

"SEMI-STOCHASTIC" SIMULATIONS AND
OTHER TRICKS OF THE TRADE

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ABSTRACT

Traditionally, simulation models have been divided into two categories, deterministic and stochastic. Stochastic models, while very useful, often have to be run for long periods of simulated time to achieve statistical validity, even if specialized statistical variance reduction techniques are used in generating deviates. An alternative to the two extremes, used quite successfully at Exxon Corporation, is what we call a "semi-stochastic" model. This talk describes the methodology used in constructing such a model as well as the positive and negative aspects of this decision, using as an example a generic facilities modeling tool developed at Exxon.

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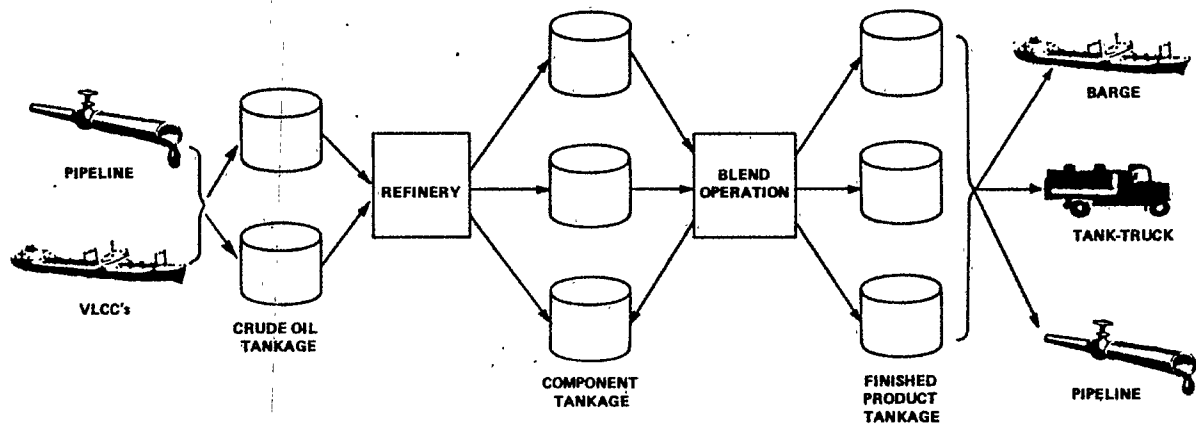
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OVERVIEW

- UNDERLYING BUSINESS PROBLEM
- MODELING DECISIONS TO BE MADE
- TRADE-OFFS
- APPROACH SELECTED
- ADVANTAGES/DISADVANTAGES

SIMPLIFIED OVERVIEW OF A PRODUCT REFINERY



MODEL REQUIREMENTS

FROM USER'S VIEWPOINT

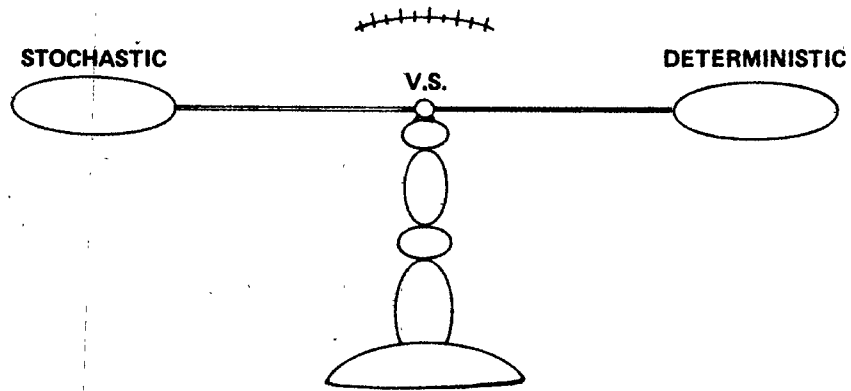
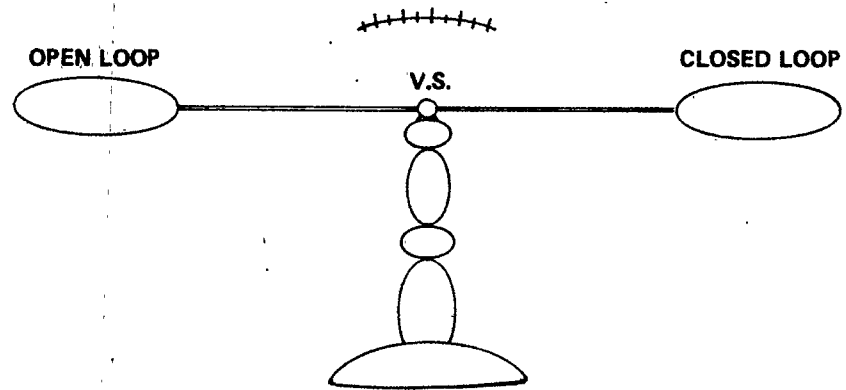
- EASY TO USE
- DATA-DRIVEN
- ADEQUATE (BUT NOT OVERWHELMING) AMOUNT OF MODELING DETAIL
- EASY TO VALIDATE

MODEL REQUIREMENTS

FROM O.R. MODELER'S VIEWPOINT

- NO INTERACTION BETWEEN INTERNAL AND EXTERNAL VARIABLES
- USE OF "NEGATIVE FEEDBACK" LOOPS WHENEVER POSSIBLE
- AVOIDING "POSITIVE FEEDBACK" LOOPS
- STRUCTURED, MODULAR MODEL (AND CODE) DESIGN
- CAREFUL MODELING OF STOCHASTICS

TRADE-OFFS



DISADVANTAGES OF STOCHASTIC MODEL

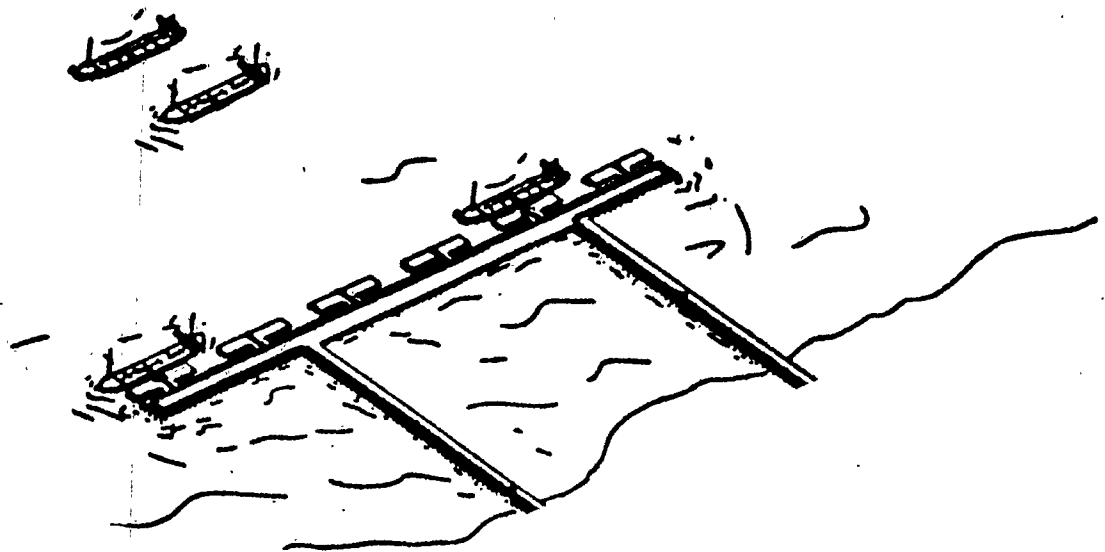
- **STATISTICAL VALIDATION REQUIRED**
- **LONGER RUN LENGTHS GENERALLY REQUIRED TO REACH "STEADY-STATE" (OR MORE RUNS NEEDED TO STUDY TRANSIENTS)**
- **HARDER TO DO GENERAL MODEL VALIDATION (INCLUDING DEBUGGING OF MODEL/CODE)**

APPROACH

- **ISOLATE STOCHASTIC SECTIONS OF MODEL IN PREPROCESSOR OR AUXILIARY ROUTINES WHENEVER POSSIBLE ("DECOUPLING" OF MODEL)**
- **OUTPUT FROM PREPROCESSOR OR AUXILIARY ROUTINES THEN FEEDS DETERMINISTIC "CORE" MODEL**

MODELING OF PRODUCT BARGES

- OPEN LOOP — BARGES COME OVER HORIZON INTO HARBOR FACILITIES
- CLOSED LOOP — BARGES MODELED ON COMPLETE ROUND-TRIP BETWEEN REFINERY AND CUSTOMERS (REQUIRES MODELING CUSTOMER FACILITIES)



ADVANTAGES OF GENERATING SHIP ARRIVAL TIMES USING A PREPROCESSOR

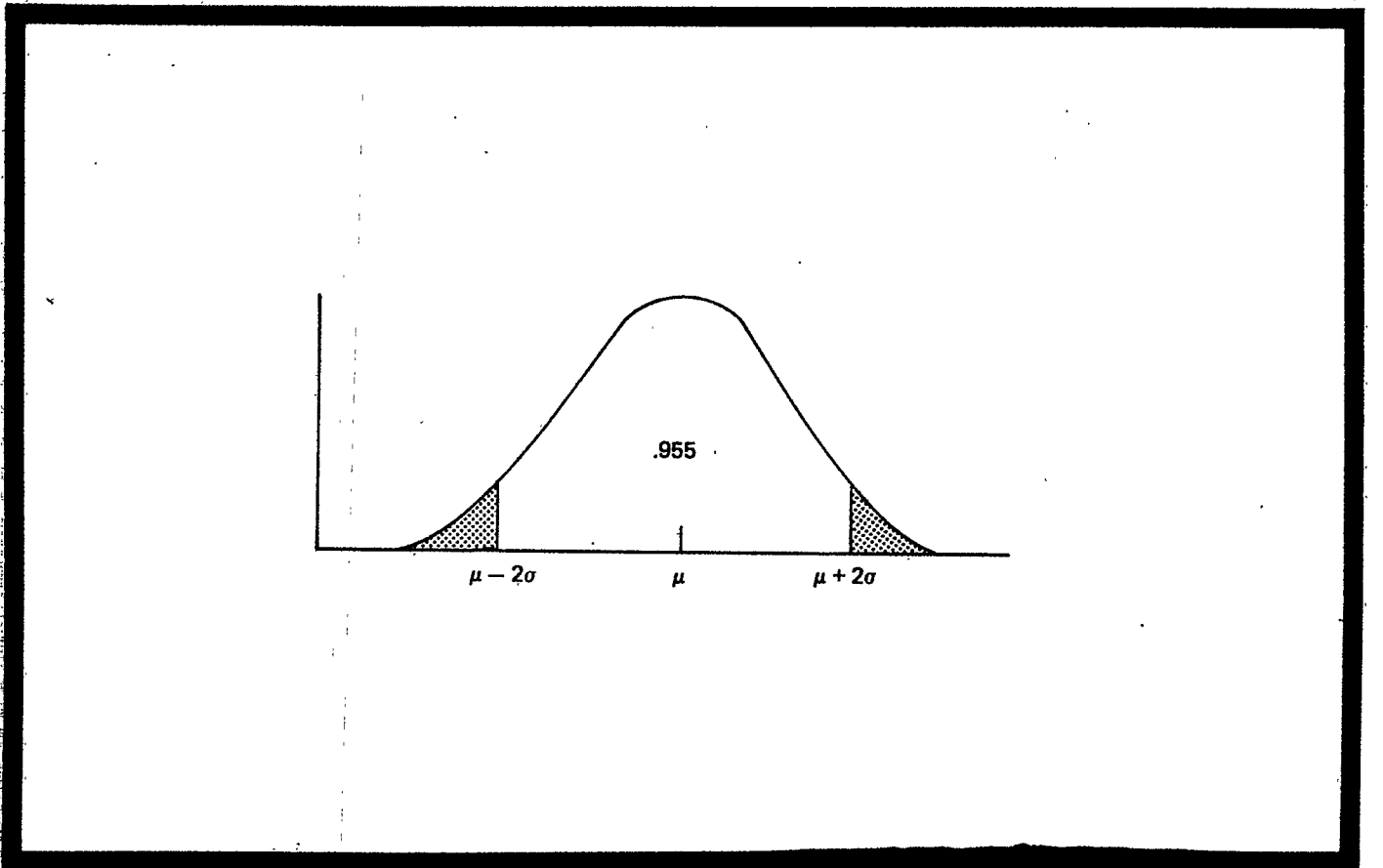
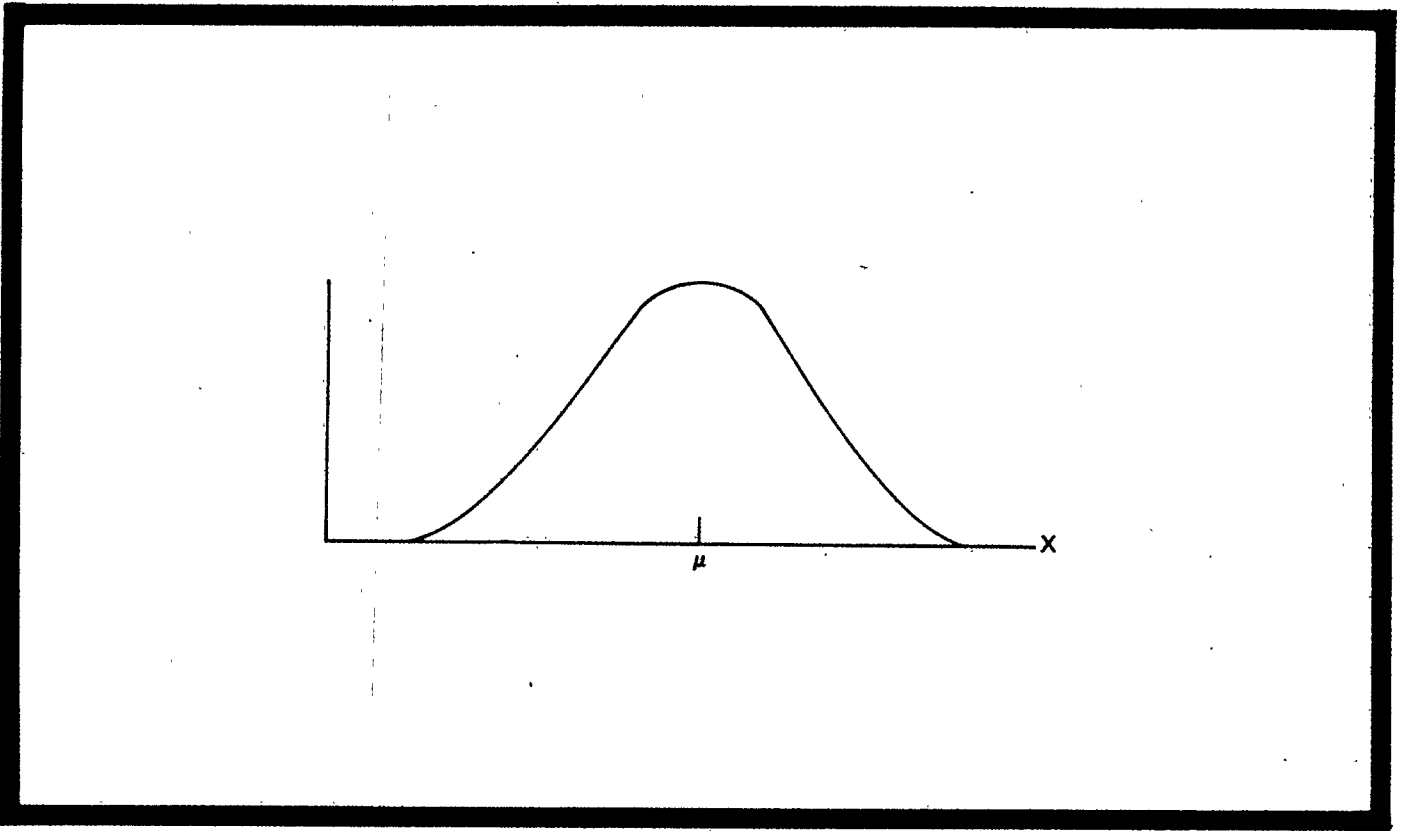
- ISOLATION OF INTERNAL/EXTERNAL VARIABLES
- EASIER TO VALIDATE ARRIVAL PATTERN
- USER CAN CHANGE SPECIFIC ARRIVALS IF DESIRED
- EASIER TO MODEL "LOOK-AHEAD" LOGIC IN MODEL CORE

OTHER PREPROCESSOR CANDIDATES

- MAINTENANCE AND BREAKDOWN SCHEDULES
- WEATHER (STORMS, FOGS, ETC.)
- OTHER EXTERNAL ITEMS

OTHER TECHNIQUES TO MINIMIZE IMPACT OF STOCHASTICS (USE WITH CAUTION!)

- STRATIFIED SAMPLING AND OTHER VARIANCE REDUCTION TECHNIQUES
- ELIMINATING TAILS OF DISTRIBUTIONS
- CONTROLLED "SHOCK" VIA TIME-VARYING DATA



DISADVANTAGES OF "SEMI-STOCHASTIC" APPROACH

- LOSS OF COMPLICATED (BUT REAL-WORLD) FEEDBACK LOOPS
- VARIANCE ANALYSIS MAY GIVE UNDERSTATED RESULTS

ADDITIONAL MATERIAL ON ORIGINAL MODELING EFFORT

**PRODUCT BLENDING: A SIMULATION CASE STUDY IN
DOUBLE-TIME**

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