Scenario Uses

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What is a scenario?

- General meaning
  - Sequence of possible events
  - Assumed to be representative of future situations
- Specific meaning within human-machine research
  - Simulated sequence of system events
  - Assumed to be representative of real operation

- In validation experiments, the content of the scenario
  - Defines the required operator tasks, and thereby the task complexity
  - Sets the premises for task allocation
  - Constitutes the performance criteria

Scenario pros and cons

- Controlled manipulation of scenario factors can reveal scientifically interesting effects
- Scenarios can be designed strategically to support other manipulations, and to ensure experimental focus
- Possible to extend the generalizability of experiments by including a wide range of scenarios

- Scenario variance can inflate the error term and mask experimental effects
- Hard to develop representative samples of scenarios
- Difficult to standardize scenarios in dynamic operating environments

Scenario-dependent manipulations

- Similar scenarios can be grouped together in order to compare types of operating conditions (e.g. high vs. low complexity tasks)
- Task conditions can moderate the effect of other experimental manipulations (interaction effects)
  - Example: Does the new operator support system enhance performance for all types of scenarios?
- Scenario-dependent manipulations can provide interesting results by itself (main effects)
  - Example: HRP-experiment that compared human performance for two types of automation malfunctions

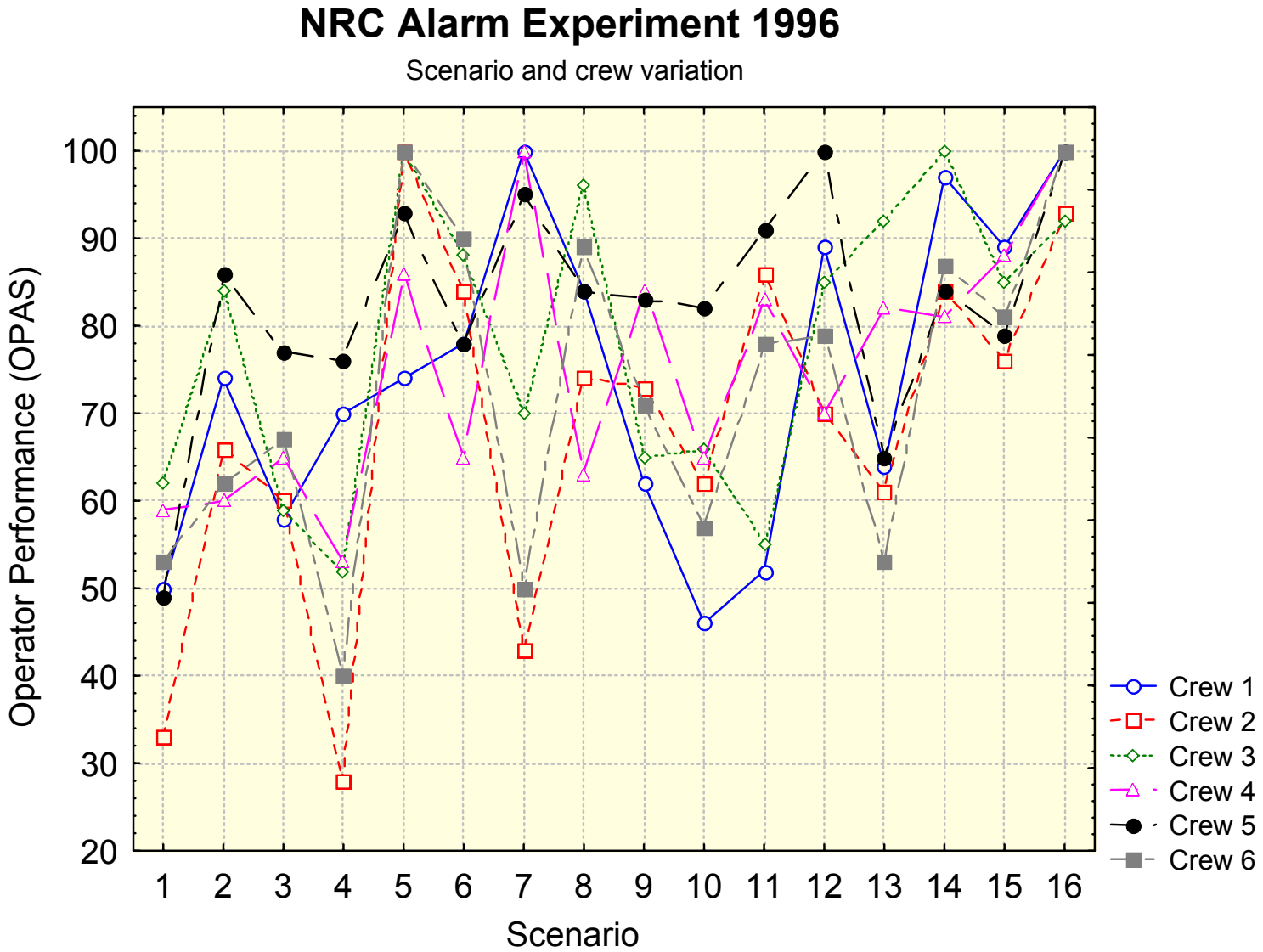
Strategic scenario design

- Adjust scenario content to enhance the sensitivity to other manipulations
  - Example: Design scenarios with many conflicts between aircrafts to demonstrate the benefits of automatic conflict detection
- Limit the scope of the validation experiment
  - Example: Focus on safety critical scenarios only, or one particular type of abnormal accident situation

Increased generalizability

- Traditional problem solving experiments are often limited to one test situation (e.g. the Tower of Hanoii problem). By including several test situations, external validity is improved
- Scenarios can be sampled along many dimensions, for example:
  - Normal vs. abnormal situations
  - Simple vs. complex tasks
  - High vs. low taskload
  - Procedural taskwork vs. problem solving

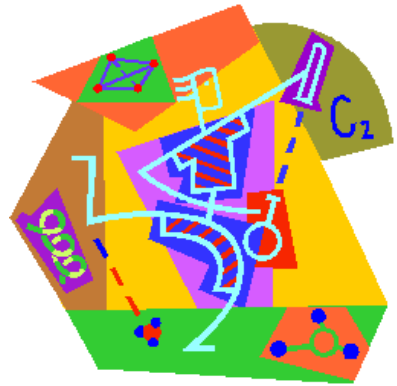
Unwanted scenario variation



Unwanted scenario variation

- Often practically impossible to include scenario classes as completely crossed (random or fixed) factors in validation experiments
- Assuming a factorial within-subject design and counterbalancing of presentation orders:
  - Running the same scenario under all treatment combinations results in learning effects
  - Running different scenarios under each treatment combination leads to unwanted scenario variation
  - Counterbalancing compensates order effects, but spreads scenario/learning effects throughout the design. Increased error variance can hide experimental effects (maximize internal validity at the cost of statistical conclusion validity)

Scenario sampling



- Essential to have representative samples of controllers and operating conditions in validation research (to generalize research findings to real controllers and work settings)
- Problems
  - Lack of systematic methodology for task-sampling
  - The “population of real task conditions” is large and has high variability
  - Possible conflict between scenarios as a tool to make other experimental effects detectable, and being representative task conditions

Scenario standardization

- To some extent, scenarios have to be standardized, otherwise:
  - Every operating team would produce an unique scenario in each experimental run
  - No longer meaningful to separate the scenario from performance
- Challenge:
  - Standardization is inherently problematic in dynamic and ill-defined problem solving situations
- Possible solution:
  - Standardize the challenge presented to the operators (perceived task complexity), not the exact sequence of system events (scenario syntax)

Dynamic situations and scenario design

- Two approaches…
  - time vs. event based malfunction implementations
- Time based malfunction implementation:
  - Malfunctions are introduced at pre- defined times in the scenario
- Event based malfunction implementation:
  - Timing of malfunction depends upon operator activity and/or process events

Dynamic situations and scenario design

- Time-based malfunction implementation
- Advantages
  - Realistic – no artificial and hidden dependence between operator performance and accident evolution
  - Simple administration
- Disadvantages
  - Dynamic operator performance with completely different solution paths – the scenario is constructed by the crew
  - Difficult to standardize performance measurement and introduce comparable data collection breaks in scenario

Dynamic situations and scenario design

- Event-based malfunction implementation
- Advantages
  - Effective standardization of scenarios, i.e. the number of solution paths are drastically reduced
  - Controlled performance measurement in scenario breaks
- Disadvantages
  - Unrealistic and artificial adjustment of accidents to operator performance
  - Difficult to complete scenarios within reasonable time frames
  - Reduced variability in performance