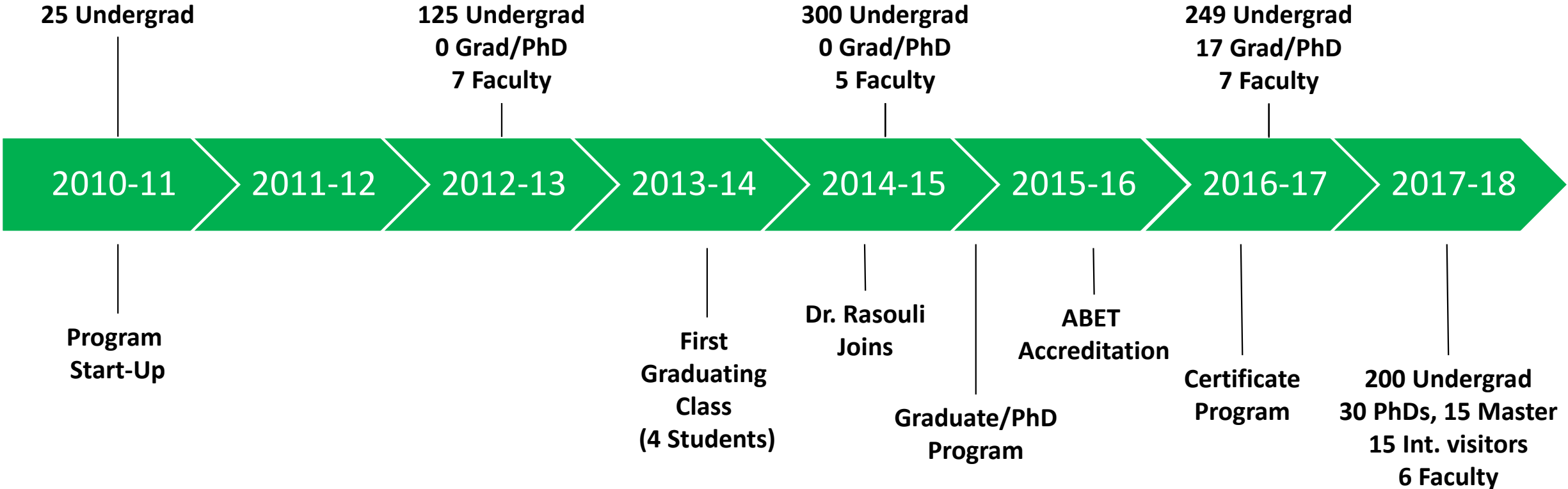# "State of the Program"

Dr. Vamegh Rasouli
Department Chair, Continental Resources Distinguished Professor

May 2, 2018

History of UND Petroleum Engineering

25 Undergrad

125 Undergrad
0 Grad/PhD
7 Faculty

300 Undergrad
0 Grad/PhD
5 Faculty

249 Undergrad
17 Grad/PhD
7 Faculty

2010-11 > **2011-12** > **2012-13** > **2013-14** > **2014-15** > **2015-16** > **2016-17** > **2017-18**

Program
Start-Up

First
Graduating
Class
(4 Students)

Dr. Rasouli
Joins

Graduate/PhD
Program

ABET
Accreditation

Certificate
Program

200 Undergrad
30 PhDs, 15 Master
15 Int. visitors
6 Faculty

UND PETROLEUM ENGINEERING
UNIVERSITY OF NORTH DAKOTA

Highlights of Program Development Since 2015

- Growth of the industry advisory council (IAC) to 23 companies in 2018

- Establishment of Ph.D., Master, and Certificate programs (2016)

- Moving into a central advising model (CAM), (2015)

- Establishment of the drilling fluids teaching labs, Hess & Drilling Systems drilling simulator lab, Hess Virtual Reality lab, and Hess Innovation labs (2016-2017)

- 2+2 (undergraduate) and 2+1 (master degree) joint teaching programs with some universities in China (2017)

- Successful shift into practical research activities and receiving over $2M of research income from several projects that the faculty applied for in 2017-2018
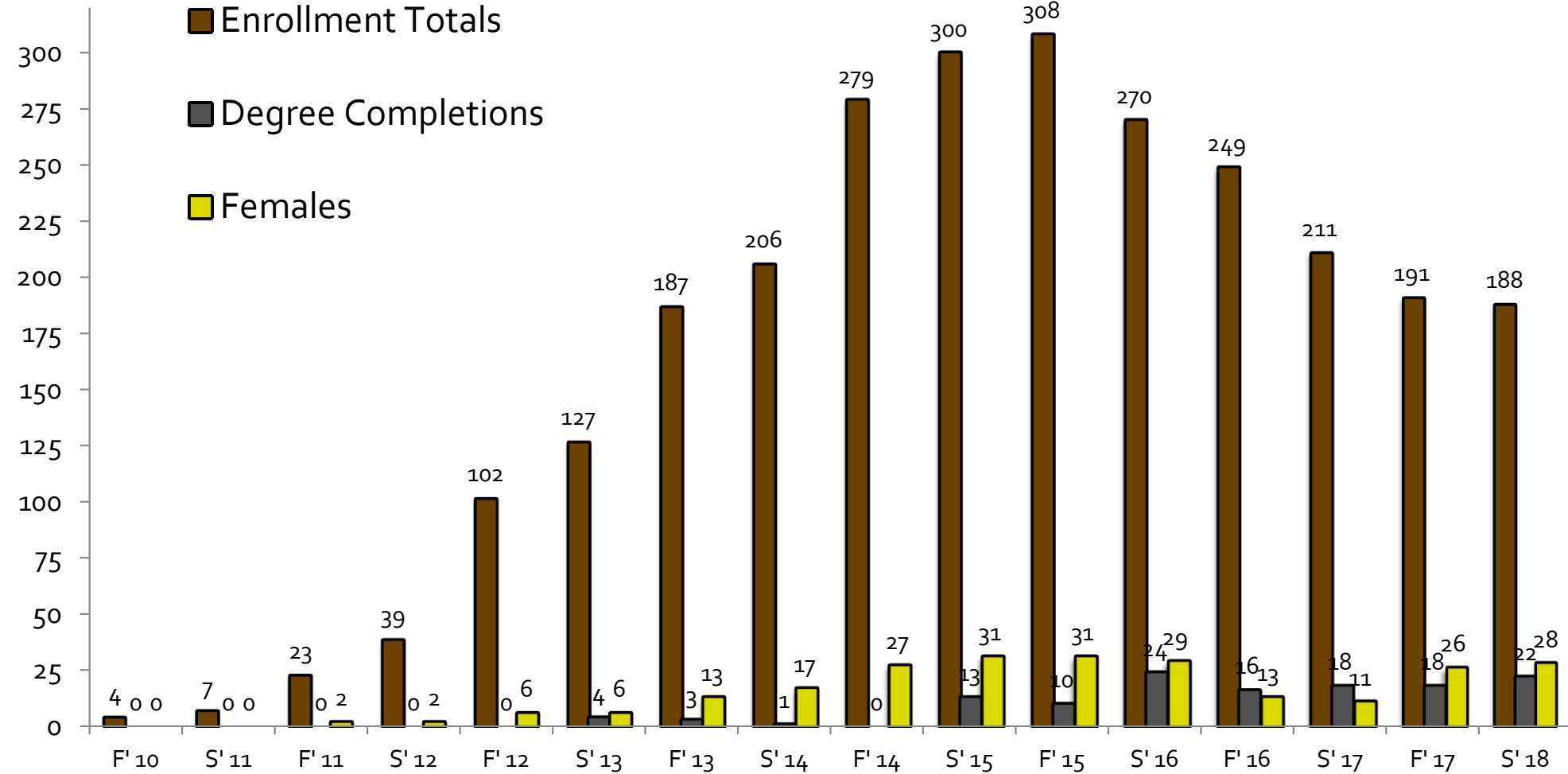
Great concerns regarding the lack of interest of ND students to do Petroleum Eng. This may result in no enrolment in a few years from now. We need to do something!

• Undergraduate Enrollment- Spring 2017

211 total students (including 64 DEDP)

• 11 FR

• 25 SO

• 33 JR

• 142 SR

Total Enrollment/Graduates

Legend:
- Enrollment Totals
- Degree Completions
- Females

Data by term (Enrollment Totals / Degree Completions / Females):

- F' 10: 4 / 0 / 0
- S' 11: 7 / 0 / 0
- F' 11: 23 / 0 / 2
- S' 12: 39 / 0 / 2
- F' 12: 102 / 0 / 6
- S' 13: 127 / 4 / 6
- F' 13: 187 / 3 / 13
- S' 14: 206 / 1 / 17
- F' 14: 279 / 0 / 27
- S' 15: 300 / 13 / 31
- F' 15: 308 / 10 / 31
- S' 16: 270 / 24 / 29
- F' 16: 249 / 16 / 13
- S' 17: 211 / 18 / 11
- F' 17: 191 / 18 / 26
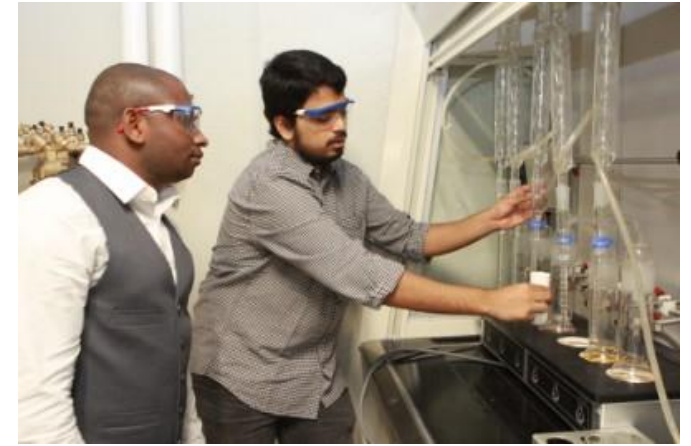- S' 18: 188 / 22 / 28

Petroleum Eng Industry Advisory Council (IAC)

- 24 members from oil and gas companies

- Meet in fall and spring

- Reviewed BS course materials to have industry applications

- Student job placement over 90%

- Supporting summer internship positions

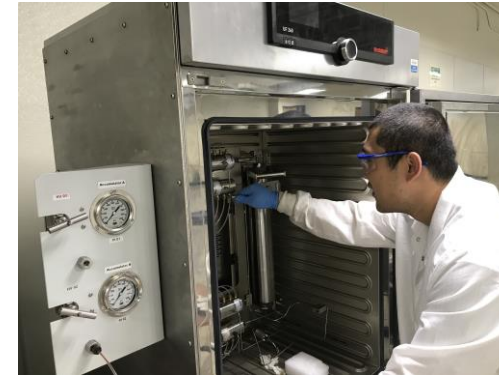- Supporting department research projects as industry partners

PE Lab Status

Drilling Fluids lab

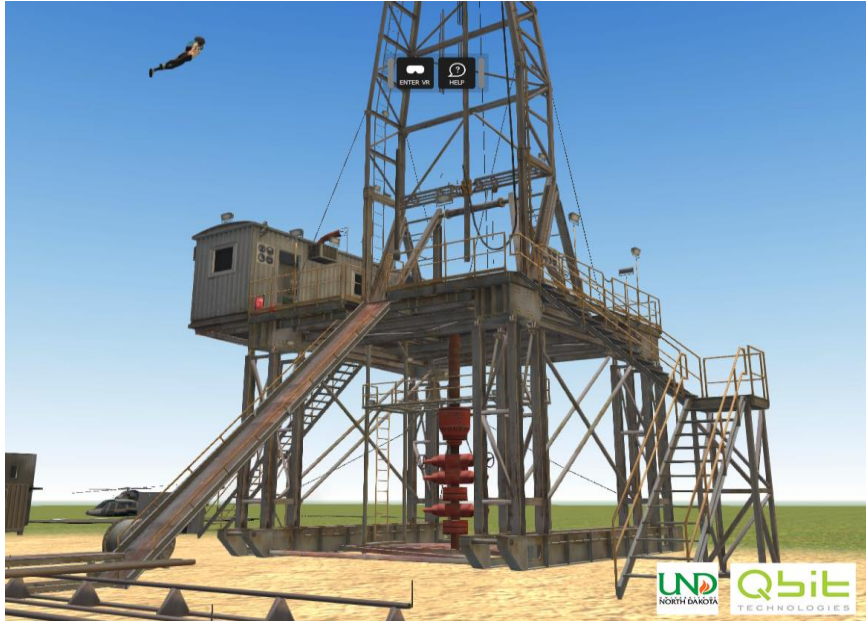# Hess Innovation Labs

Hess/Drilling Systems Simulation Lab

Full size rig floor Drilling and Well Control Simulator

DrillSIM-5000 Classic

PC based portable simulator DrillSIM-20

Hess Virtual Reality Lab

Challenges of Petroleum Eng Department

- Currently 7 faculty including Chair and one instructor who is the Professional Advisor for all students.

- All faculty are young and at the beginning of their career, so need to grow their industry contact and experiences in addition to teaching.

- Lack of funding to hire more faculty and lab technician.

- Experienced several budget cuts since 2016.

- Need to establish labs for the new program.

- Many additional activities and costs for a new program.

- Faculty in all US Universities are on 9 months of contract so they do not receive salary in Summer, while practically still need to work at full load to prepare for Fall semester classes and other activities.

Current Approach to Manage the Workload

- Hired several Ph.D. students with years of industry experiences.

- They do the tutoring and some teaching for undergrad students.

- In overall they do a great performance in their teaching and tutoring. Good for their experience and also for UG students.

- They also work on a research project towards their Ph.D. thesis.

Funding Request Proposal

1. Tuition and Stipend of Ph.D. students

2. Summer Salaries for Faculty

1. Tuition and Stipend of PhD students

What Support will Ph.D. Students Offer?

- Work on some of the practical research topics in line with the needs of the industry in ND.

- Provide teaching and tutoring support to the undergrad students; and

- Help to run the undergraduate teaching labs, maintain the research labs and state-of-the-art Drilling Simulator and Virtual Reality (VR) labs.

- Present their work in international and national conferences and let people to know how great ND is.

1. Tuition and Stipend of PhD students

Approximate Costs of a Ph.D. Student Per annum (3 years Graduation Period)

Tuition (24 Credits)	**$15,000**
Stipend (12 months)	$15,000
PC & office Supply ($1500 PC, $500 supply per year)	$1,000
Travel to Conferences, Workshops	$1,000
Lab Material Supply & Maintenance etc for lab based projects	$2,000
Total	**$34,000**

2. Faculty Summer Salary

- Including fringes & benefits varies between $15,000 and $19,000 monthly for Assistant to Full Professor position. Average of $16,000.

- We request one month summer salary for 6 faculty per year at **$96,000**.

Total Funding Request for 18 Months

1. Tuition and Stipend for 9 PhD students	$459,000
2. Summer Salaries for 6 Faculty	$144,000
Total	**$603,000**

Matching Fund

Companies	Project Area	Type of Support	Total Cash Reserved or In-kind
Continental Resources/ Hess/ Qbit	Big Data Analytics/UAS/Data Mining	Technical Consultation	$128,800
SASOL-USA Corporation	CO2-EOR	Technical Consultation, Samples	$192,000
Conoco Phillips/ Continental Resources/ Creedence Energy/ Vinci Technologies	Sulfate Deposition	Technical Consultation, Samples	$300,800
Neudax	Machine Learning/Refracking	Technical Consultation, Software	$39,000
Total			**$660,600**

PE Department Contribution

- Supporting 6 more PhD students (tuition and stipend) to work in the projects defined as part of this funding. So, a total of 15 students will be involved in the proposed projects.

- Define 4 project topics, approved by the OGRC, to work on for the next 3 years.

- Run bi-annual one day workshop to present the results of the studies carried out by the faculty and the students to the OGRC and invite others from industry.

- Will involve as many UG students as possible to do their design projects in line with similar topics.

- Put all effort to work closely with industry in ND and develop solutions for industry problems.

Some of the Proposed Project Topics

Enhancing Regulatory Compliance in the Oil & Gas Industry by Capitalizing on Data-Driven Technologies

Dr. Minou Rabiei

Department of Petroleum Engineering

Regulatory Compliance Issues

- Regulatory compliance is a major area in sustainable development in the oil and gas industry.

- There are increasing demands for proper management of regulatory compliance procedures.

  - Complex and ever-changing rules imposed by the government.

  - Rapid advances in the technologies developed by the industry.

  - Lack of a systematic evaluation of the efficacy of the executed regulations.

Industry Perspective	General	Government Perspective
Data Collection	Data Management	Data Analysis
Rule Complexity	Adaptive Regulation	Regulations Evaluation
Change Management	Trust and Transparency	Logistics
	Responding to Non-Compliance	

Proposed Algorithmic Regulatory System

- Rules & Regulations
- Control Policies & Procedures
- Education & Communication
- Internal Monitoring & Inspection
- Regulatory Reporting
- Enforcement & Discipline
- Detect & Response to Incidents

User Interface

Application Layer
- Data Collection
- Predictive/ Comparative Analysis
- Compliance Reporting
- Real-time Monitoring
- Policy Update

System Core

Technology Layer
- Big Data
- Blockchain
- IoT

Machine Learning Algorithms
- Decision Trees
- ANN
- SVM
- Genetic Algorithm
- Fuzzy Logic
- Clustering

Rules and Regulation Layer

An Expert System for Hydraulic Re-Fracturing Procedures in Petroleum Industry

Dr. Minou Rabiei

Department of Petroleum Engineering

A Promising Expert Approach

Case-Based Reasoning (CBR)

- An artificial Intelligence workflow which can provide suggestions regarding input, by breaking the input down to specific elements and then comparing it to cases stored in the database.

- An interactive system which can relate cases to older cases, and adapt to cases based on experience much like how a human being behaves in daily life.

- The elements of Case based Reasoning include:

  - Case Representation
  - Reuse
  - Retrieve
  - Revise/Adapt
  - Retain
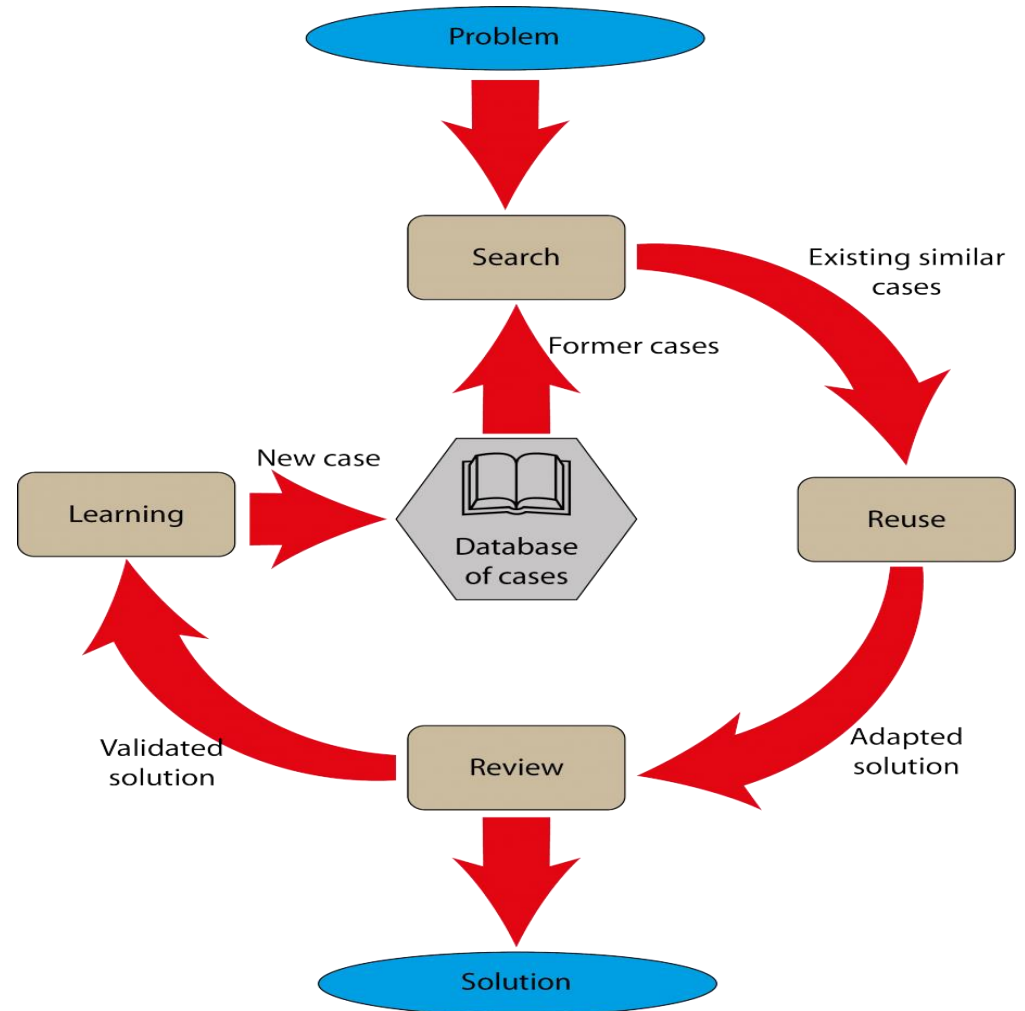
Enhancing Hydraulic Re-Fracturing using CBR

- Improving the Data Quality of stored cases.

- Improved Feature Selection and Development of more Informative Models.

- Optimization of Candidate Well Selection based on Expert Knowledge.
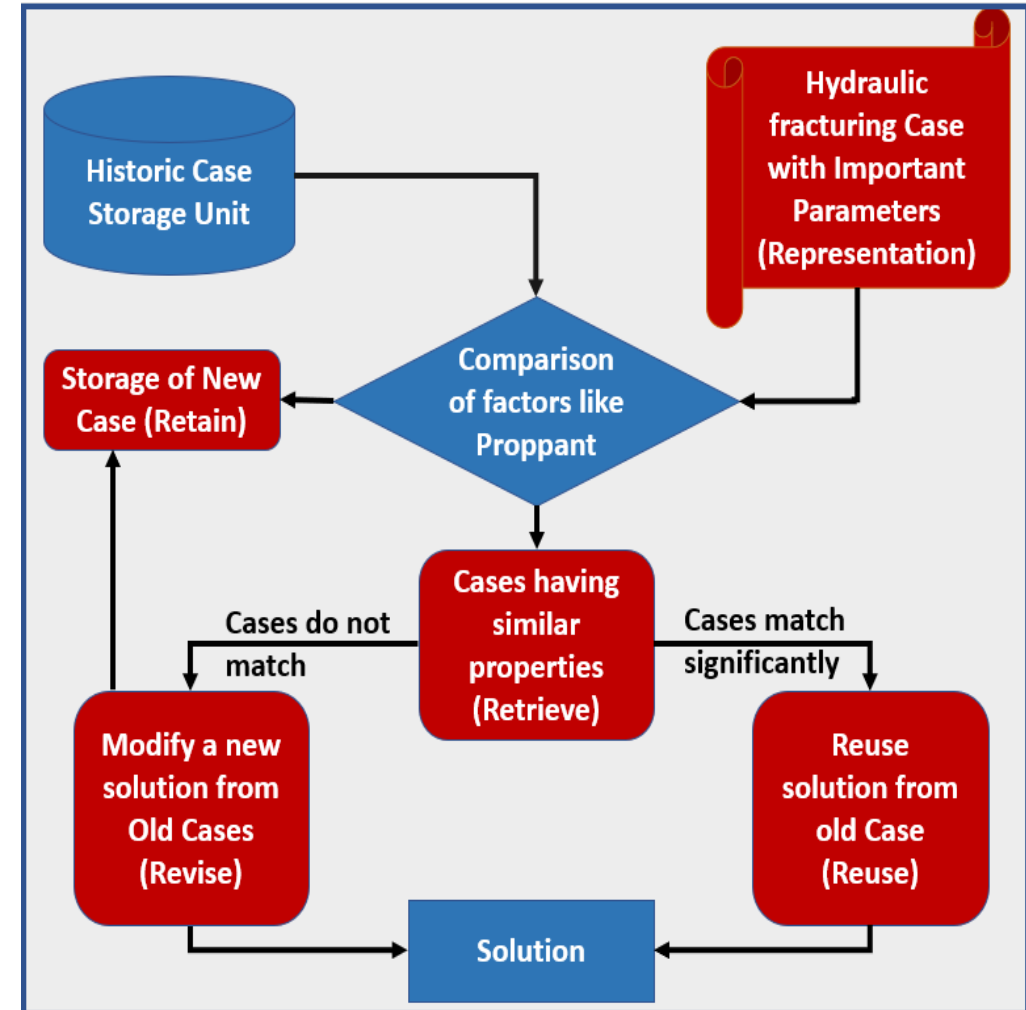
Data Driven Well Selection for Re-Fracking

Dr. Mehdi Ostadhassan

Department of Petroleum Engineering

Specific Aim:

- Increase the added value of stored data at NDIC to select the best wells for refracking in the Bakken and Three Forks Formations.

- Attract smaller operators to the state for refracking by showcasing preliminary results.

How:

Through Artificial Intelligence and Machine Learning methods.

Duration: 1 year

Industry partner: NeuDax Data Analytics-a leading big data company in petroleum industry based in Denver.

Objectives

- Understand petrophysical properties/production history of individual wells in Williston Basin- Bakken and Three Forks.

- Assess initial completion method in the history of wells and classify them into multiple technique types.

- Establish ML-based models to evaluate the technical feasibility of refracking.

- Integrate ML algorithm into AI-assisted economic model for well ranking through a probabilistic approach.

Methodology

- **Tasks:**

1. Extraction and Processing Big Data at NDIC website

2. Design and Training Machine Learning algorithm

3. Model Prediction and Verification

4. Report writing and deliverable preparations
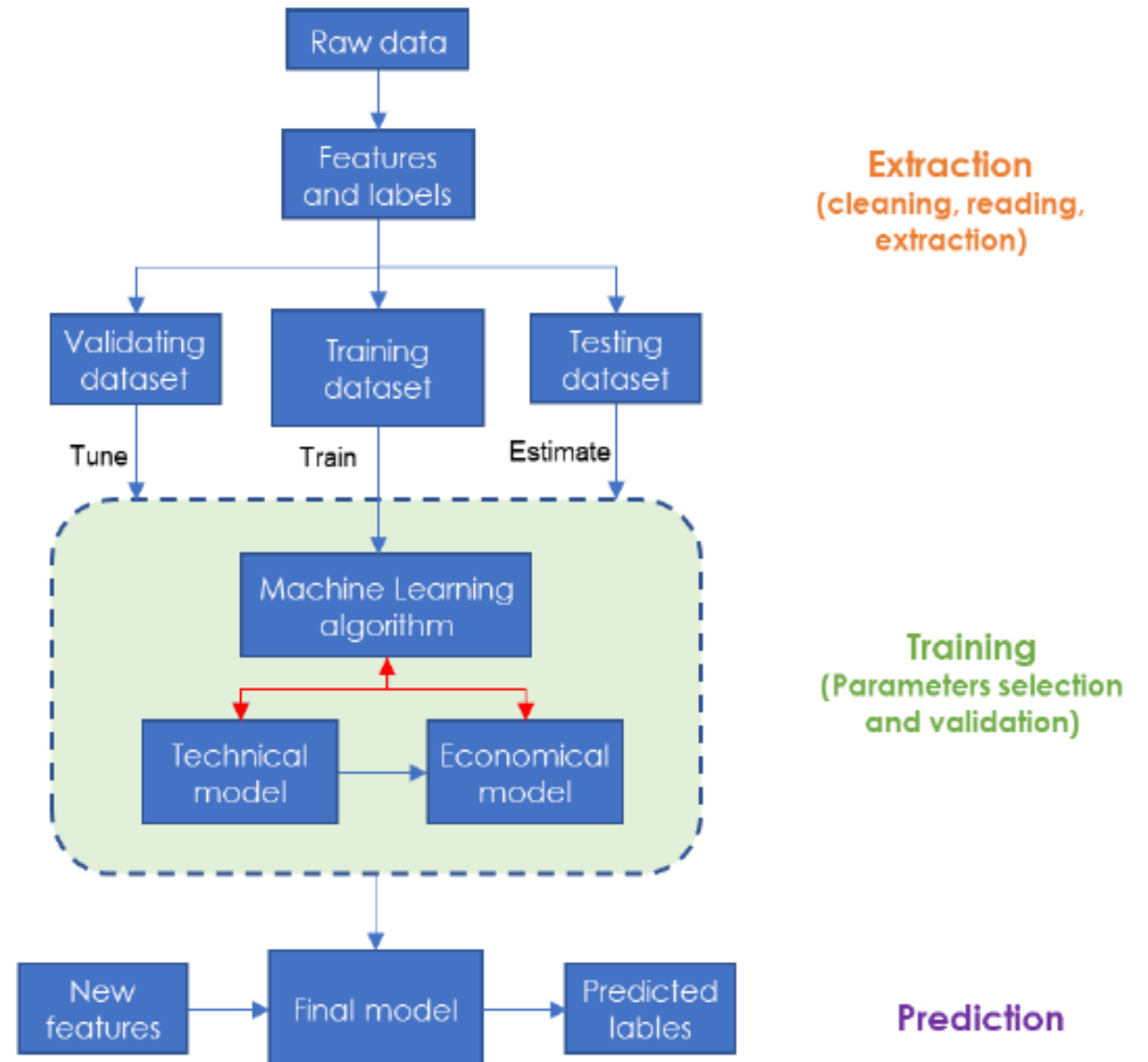
Intelligent workflow for an Effective Hydraulic Fracturing (HF)

Dr. Mehdi Ostadhassan

Department of Petroleum Engineering

- **Specific aim:** reduce operation costs by improving HF success and increased productivity.

- **Objective:** enhance existing methods of acquisition, processing and interpretation of microseismic data from shale plays via <u>laboratory</u>, <u>3D printing</u> and <u>AI based numerical modeling</u>.

- **Expected results:** Develop state-of-the-art software package to get more insight into microseismic data.

- **Duration:** 2 years.

- **Participants:** SigamCubed, Hess, NeuDax and Marino Engineering Associates.

Methodology

1. Developing a Pattern Recognition System for Prediction of Perturbation Model from the Recorded Signals

Image: courtesy of Mehdi Ostadhassan
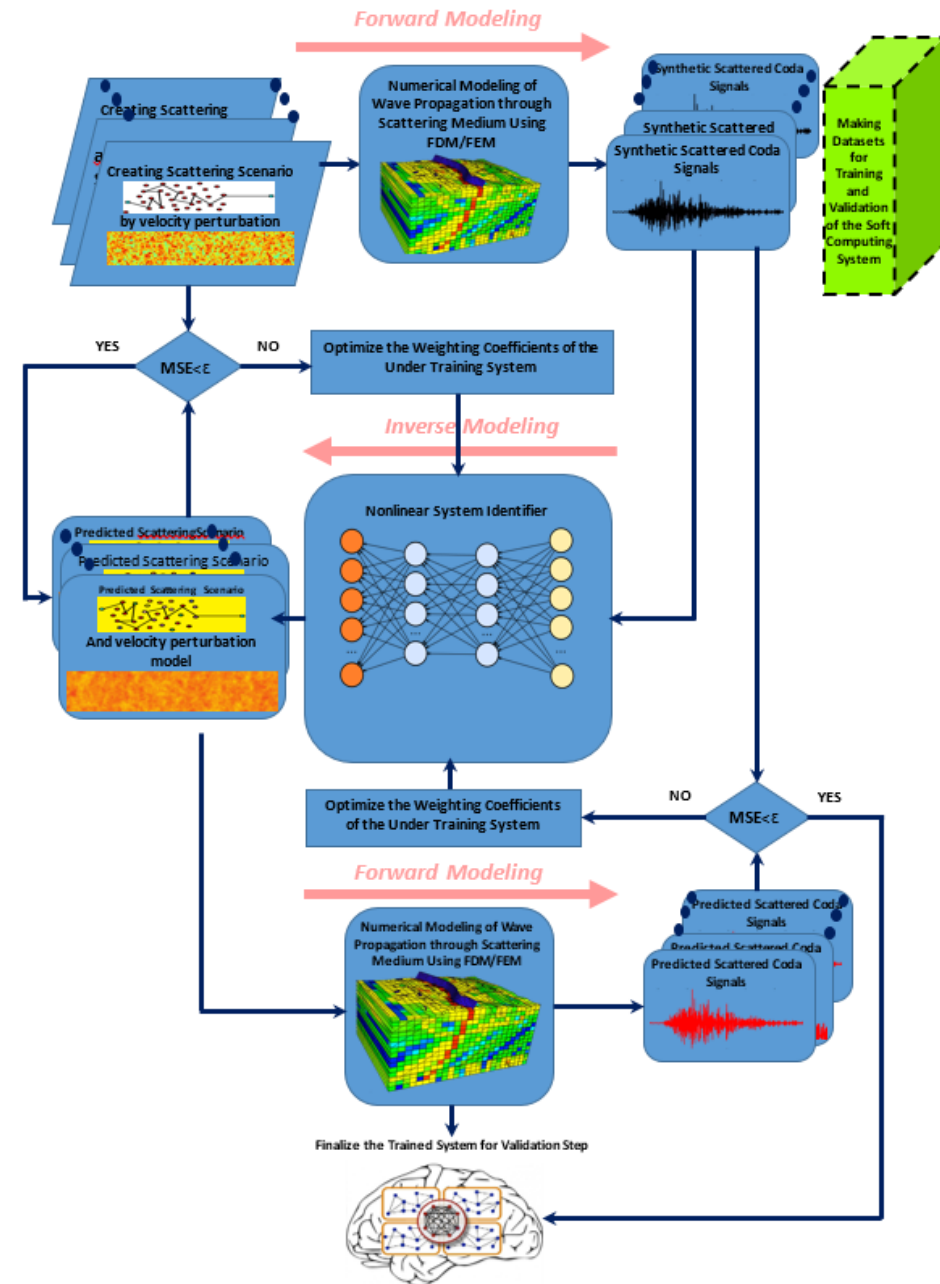
Methodology

2. Applying the Developed Pattern Recognition System to Real Data Signals in Order to get the Perturbation Model

Image: courtesy of Mehdi Ostadhassan
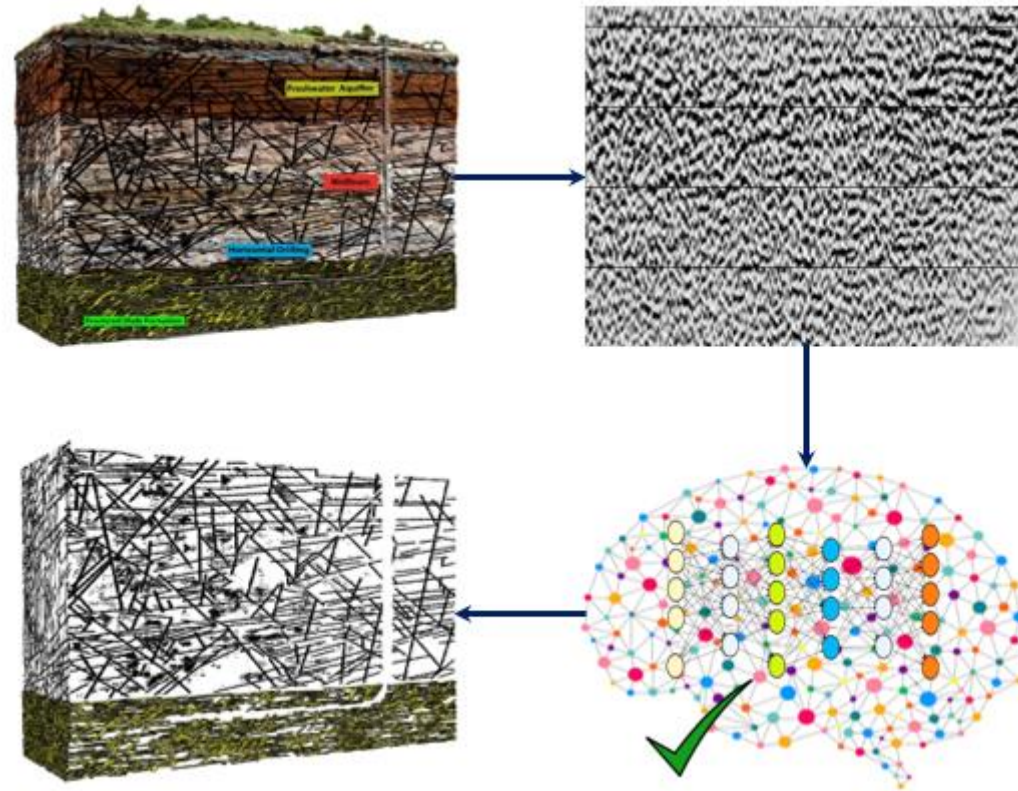
Methodology

3. Integration of Experimental and Numerical Modeling to Build a Reliable Numerical Model

Image: courtesy of Mehdi Ostadhassan
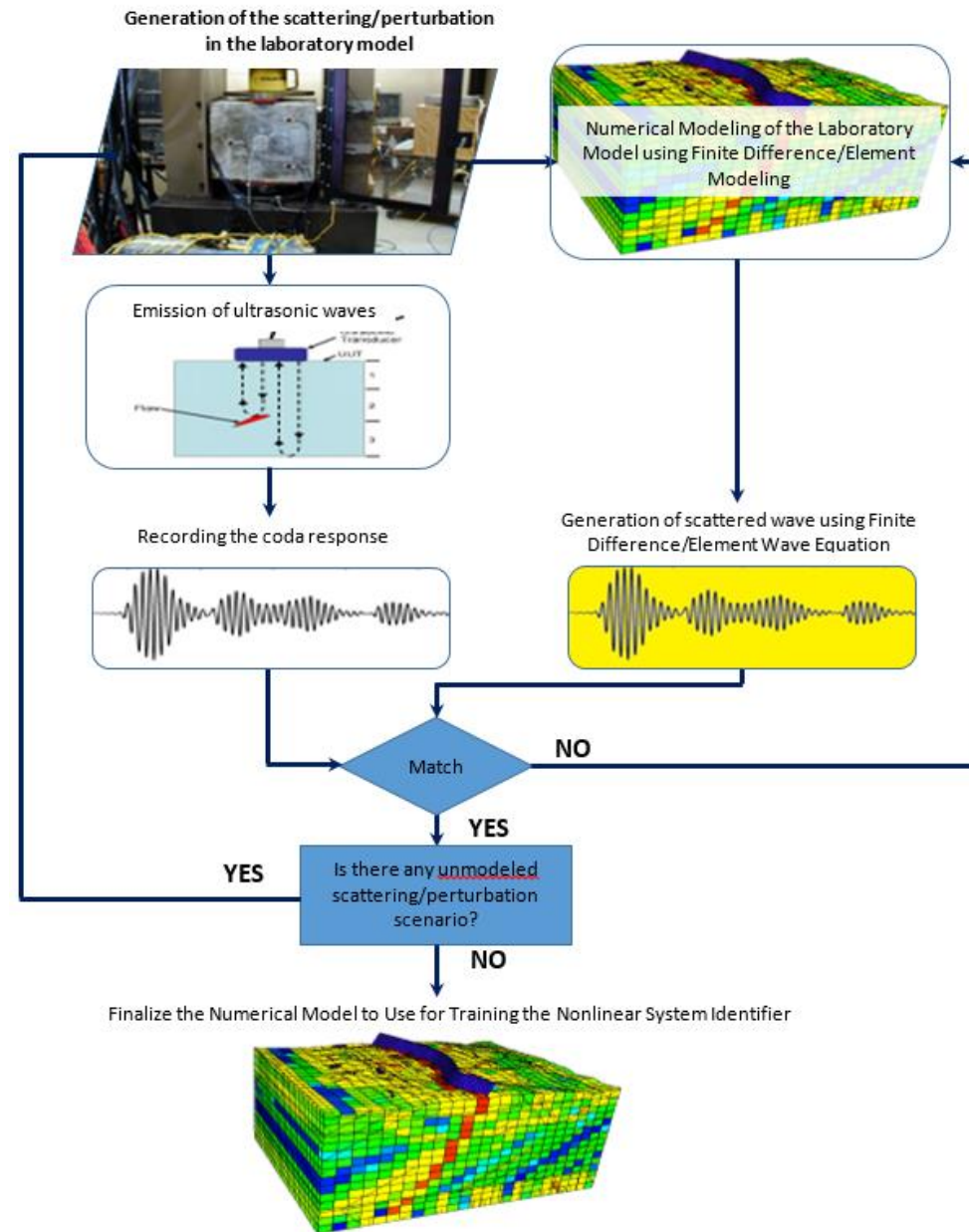
On the Mechanism of Formation & Inhibition of Barium Sulfate Deposition in McKenzie & Williams Counties, ND

Dr. Hadi Jabbari

Department of Petroleum Engineering

HIGH NUMBER OF WELLS = HIGH MAINTENANCE ($)

Crude oil production
million barrels per day
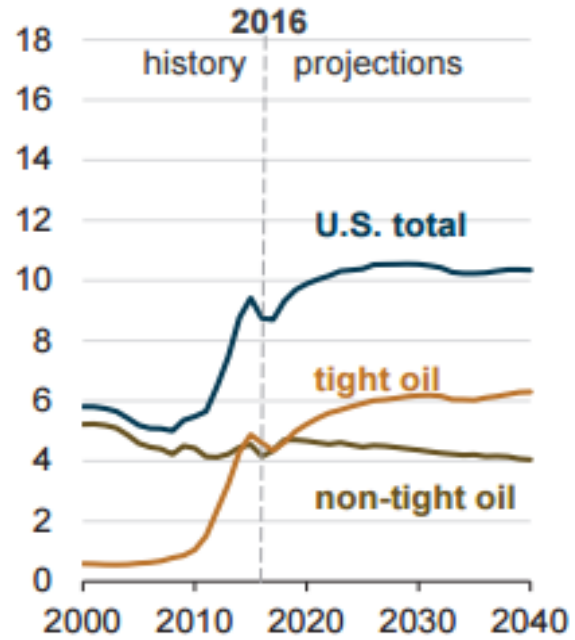
Current Technology
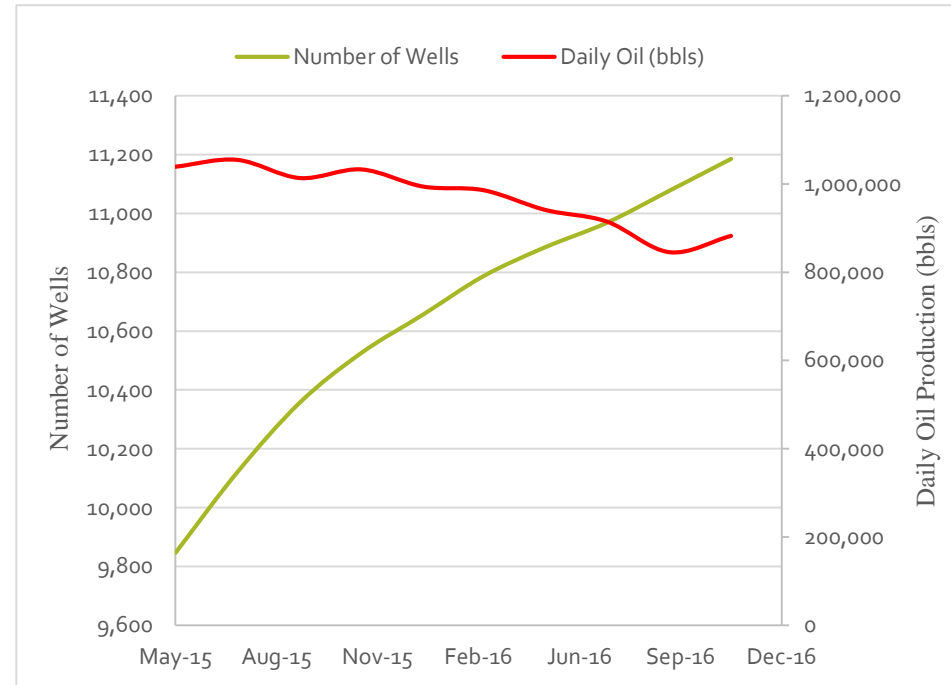
January 2017 Bakken-Three Forks well count is over 10,000 and daily oil production is over 1 million STBD [*NDIC, 2017*]
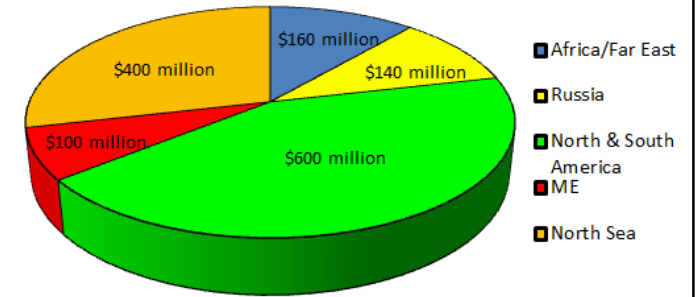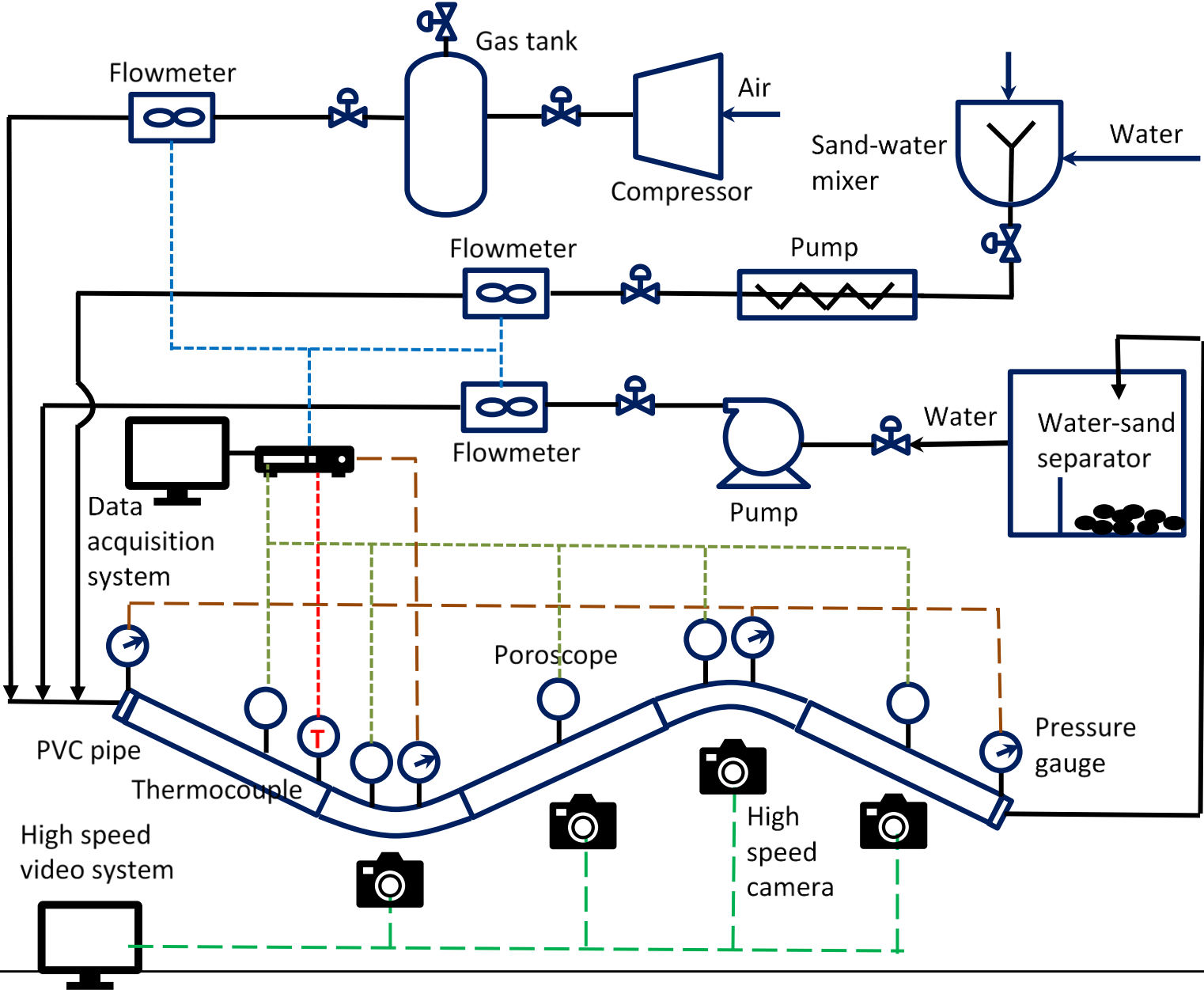
Petroleum Pipeline Leak and Blockage Detection

Dr. Kegang Ling

Department of Petroleum Engineering
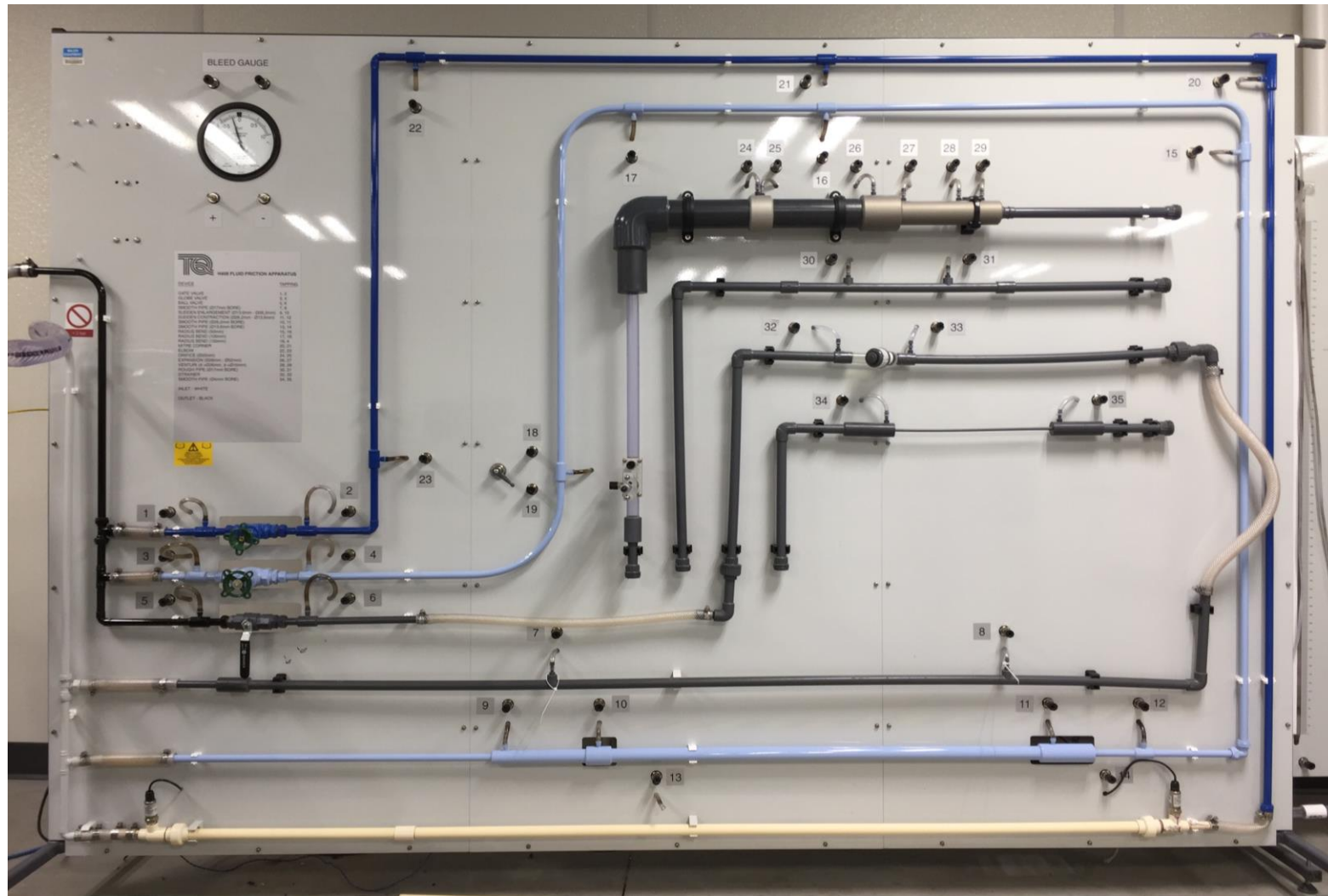
Multi-Phase Flow in Undulating Wells/Pipelines

Simulations of Cuttings Transportation in the annulus space in deviated wellbores

Dr. Vamegh Rasouli
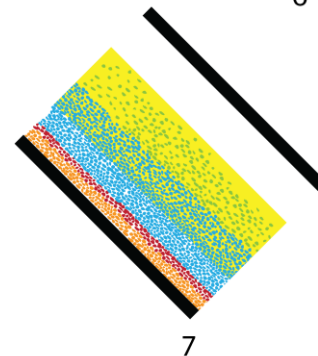
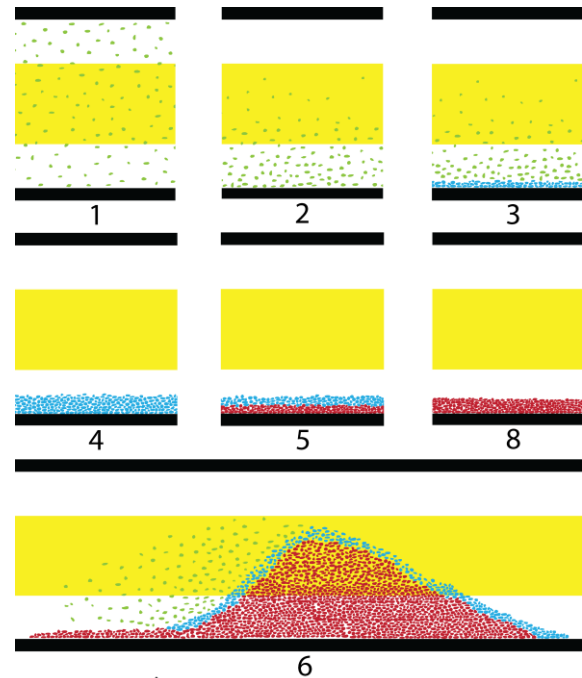Department of Petroleum Engineering

Study Cuttings Transportations in the annulus and optimize the parameters causing undesired transportation mechanisms.

Analyzed Data:
- Cuttings Concentration
- Temperature
- Flow Rate
- Pressure
- Rheometry
- Density
- PH

UND Students involved in the design of the Slurry Loop

Particles
- suspended
- moving
- stationary
- sliding

Modes of cuttings transportation
1. Homogenous suspension
2. Heterogeneous suspension
3. Suspension and moving bed
4. Moving bed
5. Moving/stationary beds
6. Dune movement
7. Boycott transportation
8. Stationary bed