PROJECT PRODUCTION INSTITUTE

Inaugural Symposium

December 3rd, 2014

San Francisco

Application of Simulation Models to Optimize Oil and Gas Well Delivery

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Agenda

1. Current Challenges
2. Description of Proposed Model
3. Case Study Application
4. Conclusions / Next Steps

Overview of Rig Fleet Management

Goal: Optimize drilling and rig scheduling in consideration of multiple objectives and/or constraints, namely:

- production cost
- production rate.

Scope:

- number of rigs
- pad drill strategy
- pad drill sequence

Current Challenges

- **Problem complexity**

Assuming a single rig:

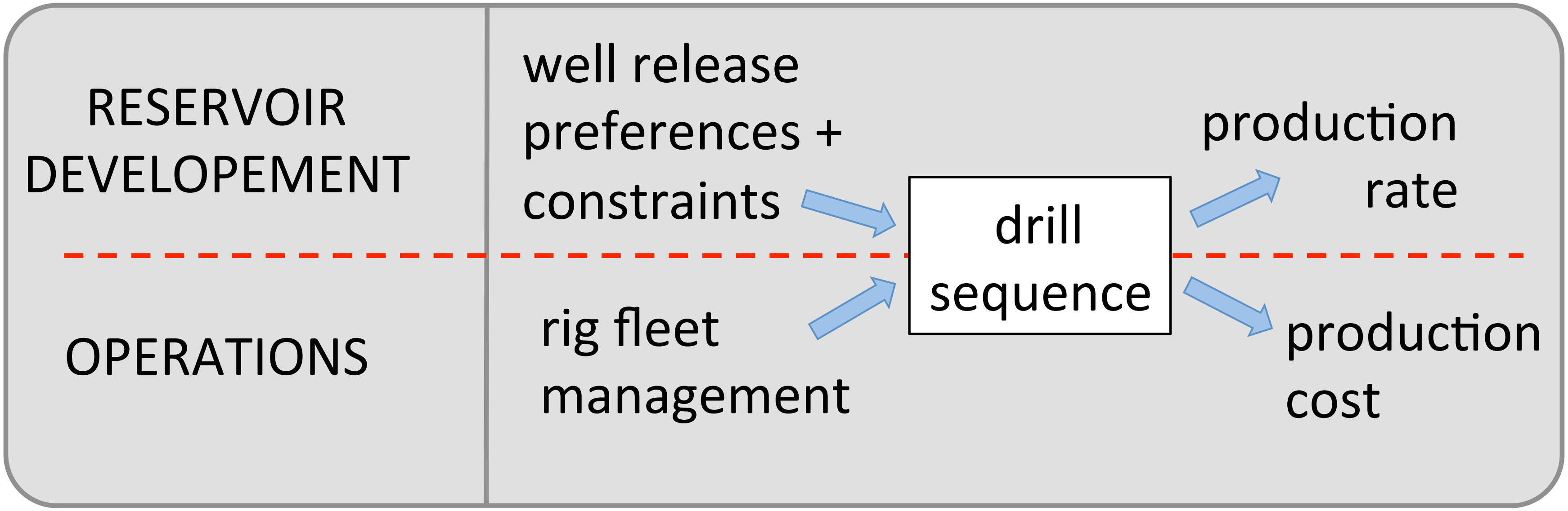
(50 PADS **)! =** **3.04E64** POSSIBLE DRILLING SEQUENCES

(50 PADS **)!^3** PAD DRILLING STRATEGIES **=** **2.81E193** POSSIBLE DRILLING SEQUENCES

Rig counts, well completions and drilling distances continue to increase…

Current Challenges

- Problem complexity
- **Alignment of operational decisions with overall reservoir development strategies**



Current Challenges

- Problem complexity
- Alignment of operational decisions with overall reservoir development strategies
- **Ability to act on available operational data**

Operational situation constantly changing:
- site readiness
- reservoir management requirements
- equipment availability
- weather

Limitations of Existing Methods

- **Alignment of operational decisions with overall reservoir development strategies**
  - **Focus is on maximizing rig utilization**
  - **Assumption: results in ↑ production and ↓ cost**

Limitations of Existing Methods

- Alignment of operational decisions with overall reservoir development strategies
  - Focus is on maximizing rig utilization
  - Assumption: results in ↑ production and ↓ cost

- **Ability to act on available operational data**
  - **Probabilistic data exists, e.g., P10, P50, P90 numbers for task durations, but are not incorporated into scheduling**
  - **Robustness of solution is not known**

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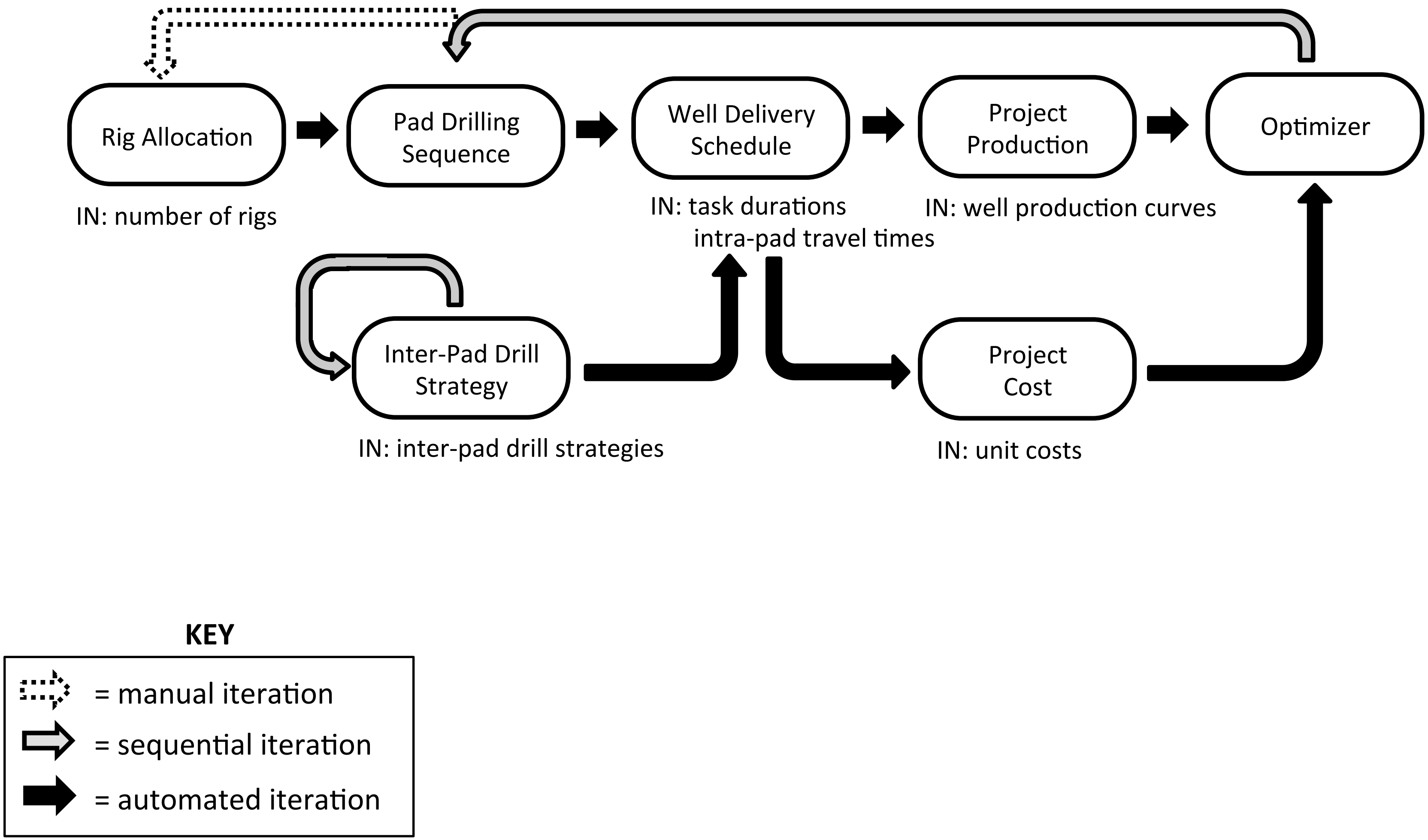
Key Model Requirements

- Handle multiple objectives without a priori articulation of preferences
- Account for uncertainty in planning assumptions
- Produce solutions in time to act on current information

Model Description



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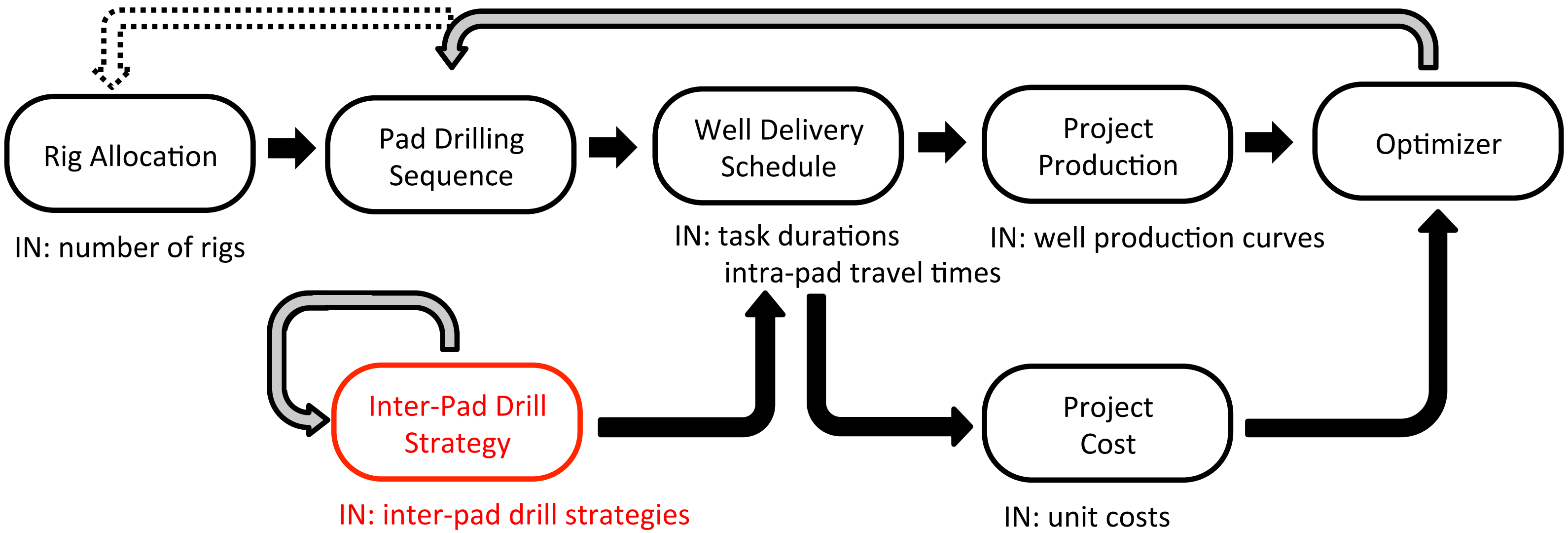

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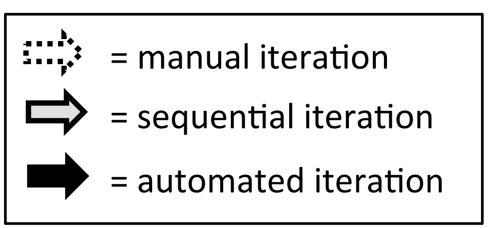
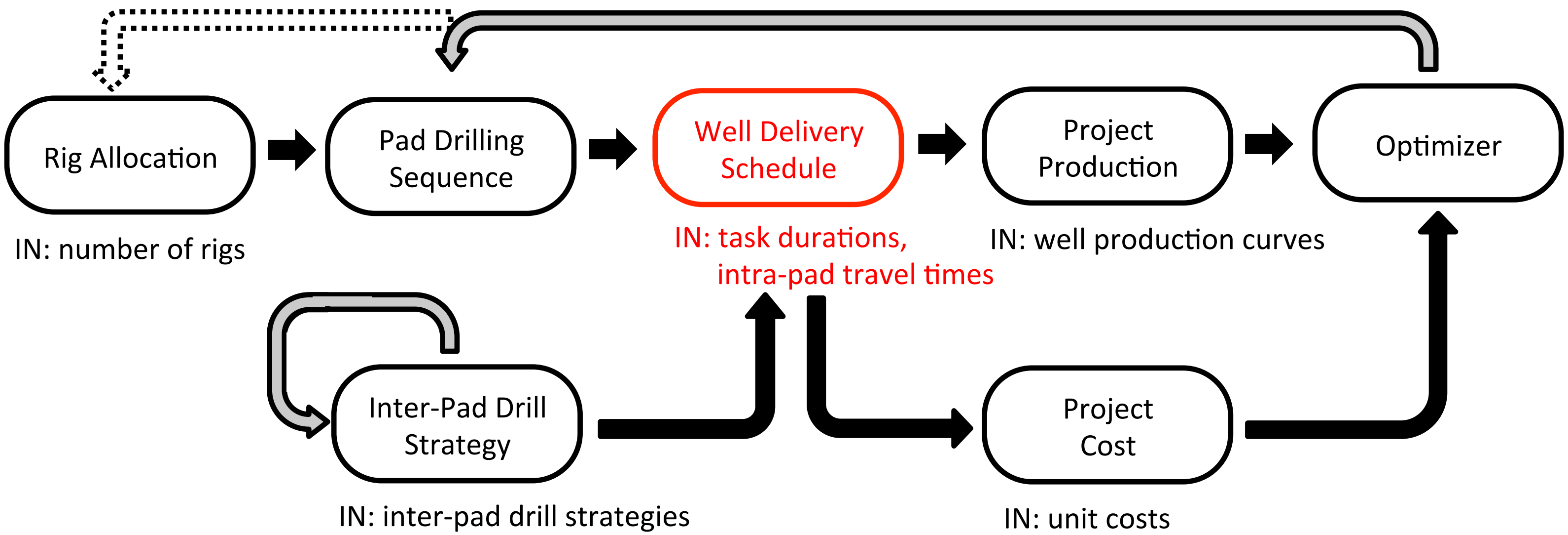


INTERPAD DRILLING STRATEGIES:

MTVL =	Rig Move	Top Hole	Vertical	Laterial
MTV =	Rig Move	Top Hole	Vertical	
MT =	Rig Move	Top Hole		

Model Description



TASK DURATIONS:

Duration by Activity (days)	P10	P50	P90
Rig Move	1	5	8
Drill Top Hole	3	5	6
Drill Vertical	12	16	22
Drill Lateral	13	15	21
Rig Down	3	3	4
Well Completion	8	10	14

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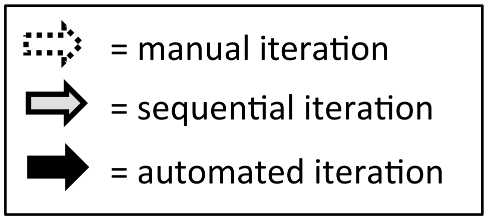

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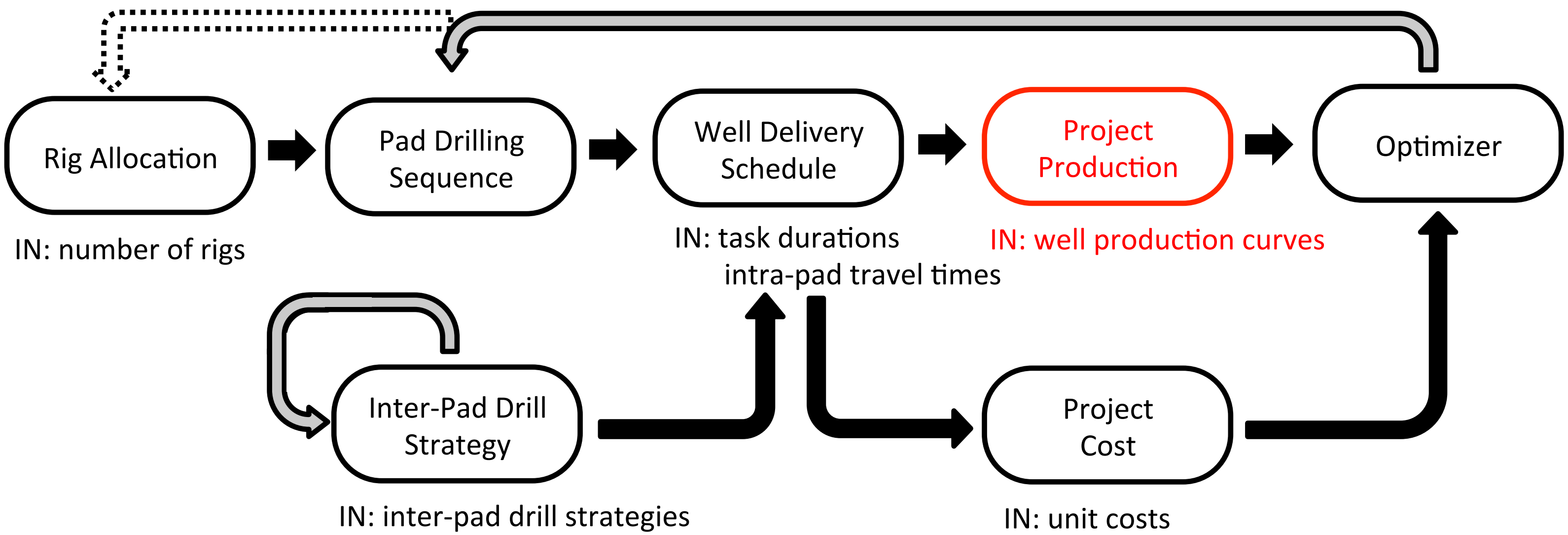

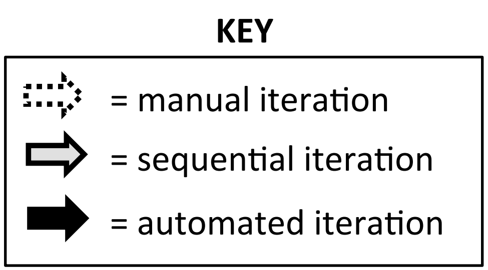

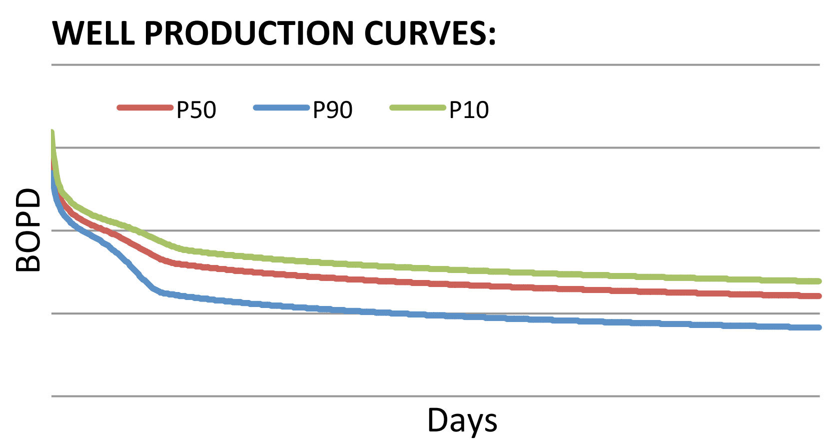

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Project Overview

Location:

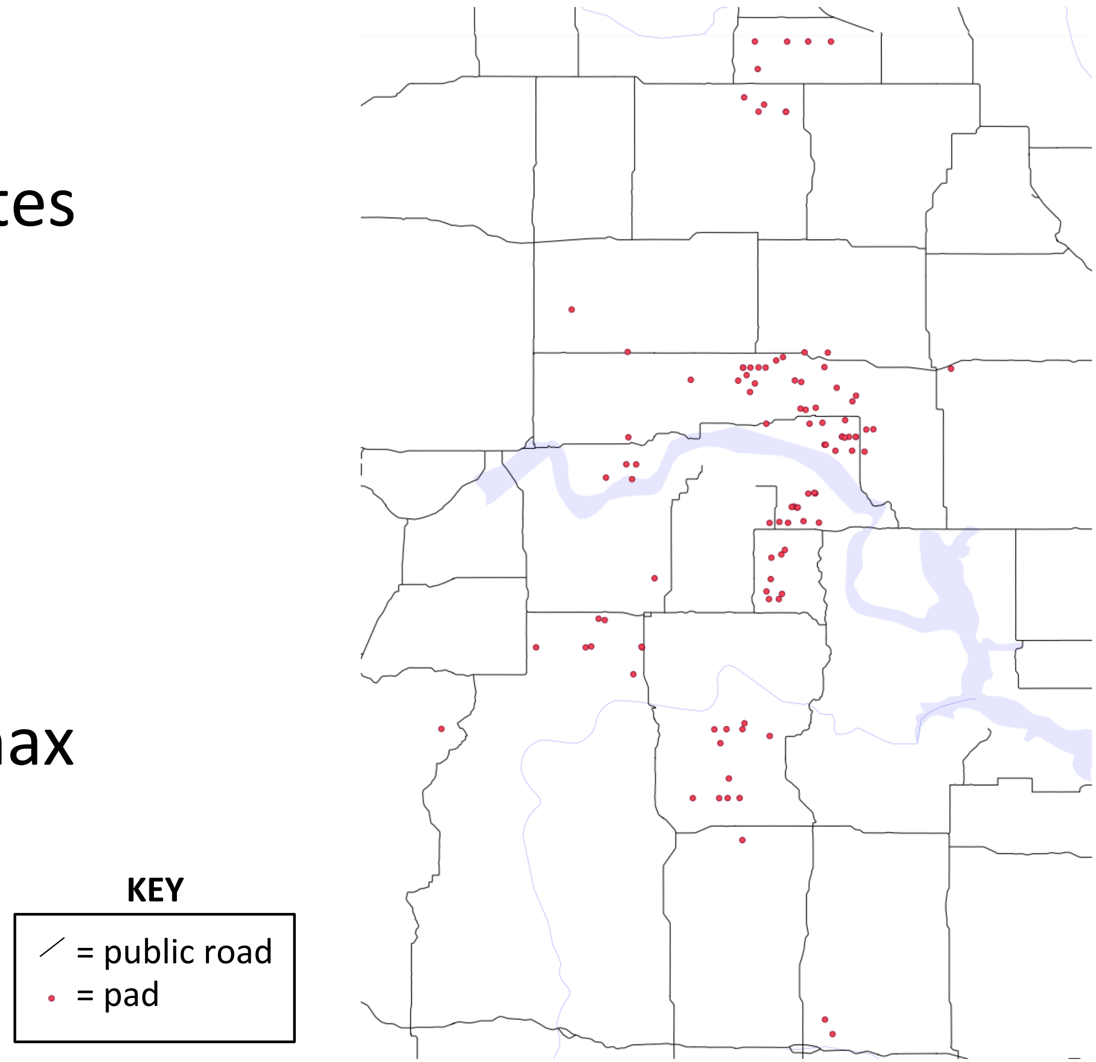
- Northern United States

Well Description:

- 237 wells
- 103 pads

Drilling Distance:

- 316km (196 miles) max



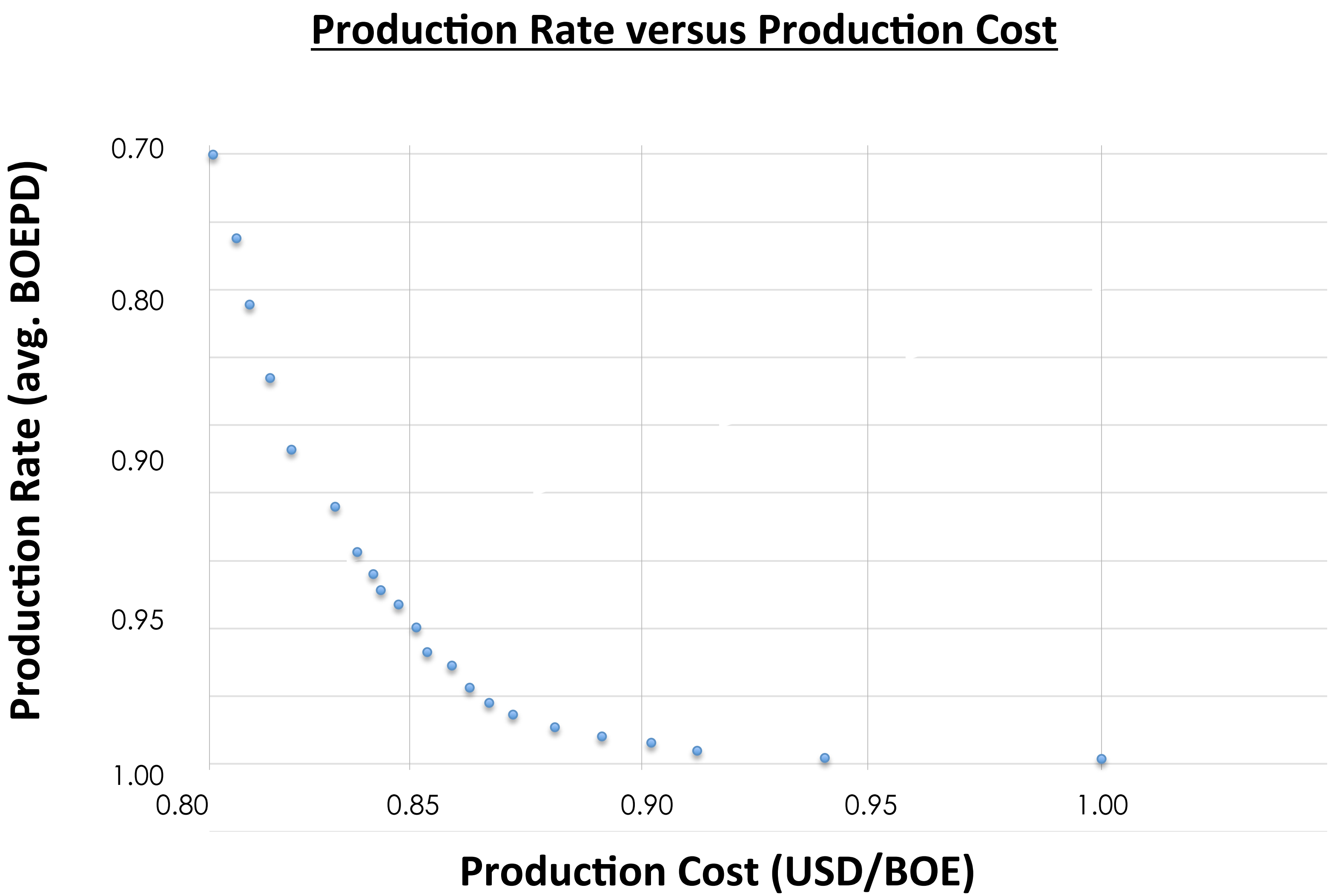
Experiment 1: Problem Formulation

Objectives: - *minimize* **production cost** (USD/BOE)
- *maximize* **production rate** (avg. BOEPD)

Variables: - **number of rigs** (1-5)
- **pad drill strategy** (MTVL, RTV, RT)
- **pad drill sequence** (1,2, … , 103)

Algorithms: - DAKOTA multi-objective genetic algorithm
- Monte Carlo DOE

Experiment 1: Results



Experiment 2: Problem Formulation

Objective: - *minimize* **production cost** (USD/BOE)

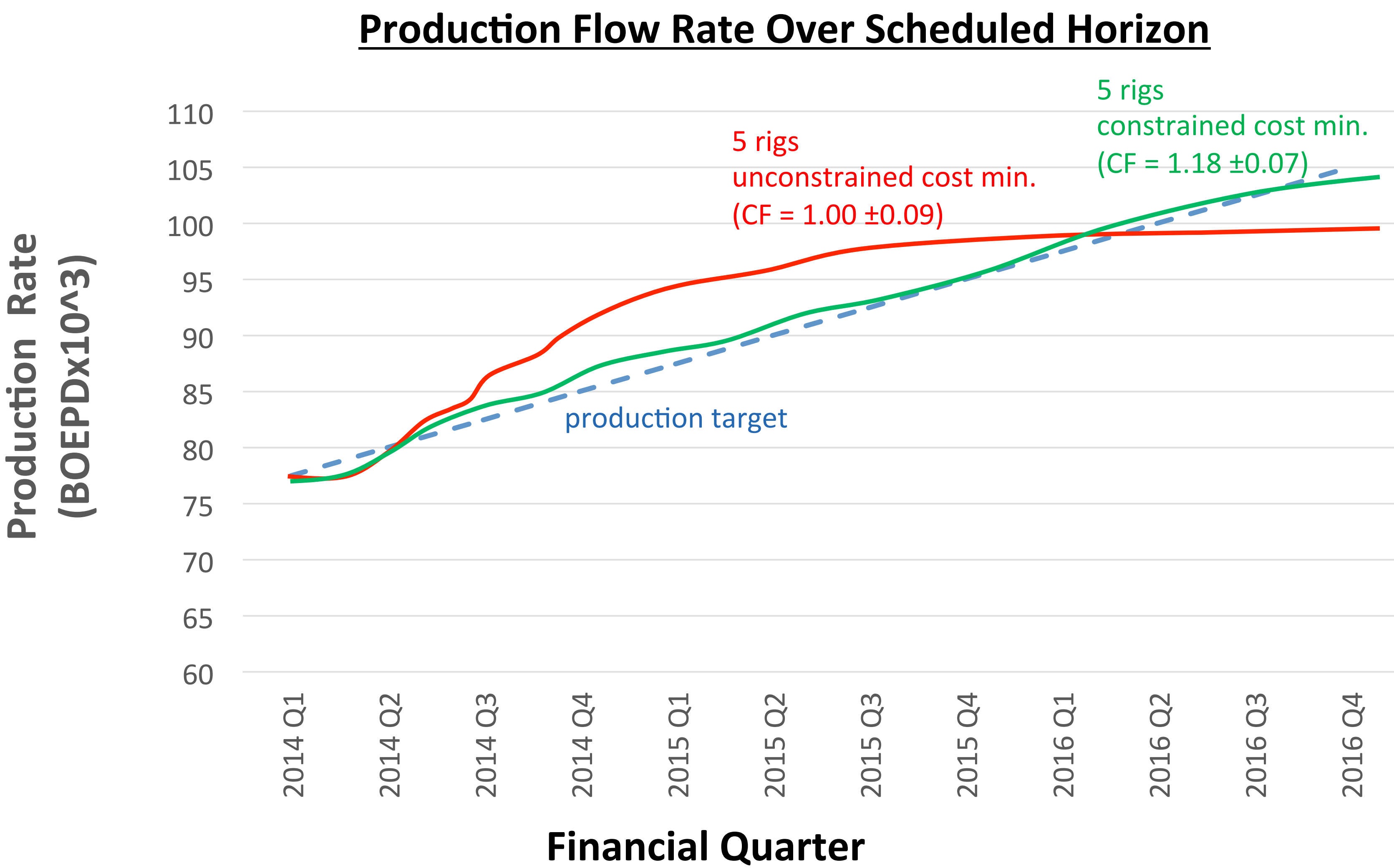
Constraints: - **quarterly production rate** (BOEPD x 10^3)

2014				2015				2016			
Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
77.5	80.0	82.5	85.0	87.5	90.0	92.5	95.0	97.5	100.0	102.5	105.0

Variables:
- **number of rigs** (1-5)
- **pad drill strategy** (MTVL, RTV, RT)
- **pad drill sequence** (1,2, … , 103)

Algorithm:
- Darwin genetic algorithm
- Monte Carlo DOE

Experiment 2: Results



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Conclusions

- Case study data supports the hypothesis that optimizing for rig utilization / cost does not necessarily best satisfy project production rate objectives
- Significant variations in production rate (30%) and costs (19%) are possible depending on management decisions

Future Work

- More detailed modeling of well completion activities
- Better analysis and representation of solution uncertainty
- Improve algorithms to reduce feedback latency

Thank You