damage assessment
- Partial restoration
- Tree work for access
- Repair dispatch
- Permanent repair

- Customers via call center, IVR, media, website, pre-mailings, outreach vans
- Governments/regulators via key contacts, calls, briefings, drills
- Media commentators via pre-meetings, photo ops, ready copy, ads, website

Effective restoration is not just about line crews. It involves the best efforts of a wide variety of company resources, including 'second jobs'

Best practices in storm restoration have certain recurrent themes

- Accurate prediction and assessment of damage
  - Essential for quick and effective decision making
  - Like military intelligence before and during a battle
  - Transforms chaos into planned activity
- Clear yet flexible command
  - Based on Incident Command Structure
  - Ability to switch ‘modes of operation’ - decentralize
  - Transform own crew members into leaders of teams
- Adjustable technology
  - Adjustable parameters on outage management system
  - Call center and interactive voice response units that can switch to ‘storm mode’
  - Adjustable use of reclosing relays to save fuses
  - Mobile data terminals - instead of voice radio – can handle surge in volume
- Consistent communication
  - Explain the restoration plan before the storm, then during it, then after it
  - Use the media, EMA agencies, and public officials to help communicate to the public
  - Use accurate damage information to provide reliable estimated times of restoration

Accurate damage prediction/assessment requires best practices

- Good meteorology
  - Need access to good, utility-focused meteorological expertise and measurement
  - Need to predict lightning, wind, rain, snow, ice accumulation by detailed area
  - Needs to be good enough for field to trust, not use their own weather instincts
- Damage prediction model
  - Translate weather forecast into initial prediction of outages to predict resources needed
  - Damage by broad type requiring different resources, e.g., line down, fuse blown
  - Uses same categories as damage assessment made during the storm
  - Key to early mobilization decisions – needs to be order of magnitude at least
- Damage assessment process
  - Trained body of damage assessors available to each area
  - May be used for line-down security, but if so, will need more
  - Consistent system with the right categories, understood by all
  - Key to accurate restoration times, mobilization of ‘second wave’
  - May be linked to location-based repair teams

Effective workflow requires clear yet flexible command

- Based on Incident Command Structure
  - Originally a fire incident concept, now dictated for all emergency events
  - Proven to be vital in utility event response
- Like modern war doctrine (a la Desert Storm)
  - Empower local teams to take action based on what they see in the field
  - Requires flexible logistical support that follows them, doesn't hold them back
- Need to be able to 'pull the trigger' at the right time
  - Switch to storm mode style of command
  - Mobilize resources: assessment teams, contractors, mutual assistance
  - Alert the public of possible disruptions
- 'Storm mode' has many dimensions, depending on the severity of the storm
  - Change parameters of outage analysis algorithm
  - Change IVR scripts
  - Change crew members into team leaders
  - Invite 'outsiders' to view operations up close

Adjustable technology is essential for large change in volume

- Storms represent a tremendous increase in ‘transaction’ volume
  - Not just 10x, but even 100-1000x
  - Challenges assumptions made in system testing, finds weakest link
  - Calls may be blocked at telco switch, your switch, your IVR, etc.
- System designed for normal operation won’t work
  - Outage analysis algorithm has to change
  - E.g., simultaneous calls behind adjacent fuses do NOT imply an upstream device is out
  - Call takers cannot afford to use long scripts
  - Centralized dispatch of all outages may not work
  - Voice radio becomes jammed, can’t communicate with all
  - Foreign crews not able to use normal systems, processes
  - Relays set to avoid momentary needs to switch to fuse-saving instantaneous reclose
- Remote relaying can help or hinder
  - Complex automatic recloser schemes may delay restoration
  - But manual SCADA operation may be too slow if damage covers a wide area
  - And isolating faulted sections helps in damage assessment and partial restoration

Consistent communication conveys the right image

- Plan the work, work the plan (even amidst the chaos)
  - Before the storm, tell the media and agencies how the process will work, who, where, etc.
  - During the storm, emphasize consistency of actions with the plan, even as details differ
  - Be aware during the storm of how it would be viewed in a post-storm audit
- Use the media, EMA agencies, and public officials – or they will use you
  - Have a full-page ad ready to run, telling the public how to respond (bilingual if necessary)
  - Including public safety and their responsibility
  - Provide photo opportunities, joint statements, canned footage, educational text, etc.
  - Include them in drills, preparation, plans, and embed them during restoration
- Reliable information is just as important to some as reliable power
  - Provide advance warning that storms may cause power outages in certain areas
  - Use accurate damage assessment to provide reliable ETRs
  - If the damage comes in waves, communicate it that way, with updated ETRs
  - Use IVR to gather and to disseminate information
  - Use outbound IVR to confirm lights back on, find downstream faults as soon as possible

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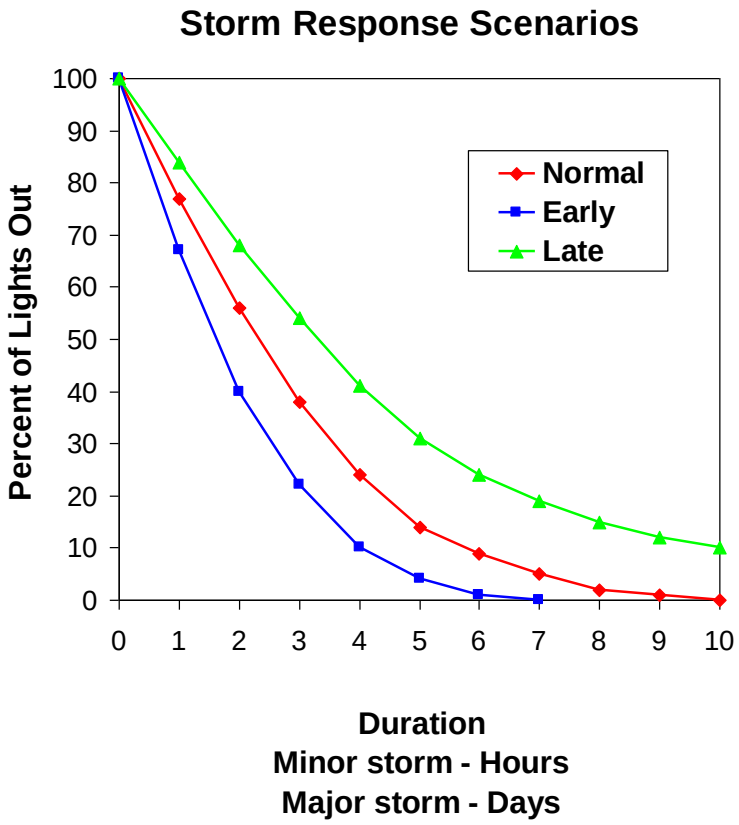
Early mobilization is the key to timely storm restoration…

With early prediction you can:

- Identify needed resources
  - Get them called out and rolling
  - In time to travel to the area
  - And be there when the trouble starts
- To get the feeders back up quickly
  - Restoring the most customers early
  - So you can find the taps that are out
  - And get working on the single no-lights
- And communicate more accurately
  - To give advanced notice and initial ERTs
  - To customers, media, and governments
  - To instill confidence and show leadership

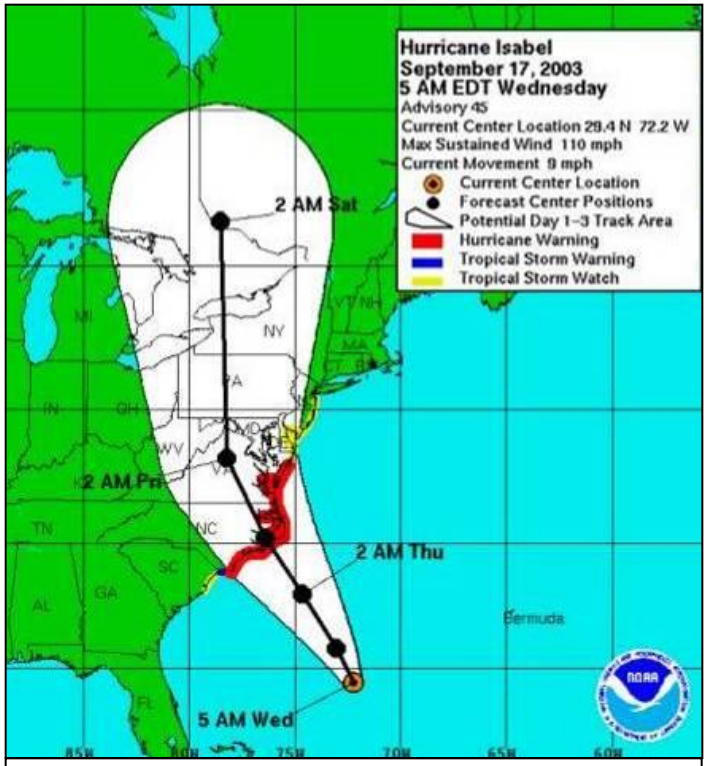


"If only I could have known I needed that many crews, I would have got them there right from the start"

…But 'pulling the trigger' can be difficult…

Barriers to mobilization include:

- Mobilization is <u>expensive</u>
  - Overtime for your own crews
  - Costs for contractors and foreign crews
  - Logistics costs (reservations, meals, etc.)
- Mutual assistance is <u>not</u> automatic
  - Other companies want you to be sure
  - 'False alarms' cause future problems
  - All companies in the area may have needs
- Inadequate information causes <u>indecision</u>
  - Will the weather really be bad?
  - Will the damage be as bad as the weather?
  - Will we have resources standing idle?



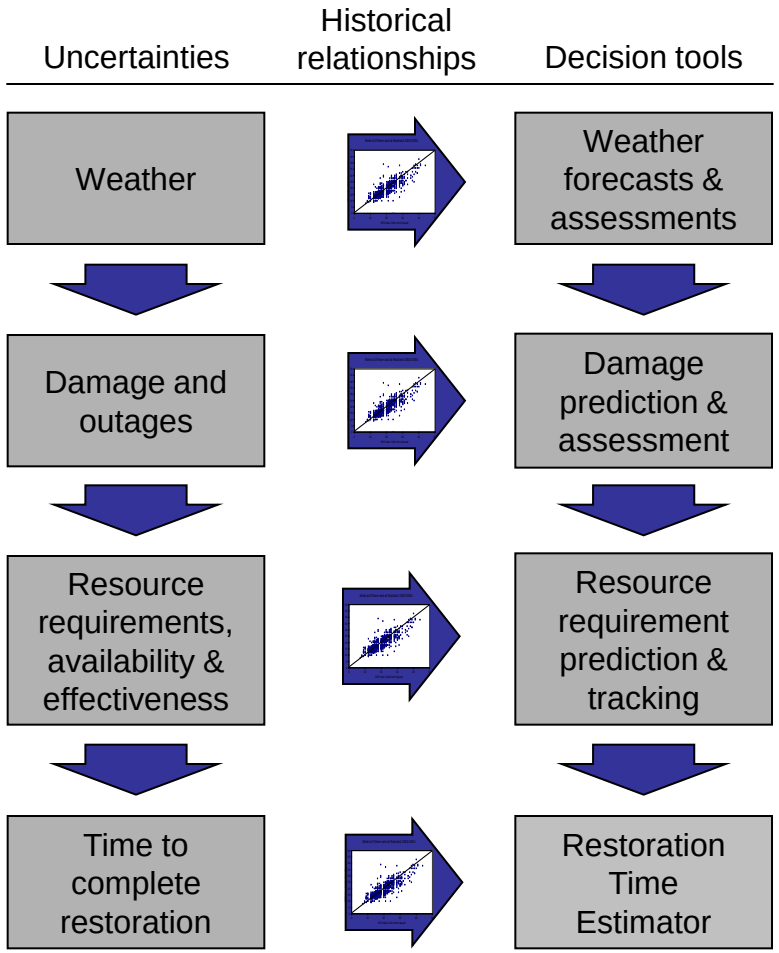
Uncertainty and inadequate information cause indecision and poor storm response

<u>Before</u> the storm, there is not enough information.
<u>After</u> the storm, there is no shortage of second-guessers

…So, better decision tools are needed

Better decision tools are needed and available:

- Weather models and measures
  - Utility-oriented forecast models
  - Ensemble forecasts for risk assessment
  - More detailed grid measurements
- Storm mobilization models
  - Relate weather to damages/outages
  - Relate damage to resource requirements
  - Relate resource requirement, availability and effectiveness to initial and ongoing Estimated Restoration Times (ERTs)



With better decision tools, emergency managers can more effectively 'pull the trigger' to make and communicate mobilization decisions

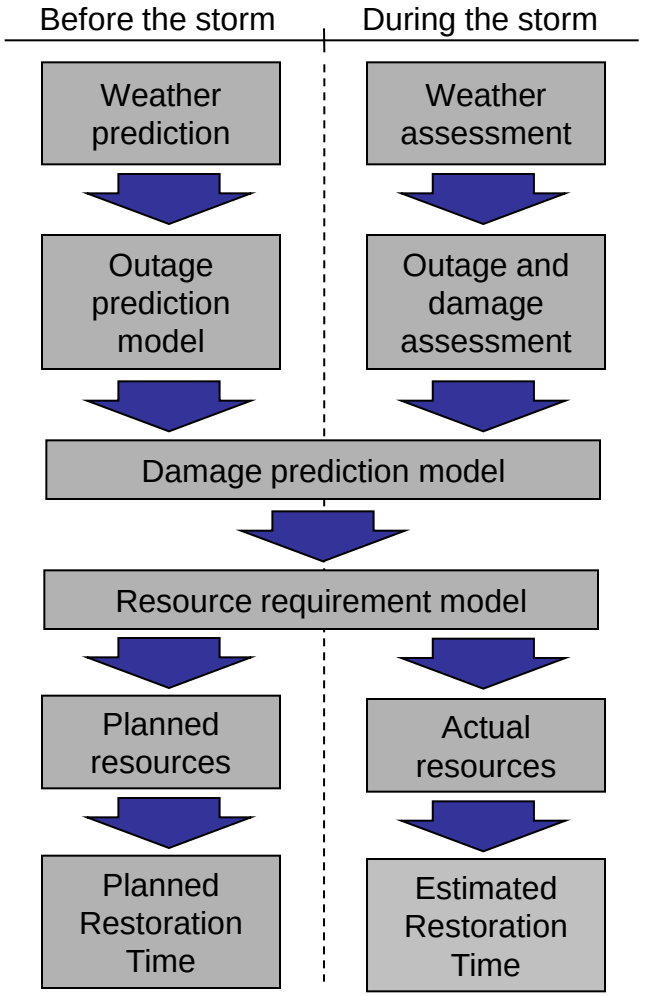
Decision models can help both before and after the storm has hit

Prediction models facilitate storm mobilization ***before the storm***

- Forecasters predict weather
- Weather drives outages
- Outages drive damage
- Damage drives resources
- Resources affect restoration time

Similar tools help manage work and ERT's ***during the storm***

- OMS and patrollers provide actual outages and damage
- Resource model uses actual outage and damage data to estimate resources
- Actual resources available versus resources needed drives estimated ERTs



With a better way to predict the resources needed, valuable time early in the storm can be saved, reaping shorter overall restoration

A mobilization model can benefit from continuous improvement

- Each new storm offers an opportunity to see how well the model fits, and to explore model enhancements and parameter changes if it does not
- Typical enhancements might include:
  - More detailed weather data
  - More non-linearities and special factors
    - Like effect of rain-soaked soil
  - Measuring the effect of changes in restoration methods and practices
  - Better data collection on damages incurred, resources used, etc.
- Like scientists, we advance best by "standing on the shoulders of others"

While storm managers will also benefit from practice, using a model like this will allow them to <u>pass it on</u> to others

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Observations and Key Questions

Observations

- Post-storm audits are full of insights into what can go wrong, and what is expected in terms of methods and processes
- Effective storm response requires skill at managing in chaos, like modern war theory – with clear and flexible command to avoid decision paralysis
- Many utilities still over-rely on naked experience and judgment, ignoring the need for and benefit of effective decision support tools that can enhance, not replace, judgment

Key Questions

- Have you read the post-storm audit reports relevant to you?
- Is your event command structure clear yet flexible?
- Do your key decision makers have the latest decision support?

Questions?

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Doing the same thing over and over again does not lead to improvement. Measuring your decisions against a model allows learning and growth

O'Neill Management Consulting, LLC