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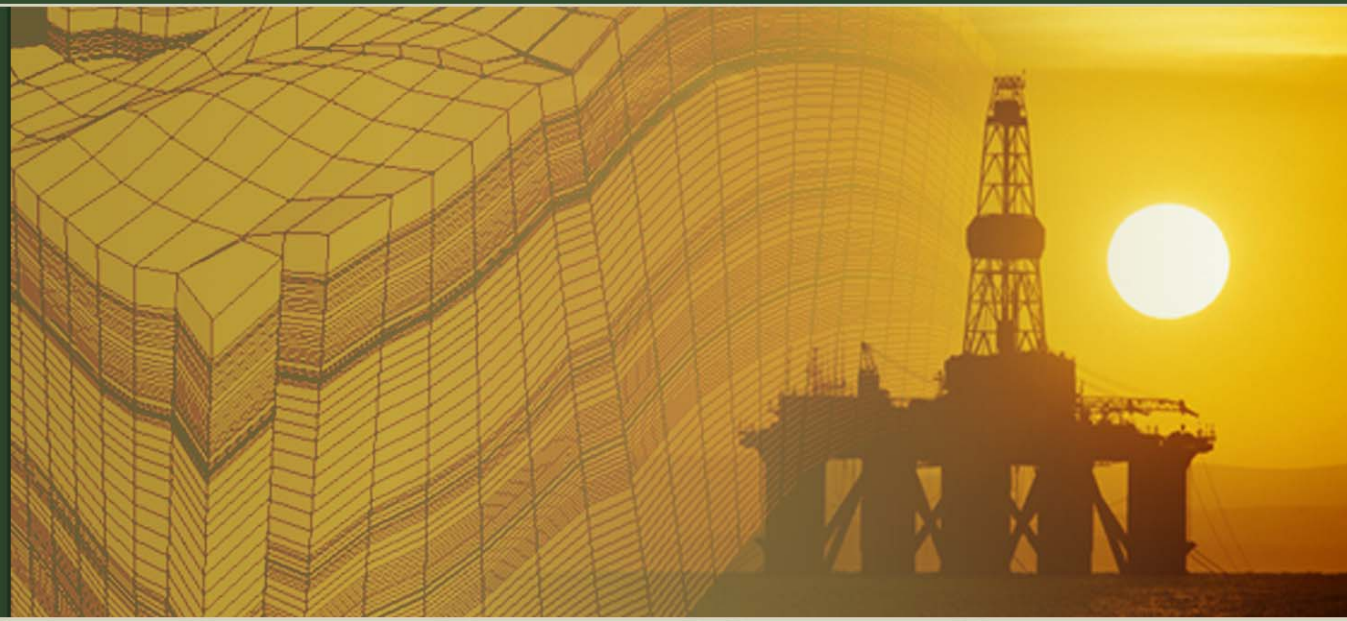
Houston

Denver

Calgary



SPE Young Professionals

Are There Enough Barrels to Make This a Project?

A Reservoir Engineer's Perspective

Dean C. Rietz, P.E.

June 4, 2009

What Does it Take to "Make a Project"?

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- SEC Perspective
  - NPV
- Internal Corporate Hurdles
  - IRR
  - NPV
  - ROI, DPI, etc.
  - Minimal payout time
- Outside Financing
  - Additional Criteria

What do we need to look at to decide if a particular project is worthwhile?

. . . . . .

What Do We Need to Look at to Decide if a Particular Project is Worthwhile?

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- Let's Look at 3 Different Projects:
  - PROJECT A ~ 10 MMBO
  - PROJECT B ~ 30 MMBO
  - PROJECT C ~ 300 MMBO
- Which is Best?
- Do We Need to Know More?

PROJECT A

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- Rock Properties . . . . . Very Good
- Fluid Properties . . . . . .Heavy Oil
- General Reservoir Characteristics
  - Shallow
  - Well known area
- Producing Concerns
  - May require thermal EOR

PROJECT B

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- Rock Properties . . . . . Very Good
- Fluid Properties . . . . . .Very Good
- General Reservoir Characteristics
  - Mid-range depth
  - Well known area
  - Demonstrated candidate for waterflood
- Producing Concerns
  - Water source

PROJECT C

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- Rock Properties . . . . . Low Permeability
- Fluid Properties . . . . . .Viscous
- General Reservoir Characteristics
  - Frontier area
  - Unknown continuity
- Producing Concerns
  - Deep Water
  - High angle/horizontal wells may be needed
  - Spacing development unknown
  - Too deep for thermal

So, are more barrels better?

Is Project C viable, what about A or B?

Let's look at more details:

"The more you detail, the more details you find need to be detailed."

Steve Claassen
Owner – Tropical Sportscars

How do the various reservoir characteristics affect project performance and overall value?

Value ⟹ Not Just Barrels of Oil

Reservoir Properties

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ITEM	POTENTIAL IMPACT
Rock Properties	
− Low permeability/ poor quality	• Slower rate of recovery (lower value) • Need for high angle/horiz wells (higher cost) • Higher residual oil saturation (lower RF)
Fluid Properties	
− High viscosity − High saturation pressure	• Slower rate of recovery (lower value) • Lower API gravity (lower product price) • May need EOR (higher dev cost) • Two-phase region reached sooner (lower RF, increased facility costs)

General Reservoir Characteristics

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ITEM	POTENTIAL IMPACT
Deeper	• More costly to drill (higher dev costs) • Increased completion costs (higher dev costs)
Drive Mechanism	• Water drive – good for oil, not so for gas • Compaction – increased energy, potentially reduced permeability
Frontier Area	• Best practices – Unknown (learning, costlier) • Commerciality not proven (increased risk) • Funding may be limited (increased borrowing cost)
Project Size	• Economies of scale (increased efficiencies) • Larger size may require ▪ More partners – potential delays ▪ Outside funding – increased costs

Project Comparison – Looking at the Details

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1. OOIP
2. Ultimate Recovery
3. Recovery Factor
4. Production Forecast
5. Cash Flow (economic results)
6. Economic Hurdles (company & project specific)

Predicting Future Performance

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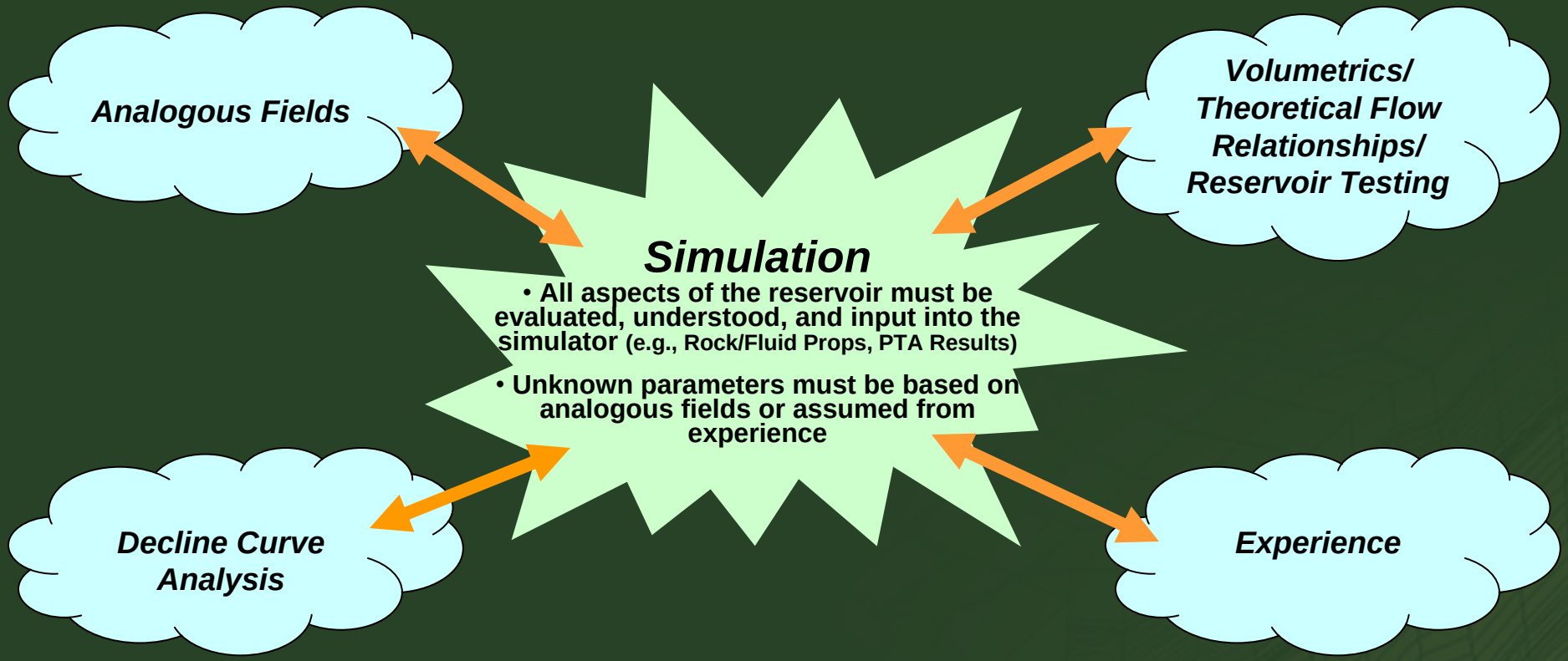

- In some cases, direct analogs may be all that is needed to conduct an evaluation.
- In other cases, known historical performance data may suffice for a reasonable and reliable forecast (DCA).

Forecasting Oil Recovery

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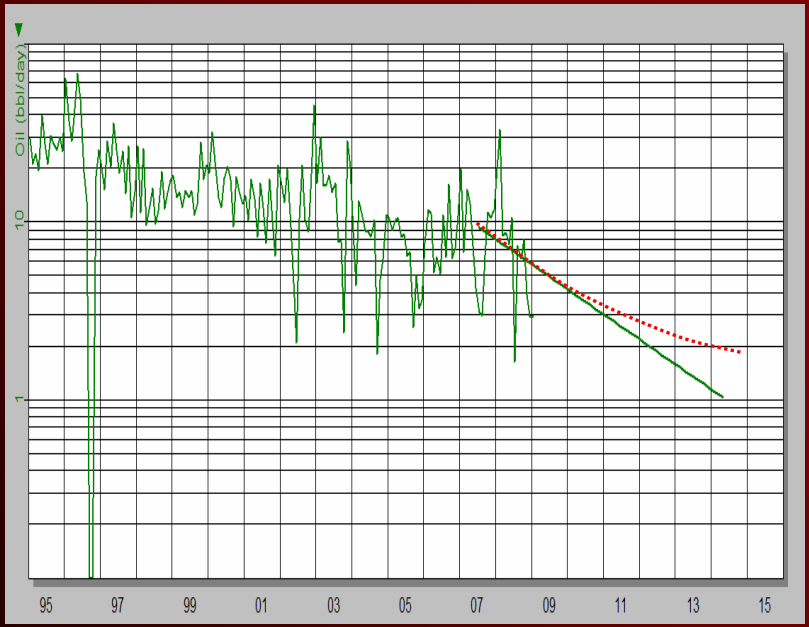
Available Production History

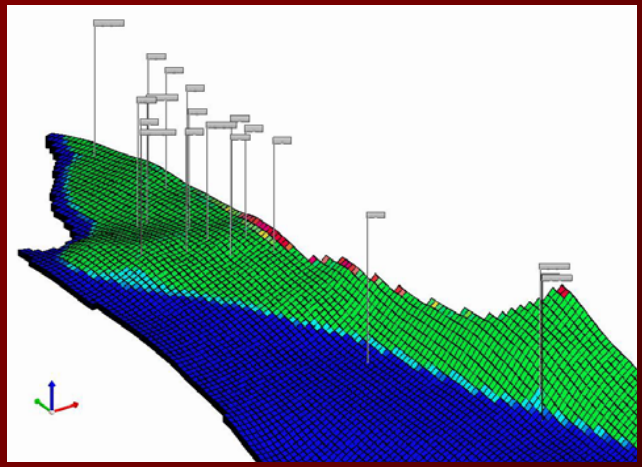
Decline Curve Analysis



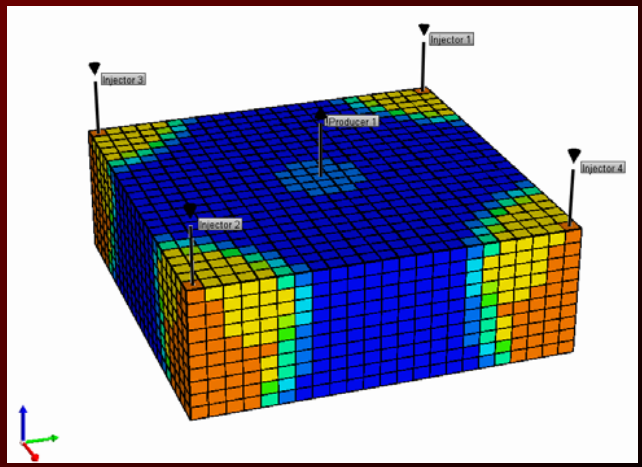
- Experience, Analogs, Transient Test Data may help to determine the forecast portion.

No History / Complex Reservoirs

Full Field Models



Pattern Elements



Forecasting Oil Recovery - Simulation

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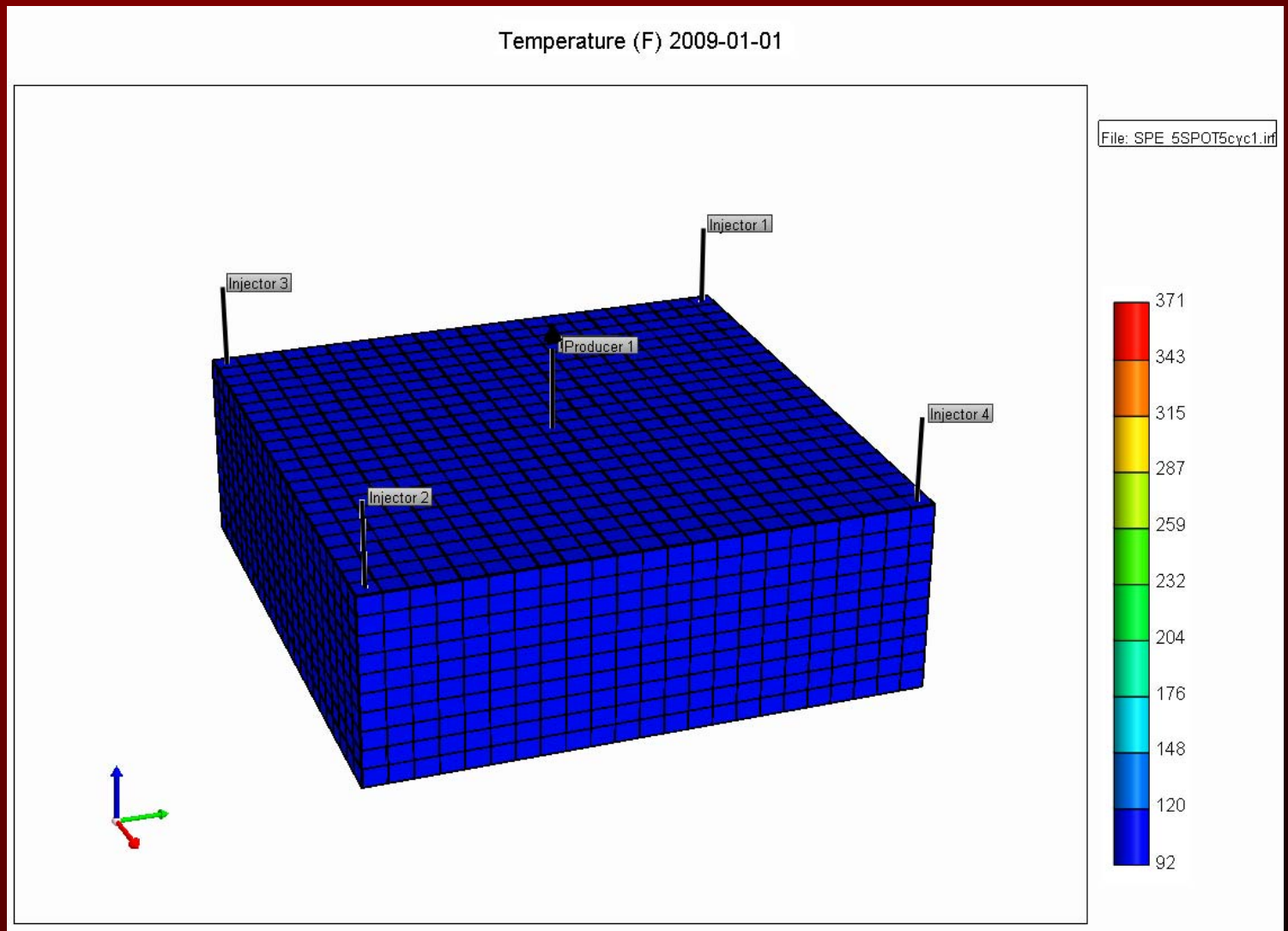
Pattern Element Model



Forecasting Oil Recovery - Simulation

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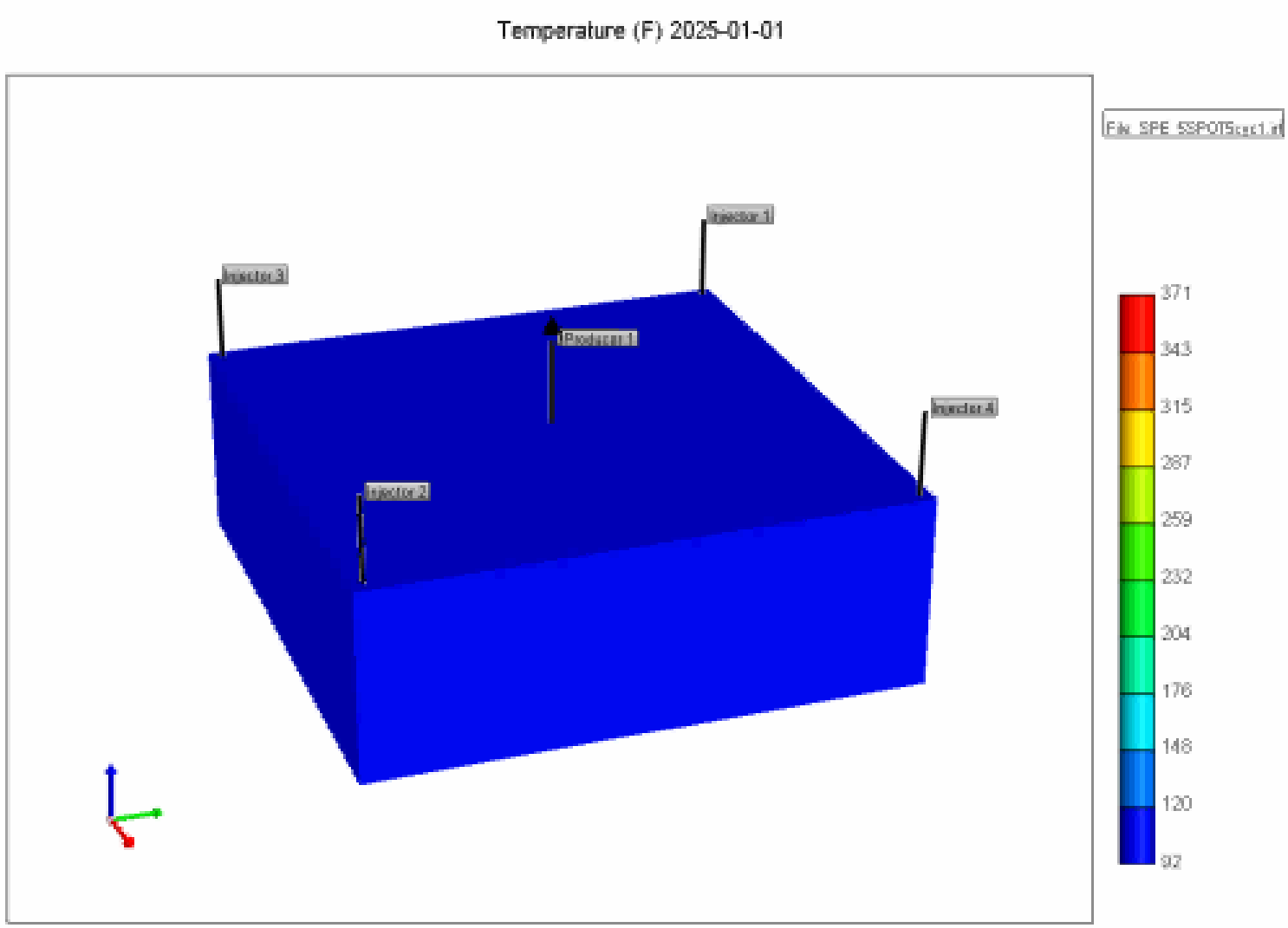
Pattern Element Model



Project A, B, & C Forecasts

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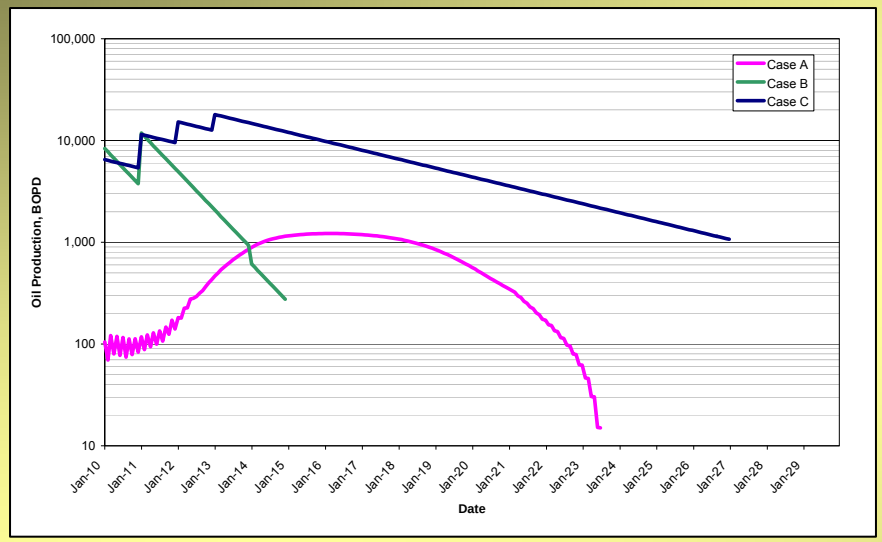
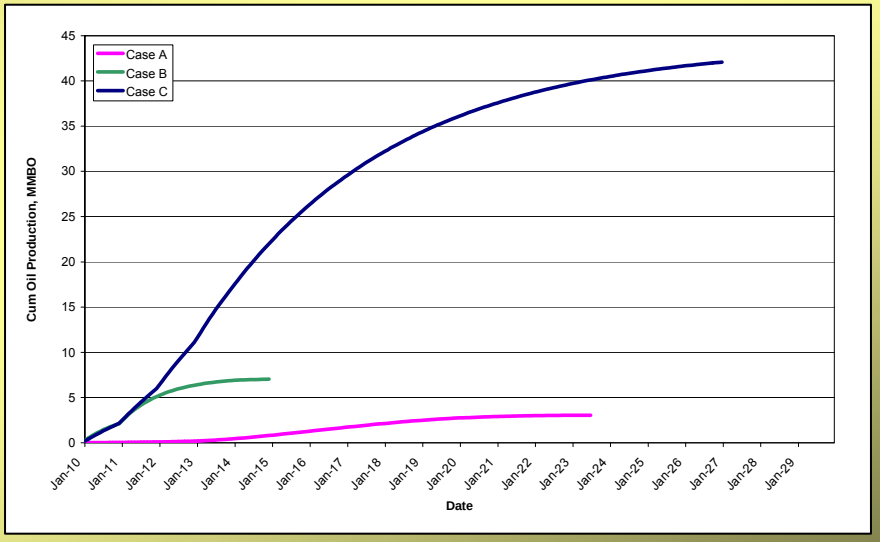
Assuming we know all we need to in order to construct our reservoir models, we obtain the following forecasts:

Oil Rate Comparison



Cumulative Oil Comparison



Compare Recoveries and Project Costs

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	OOIP *MMBO*	Ult Rec *MMBO*	RF *Percent*	Life *Yrs*	Dev Cost *MM$*
A	10	3.0 (5.2)	30% (50%)	13.5	$5.8 MM
B	28	7.0	25%	5	$74 MM
C	280	42.1	15%	17	$860 MM

Compare Project Value

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	*NPV – *M$* (Undisc)	NPV – *M$* 10%	IRR %	ROI (Disc)	Payout Yrs
A	$ 52,916	$ 26,165	52%	5.8	4.2
B	$ 199,842	$ 167,943	>100%	3.4	0.8
C	$ 452,904	$ 72,714	13%	1.1	5.8

**** Forecasted volumes must be economically viable to be considered reserves (SEC: NPV > $1).***

Based on NPV at 10%, Project B is the most valuable at this time.

Note that all of the projects are economic, thus the choice strongly depends on various factors relating to the company's financial position.

The Inter-Relationships of Project Viability

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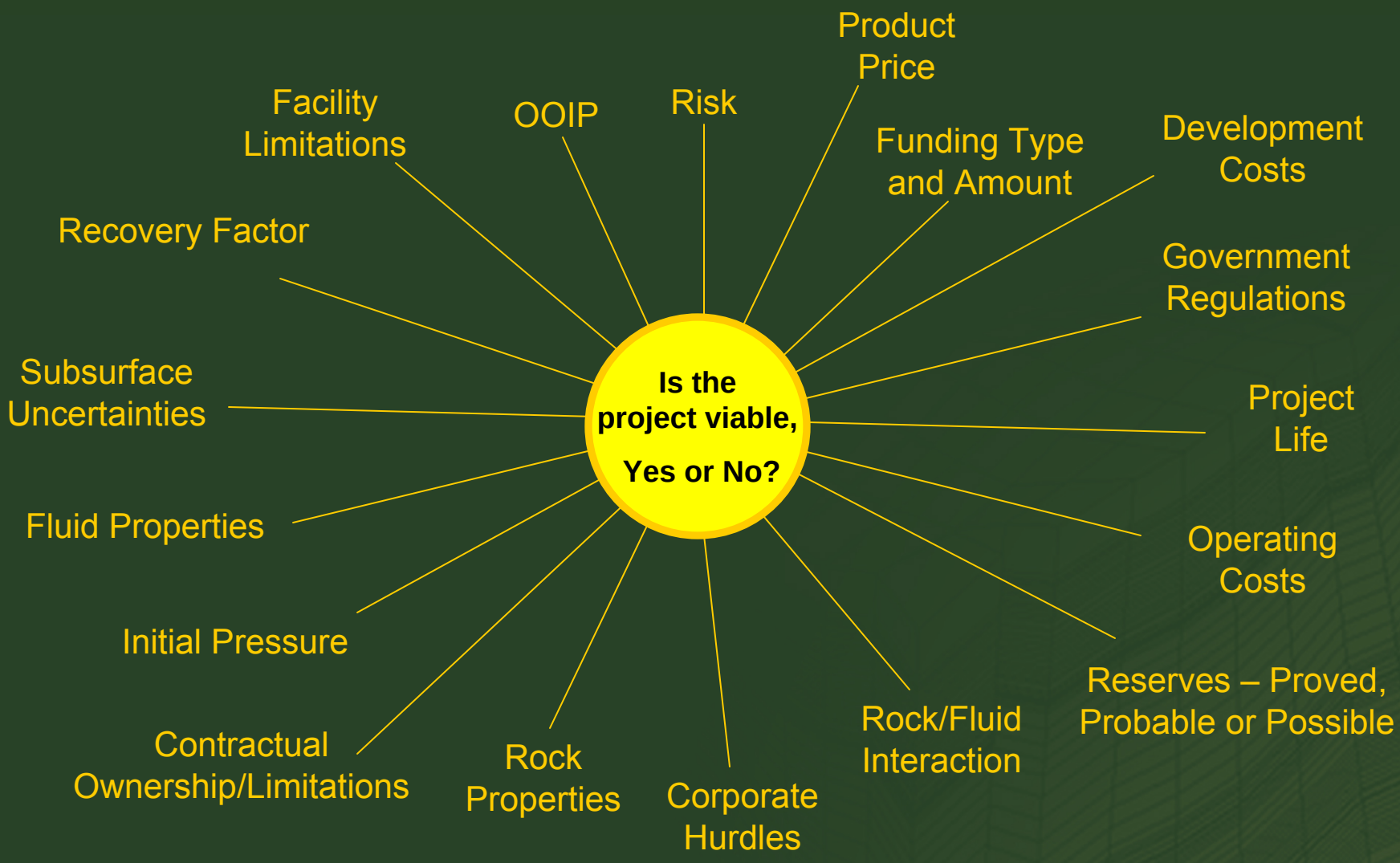

Conclusions

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- Reservoir engineering and evaluation requires significant interaction with other disciplines to fully understand the complete project.
- Even though many projects have common characteristics, they are all unique and must be evaluated individually.
- As with each step along the way following our barrel (from reservoir to the gas pump), many interrelated and interdependent facets must be evaluated.

Future Challenges

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- Knowing how much time is the right amount to spend evaluating a project.
- Dealing with more complex reservoirs and more complex methods of analysis to answer the call for future energy demands.
  - "Easy Reservoirs" have already been found and exploited.
  - Maximizing ultimate recovery (Higher RFs) will require new approaches to reservoir management and overall project design.
- Transfer of experience from the large portion of our industry who will be retiring in the next 10 years.

EVERY PROJECT IS A CHALLENGE!

Questions?

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