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## 12-14 June 2007, at US Naval Academy, Annapolis, MD

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Original title on 712 A/B: From Deterministic to Stochastic

Revised title: Same as above

Presented in (input and Bold one): (**WG 23**, CG___, Special Session ___, Poster, Demo, or Tutorial):

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# Report Documentation Page

*Form Approved*
*OMB No. 0704-0188*



| 1. REPORT DATE | 2. REPORT TYPE | 3. DATES COVERED |
|---|---|---|
| **01 JUN 2007** | **N/A** | **-** |

| 4. TITLE AND SUBTITLE | 5a. CONTRACT NUMBER |
|---|---|
| **From Deterministic to Stochastic** | 5b. GRANT NUMBER |
| | 5c. PROGRAM ELEMENT NUMBER |
| 6. AUTHOR(S) | 5d. PROJECT NUMBER |
| | 5e. TASK NUMBER |
| | 5f. WORK UNIT NUMBER |
| 7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **Center for AMEDD Strategic Studies 1608 Stanley Road Fort Sam Houston, TX 78234-5047** | 8. PERFORMING ORGANIZATION REPORT NUMBER |
| 9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) | 10. SPONSOR/MONITOR'S ACRONYM(S) |
| | 11. SPONSOR/MONITOR'S REPORT NUMBER(S) |

12. DISTRIBUTION/AVAILABILITY STATEMENT
**Approved for public release, distribution unlimited**

13. SUPPLEMENTARY NOTES
**See also ADM202526. Military Operations Research Society Symposium (75th) Held in Annapolis, Maryland on June 12-14, 2007, The original document contains color images.**

14. ABSTRACT

15. SUBJECT TERMS

| 16. SECURITY CLASSIFICATION OF: | | | 17. LIMITATION OF ABSTRACT | 18. NUMBER OF PAGES | 19a. NAME OF RESPONSIBLE PERSON |
|---|---|---|---|---|---|
| a. REPORT | b. ABSTRACT | c. THIS PAGE | | | |
| **unclassified** | **unclassified** | **unclassified** | **UU** | **15** | |

# From Deterministic to Stochastic

75th MORSS
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# Agenda

- Background
- Data
- Problem Statement
- Deterministic Model
- Partial Stochastic Model
- Full Stochastic Model
- Future
- Conclusion

# Background

- Preventive Medicine Detachment Rule of Allocation was 1 Detachment per 17,000 personnel
- We had 54 tasks with time and frequency
- Short turn around
- Our task was to determine if that rule was appropriate

- $H_0$: Mean = 17,000
- $H_A$: Mean != 17,000

# Data

- 54 PM tasks with time and frequency
- Original data from contractor questionnaire unusable
- Provided by the PM SME using PMJ consensus panel
- Three formats for time and frequency
  - Single value
  - Minimum and maximum values
  - Minimum and maximum values, with a most likely value

# Problem Statement

- Eliminate Point Estimates
  - Single number answer
  - No certainty in comparing to test value
- Provide Range Estimates
  - Minimum-Maximum values
  - Allows for risk decisions
- Limited data
- How can we use this limited data to provide an accurate range estimate to determine if 17,000 is within the range with an appropriate level of confidence?

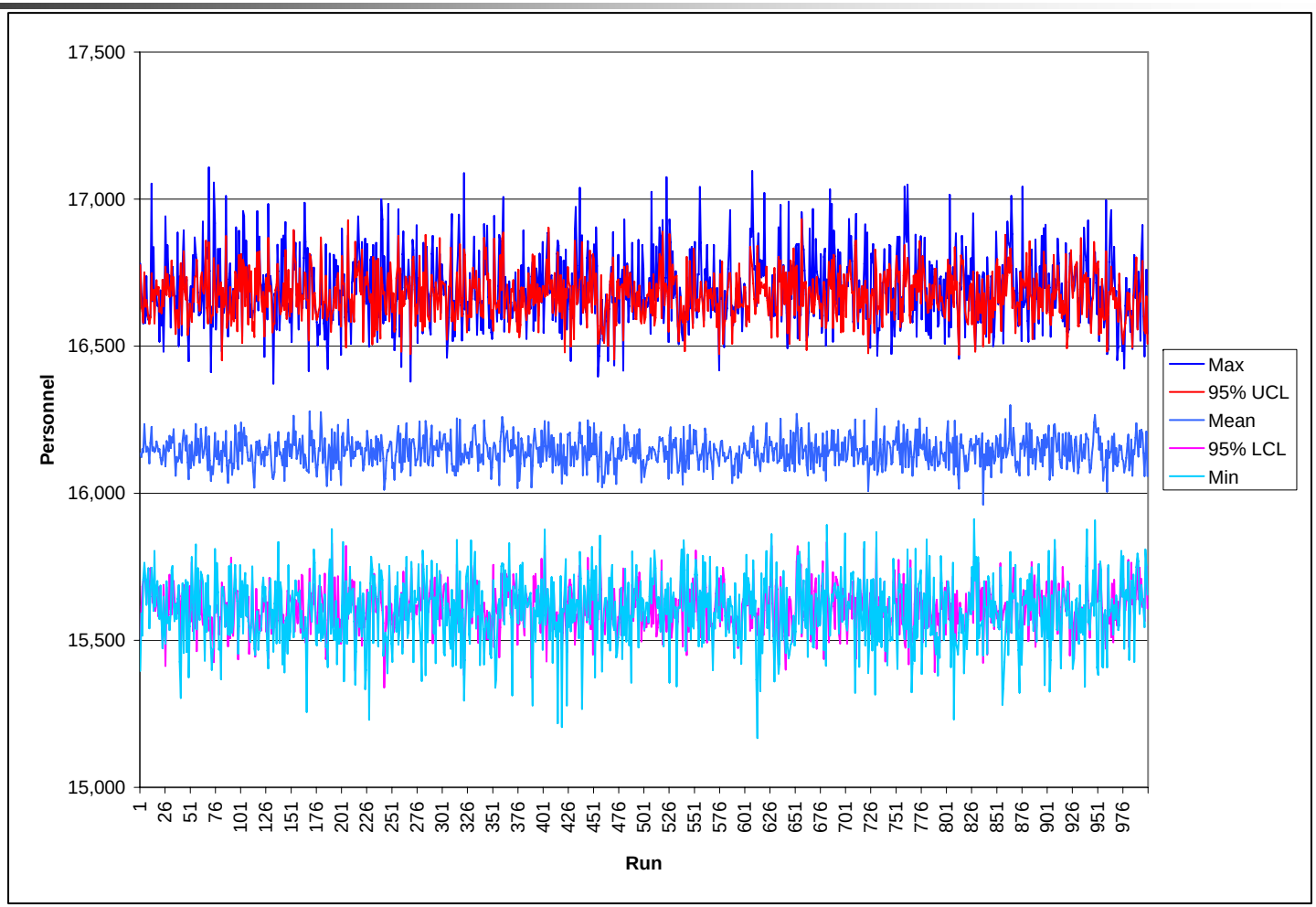
# Deterministic Model

- Provides same point estimate, always
- Task times/frequencies used:
  - Actual value when single value
  - Average value when a range
    - (Min + Max) / 2
    - (Min + Most Likely + Max) / 3
- Limitation
  - No variation
- Result: 1 PM Detachment per 16,138 personnel
- No appropriate method to compare this to 17,000

# Partial Stochastic Model

- Provides range estimate
- Based on
  - Actual value when single value
  - Uniform distribution between min and max
  - Triangular distribution with min, max, most likely
- Limitation
  - Only some tasks contributed to variation
- Result: 30,000 iterations, 95% confidence interval of (15606, 16678), with a mean of 16,142
- The 17,000 is outside this confidence interval, but is this a good representation.

# Partial Stochastic Model – Results



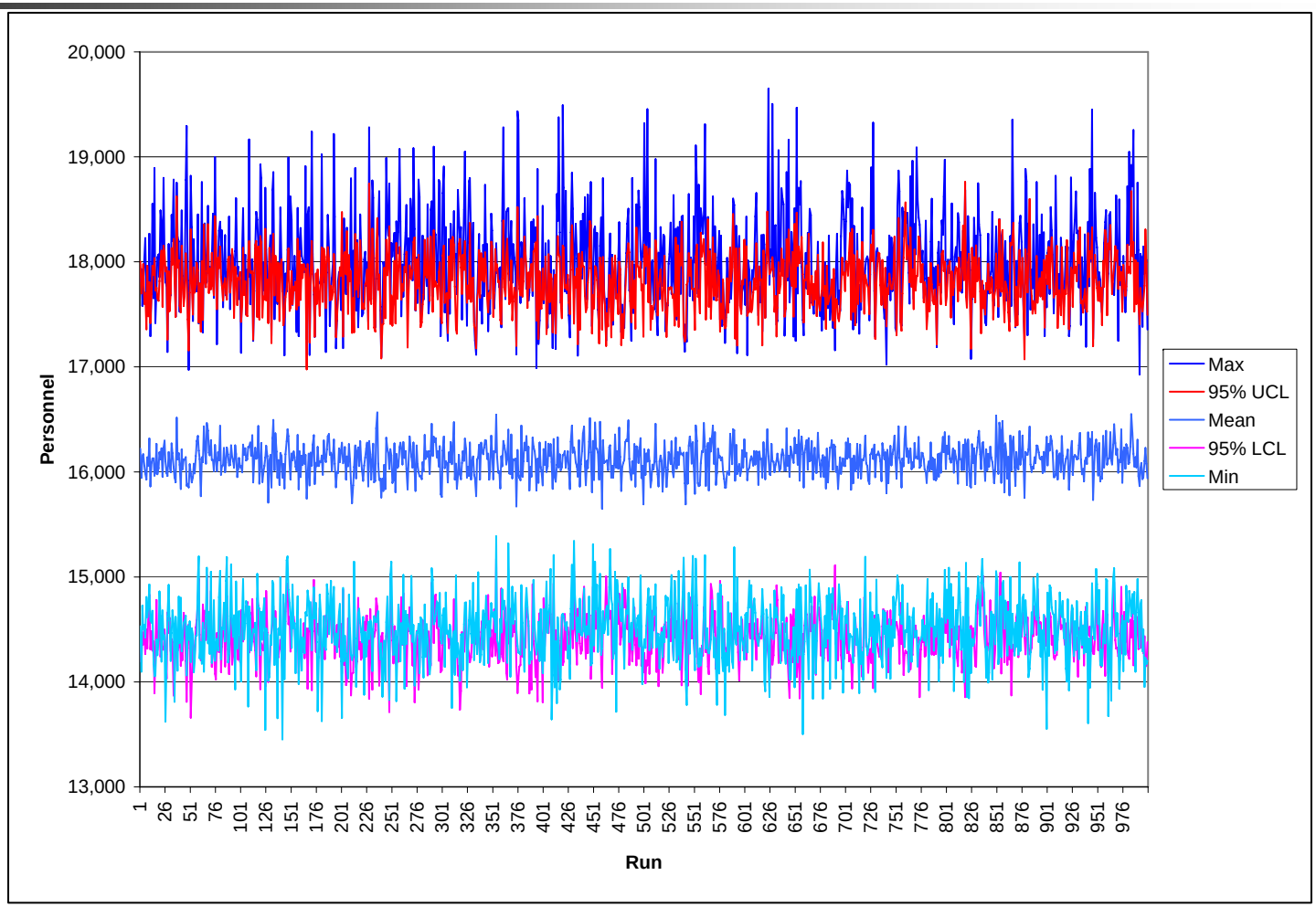
# Full Stochastic Model – Setup

- Assumptions
  - Frequency were accurate
  - Distribution of time for all tasks was normal
  - Variation of time for all tasks was constant
- Calculations
  - Task: $\hat{\sigma}_i \approx (Max_i - Min_i)/6$
    - Covers 99% of normal distribution
  - Task: $\hat{\mu}_i \approx (Min_i + Max_i)/2$
  - Task: $CV_i = \hat{\sigma}_i / \hat{\mu}_i$
  - Composite: $E(CV) = \sum CV_i / n$
  - Task: $\hat{\sigma}_i \approx Val_i * E(CV)$
  - Task: Single values converted to ranges
    - Min = Val – 3 (Val * E(CV))
    - Max = Val + 3 (Val * E(CV))

# Full Stochastic Model - Implementation

- Provides range estimate
- Based on:
  - Uniform distribution between min and max (original or calculated)
  - Triangular distribution with min, max, most likely
- Limitation
  - Some time ranges based on assumptions
- Benefit
  - All time values in the model are stochastic
- Result: 30,000 iterations, 95% confidence interval of (14410, 17824), with a mean of 16,117
- The 17,000 is within this confidence interval.

# Full Stochastic Model – Results



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# Future

- Developing survey for PM SMEs
- Will give data to develop distributions for all task times and task frequencies
- These distributions will improve the current model

# Conclusion

- As the number of stochastic variables increased, the results allowed the decision maker to better estimate the risk of the decision made.
- Selecting a value near the upper limit, accepts more risk but a lower cost (less detachments).
- Selecting a value near the lower limit, provides less risk but a higher cost (more detachments).
- Need to improve data through survey

- All models are wrong, some are useful.
  -- George E. P. Box, Ph.D., *Empirical Model-Building and Response Surfaces*


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