Career Episode 3:

Introduction:

CE 3.1 I am presenting a project I performed as student during the Bachelor of Engineering (Petroleum) at the [redacted] University of Engineering and Technology, [redacted] The project described was an Open-Ended Lab module pertaining to the Oil and Gas Production Facilities course. The assessment project was conducted in the spring semester of the [redacted].

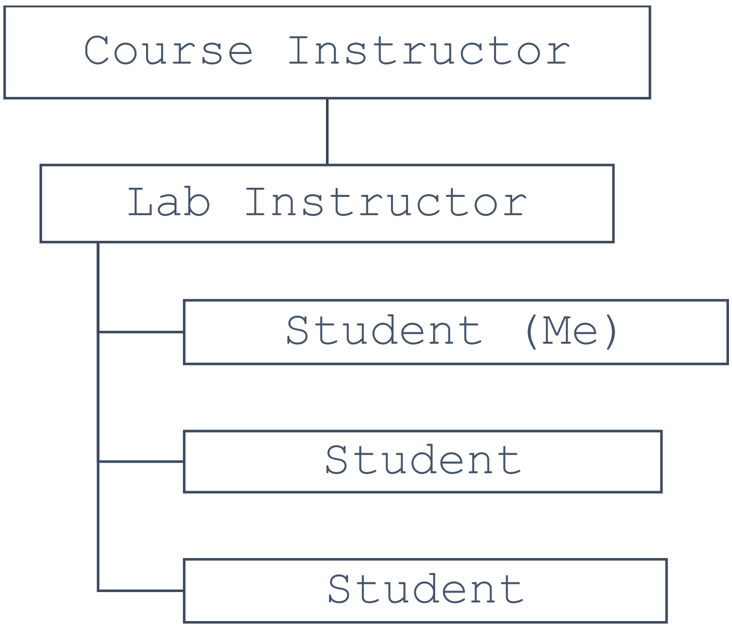
Background:

CE 3.2 The oil & gas industry is among the most significant sources of contribution towards the global economy. Besides, it is also considered as a primary energy source for almost all sectors. The increasing demand shall require optimization in production facilities besides developing new technologies for sustainability and energy efficiency. Advanced modelling tools, such as PROSPER, are essential to make this realization. This project illustrated the application of PROSPER software, which is well known in the industry of oil and gas for profitability as well as efficiency improvement in oil producing wells.

CE 3.3 PROSPER is an integral component of the Integrated Production Modeling Tool-box, which petroleum engineers often employ in refining and analyzing well performance. This software further works on surface network models, wellbore and reservoir models to enclose the well and perform excellent stimulation of production system behavior. Therefore, these different aspects of PROSPER provide the production operator with several options for optimizing the process, such as artificial lift systems, choke sizing, surface network configurations, and well placement. This very thorough approach helps identify bottlenecks in production, formulate proper production strategies for enhanced field performance, and predict the actual production rate.

CE 3.4 An important part of the data in such a model includes well parameters, vertical lift performance, and reservoir characteristics, which makes it well-rounded in evaluating the potential of the well. During this project, PROSPER was used to create a well model for a theoretical case where one oil production well would be improved and analyzed. Data collection involved analyzing PVT properties, surface oil pressure, gas pressure, and oil flow rates under different oil rates.

CE 3.5 The Open-Ended Lab module was part of the course on Oil and Gas Production Facilities during my BE degree at the [redacted] The project was a collaborative effort undertaken by a team of engineering students under the guidance the course and lab instructors.



Personal Engineering Activity:

CE 3.6 My primary objective for this assignment was to use PROSPER to assess and improve well production. I worked on developing a methodology that would simulate and trace performance metrics of the well using the PROSPER software. I divided the project into four distinct phases. I commenced the project by making use of the PROSPER data repository for the development of a suitable well model. The repository provided me the data on pressure, volume, and temperature (PVT) along with the inflow performance curves, well equipment and trajectory. I analyzed and drafted the reservoir, wellbore, and surface network components using

PROSPER, and integrated these with the available data to obtain a well model. This activity constituted the first phase of the project.

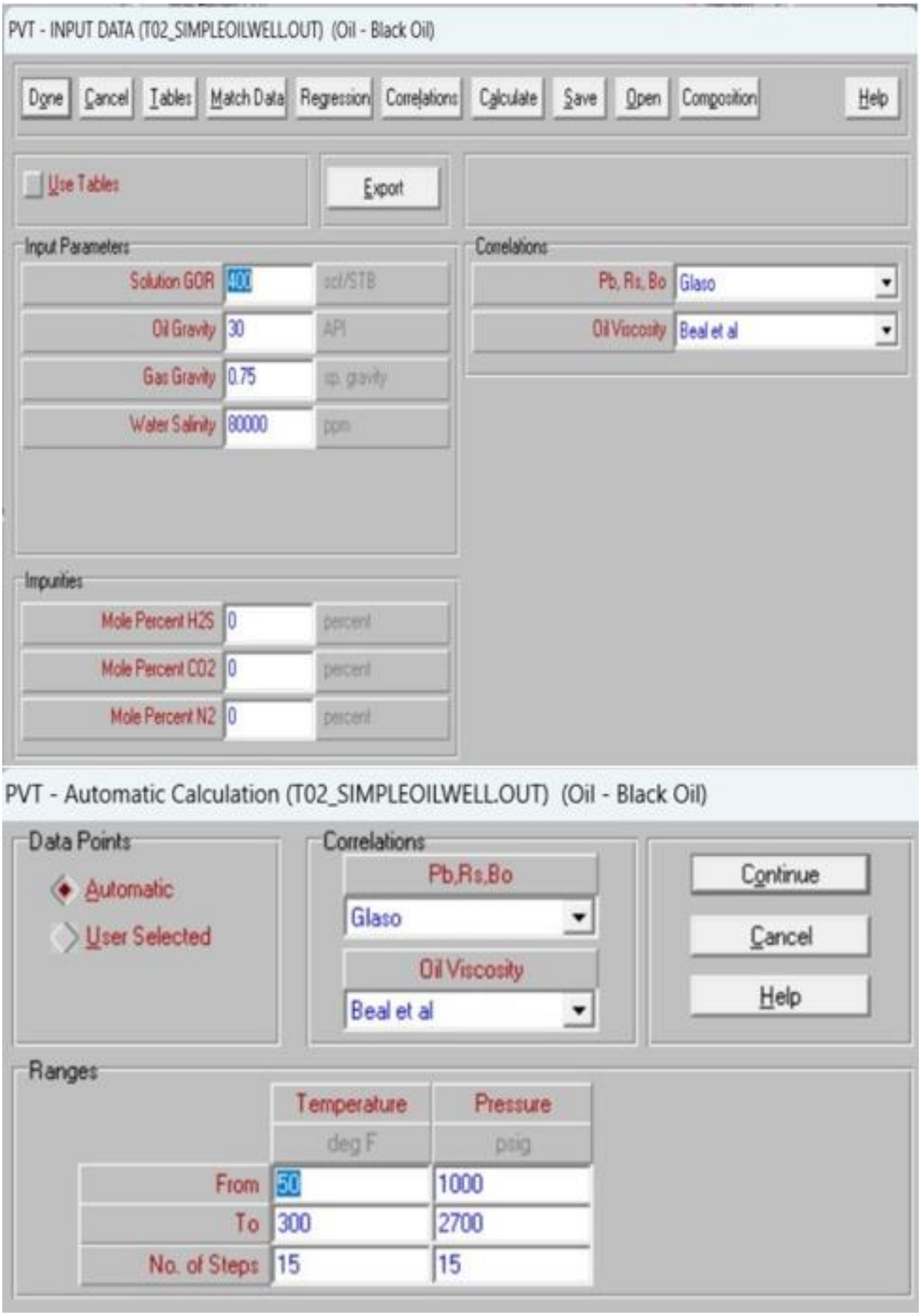
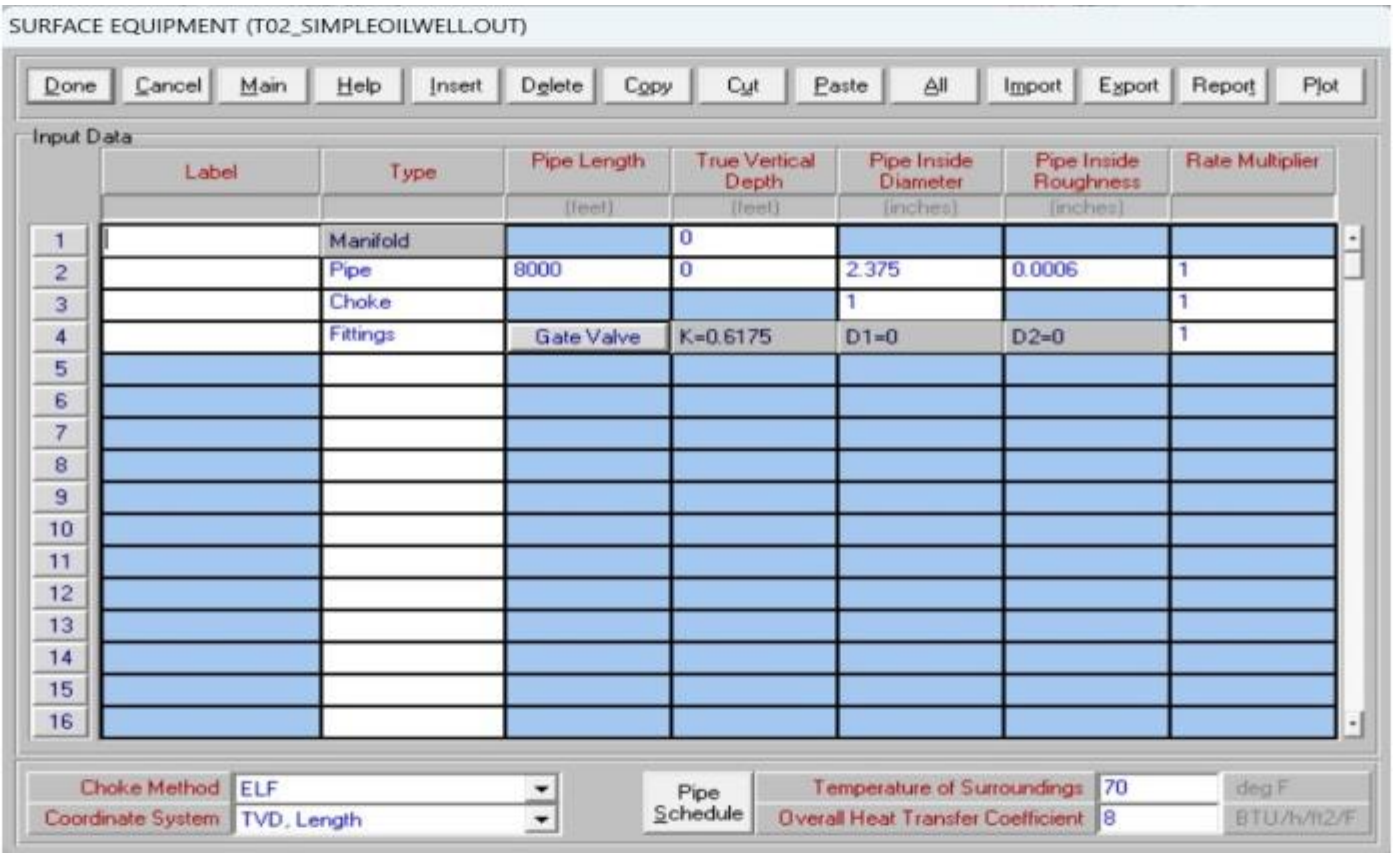


FIGURE 1 PVT INPUT DATA



SURFACE EQUIPMENT (T02_SIMPLEOILWELL.OUT)

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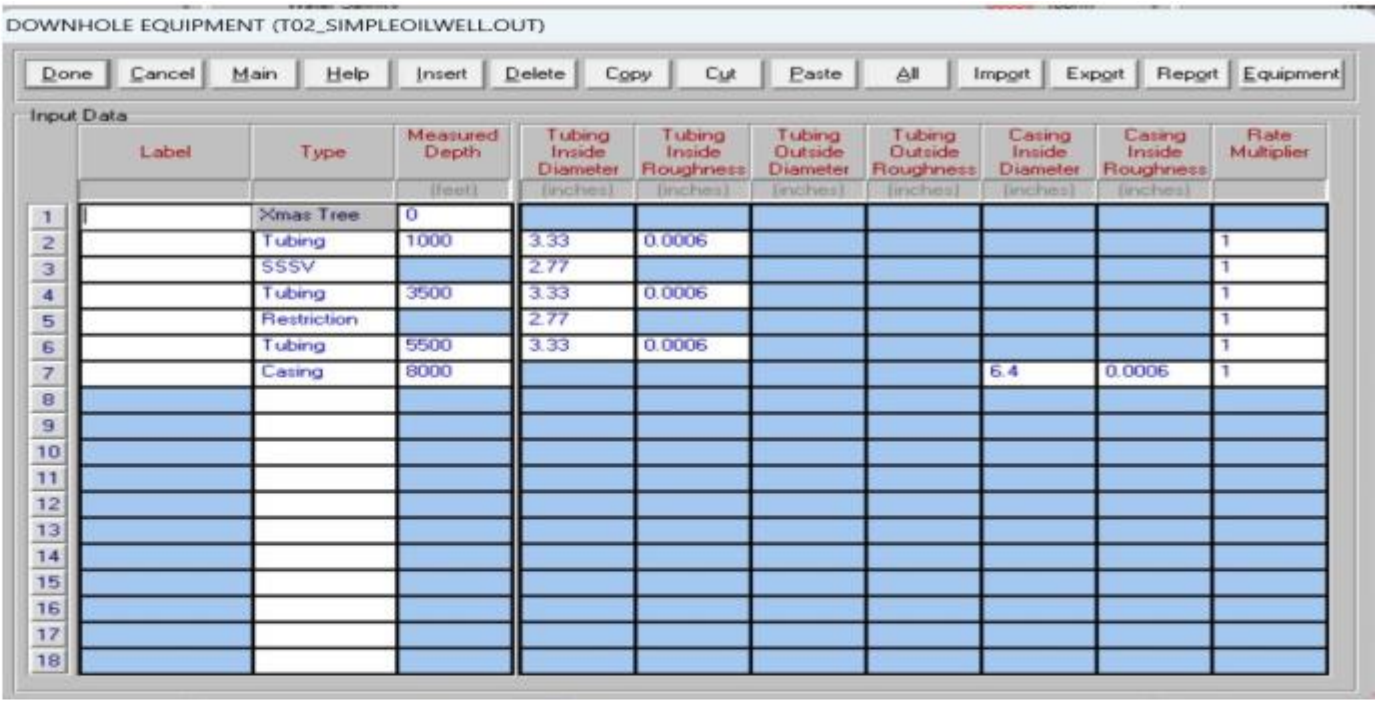
Input Data

	Label	Type	Pipe Length (feet)	True Vertical Depth (feet)	Pipe Inside Diameter (inches)	Pipe Inside Roughness (inches)	Rate Multiplier
1		Manifold		0			
2		Pipe	8000	0	2.375	0.0006	1
3		Choke			1		1
4		Fittings	Gate Valve	K=0.6175	D1=0	D2=0	1
5							
6							
7							
8							
9							
10							
11							
12							
13							
14							
15							
16							

Choke Method: ELF
Coordinate System: TVD, Length
Pipe Schedule
Temperature of Surroundings: 70 deg F
Overall Heat Transfer Coefficient: 8 BTU/h/ft2/F

FIGURE 2 SURFACE EQUIPMENT DATA



DOWNHOLE EQUIPMENT (T02_SIMPLEOILWELL.OUT)

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Input Data

	Label	Type	Measured Depth (feet)	Tubing Inside Diameter (inches)	Tubing Inside Roughness (inches)	Tubing Outside Diameter (inches)	Tubing Outside Roughness (inches)	Casing Inside Diameter (inches)	Casing Inside Roughness (inches)	Rate Multiplier
1		Xmas Tree	0							
2		Tubing	1000	3.33	0.0006					1
3		SSSV		2.77						1
4		Tubing	3500	3.33	0.0006					1
5		Restriction		2.77						1
6		Tubing	5500	3.33	0.0006					1
7		Casing	8000					6.4	0.0006	1
8										
9										
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18										

FIGURE 3 DOWNHOLE EQUIPMENT DATA

CE 3.7 I generated several pressure, volume and temperature (PVT) plots to illustrate the effect on bubble point under varying pressure, formation of oil, gas oil ratio and volume factor for the selected well sample. I had knowledge that an IPR plot is a quantitative expression of an inflow performance versus production rate relationship for a well. I realized that data such as the pressure and temperature inside the reservoir, wellbore geometry, and information about the characteristics of fluid, were necessary for the generation of an IPR plot. I generated and examined the IPR plot of the well sample and concluded that the reservoir could supply the well at various flow rates. I estimated the flow efficiency, productivity index, and absolute open flow potential of the well. The selected well sample had a formation PI of 10.03 stb/day/psi and absolute open flow of 23498.7 stb/day.

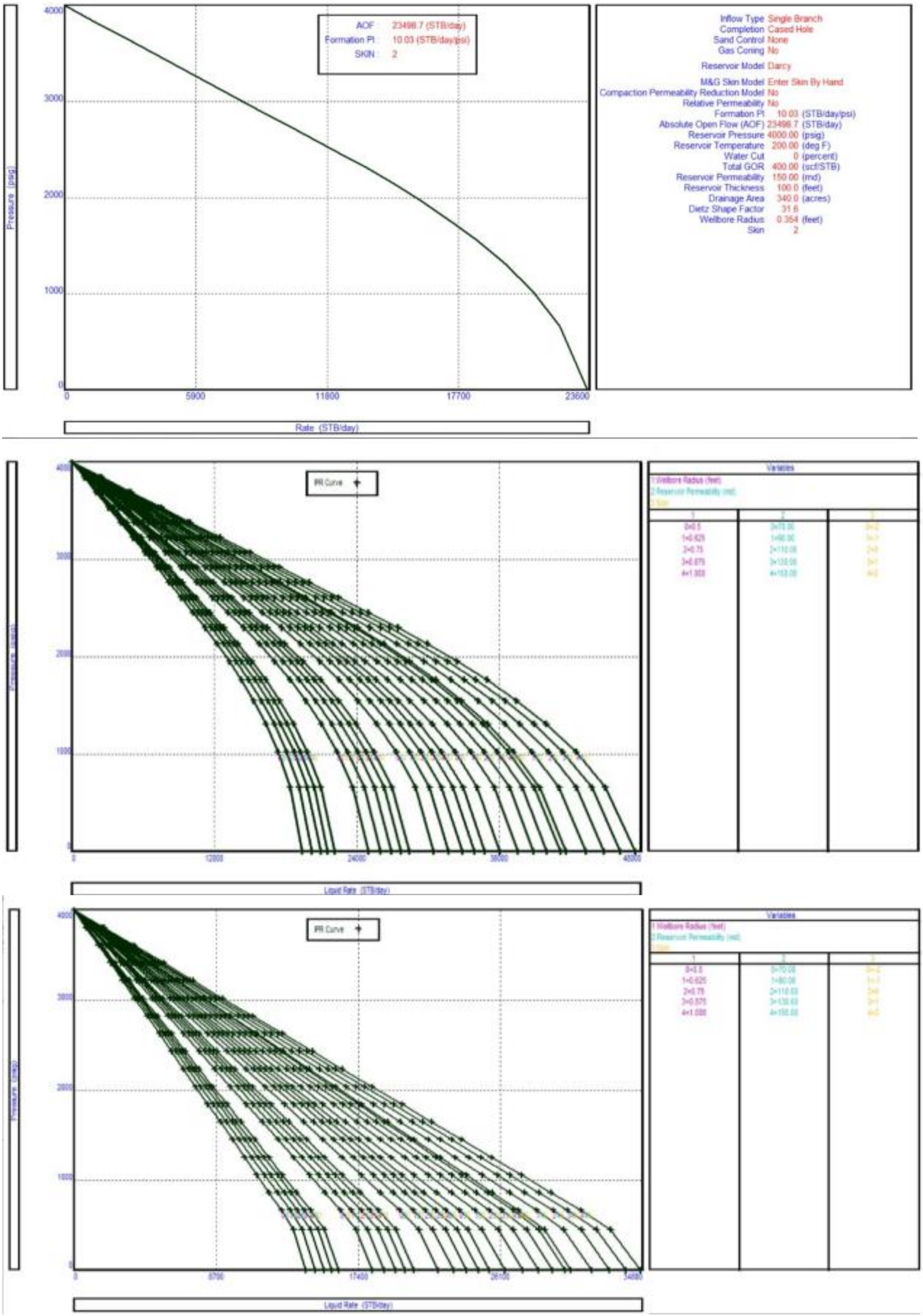

FIGURE 4 IPR PLOTS

CE 3.8 In the second phase of the project, I independently conducted a sensitivity analysis to evaluate how various characteristics of the reservoir will affect the output of the well. This involved assessing the effect of several parameters on production of oil, including reservoir pressure, tubing diameter, and skin. In addition to these, I also generated system plot to find the well's operational point, which shows the pressure and real flow of the well. I had knowledge requires data on IPR and VLP to generate a graphic illustration of the bottom-hole pressure as a function of the flow rate from reservoir towards surface, showcasing reservoir and well collective performance.

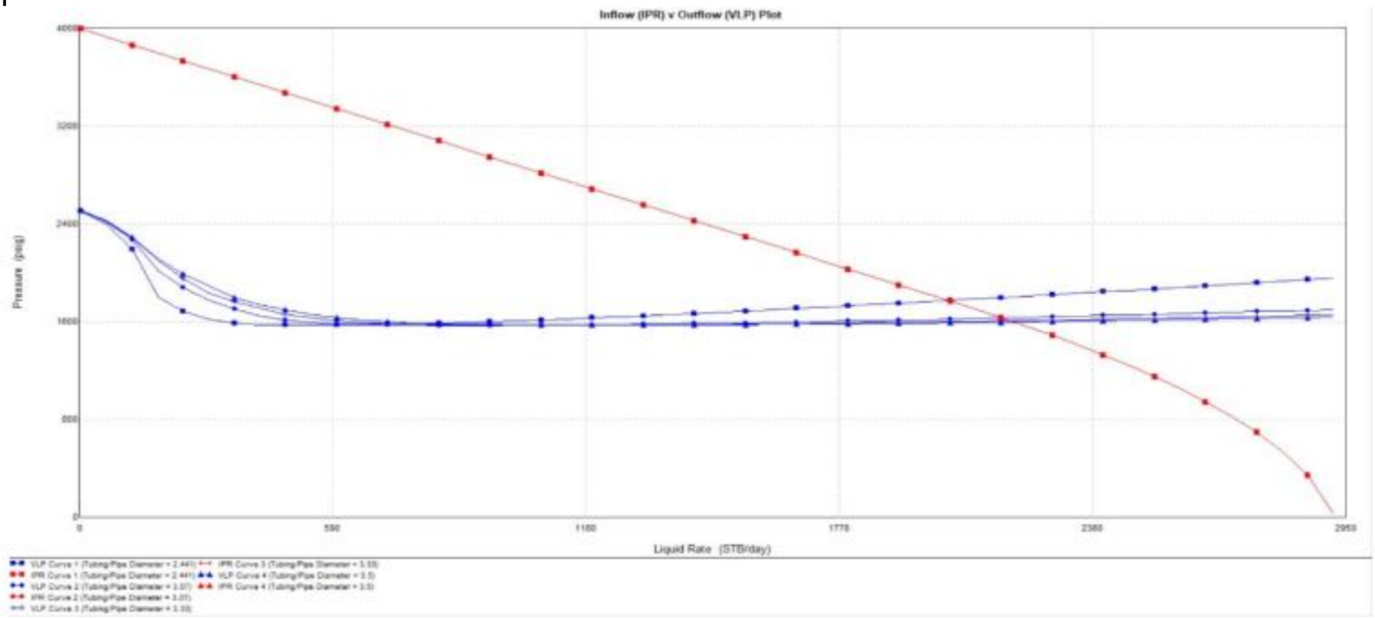

FIGURE 5 IPR VS VLP PLOT

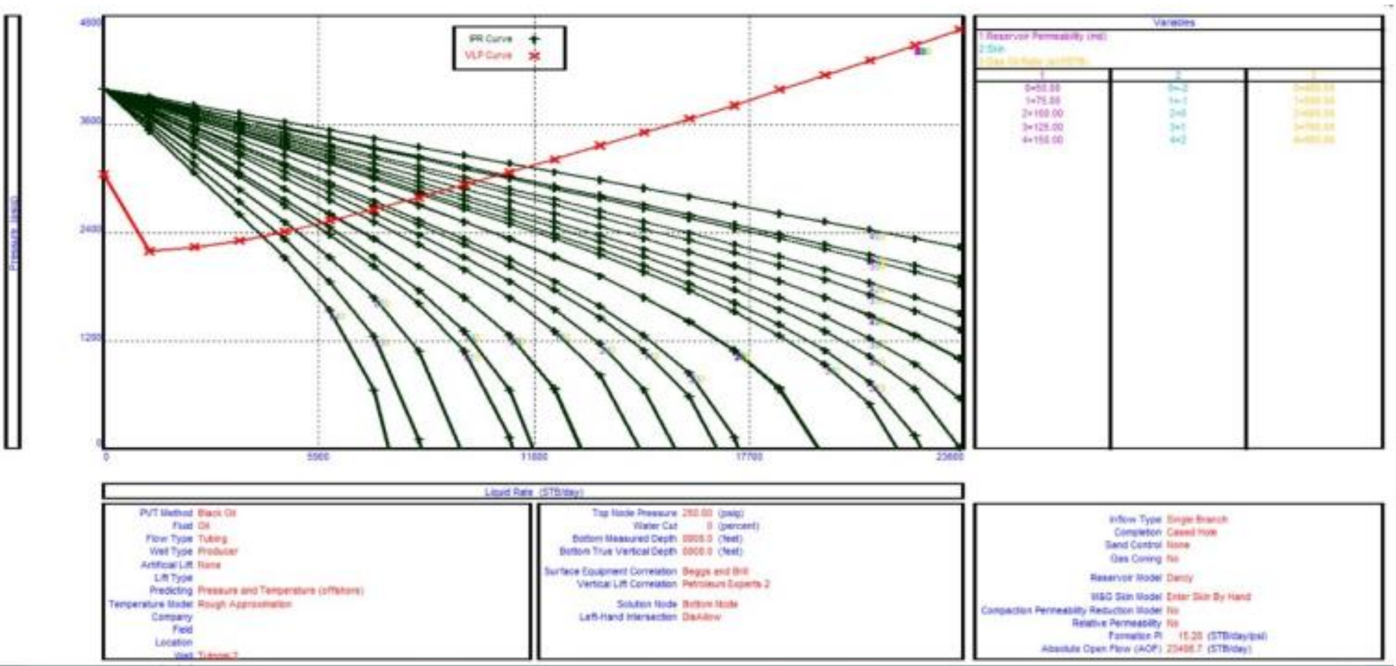

FIGURE 6 IRP SENSITIVITY ANALYSIS

CE 3.9 I performed the sensitivity analysis by varying skin factor. A pressure drop close to the wellbore can have significant affect on the efficiency of the flow of well. I understood that skin factor is responsible to measure this concept, which may be a negative or a positive quantity. A reduction in the flow efficiency is indicated by a positive skin factor. I realized that an array of factors may be responsible for this decrease such as scale deposition, fines migration, or clay swelling. I understood that a well with positive skin would manufacture less than its capacity, necessitating treatments such as fracturing or acidizing to stimulate production. In contrast, an enhancement in the flow efficiency was reflected by a negative skin factor. Successful stimulation treatments such as fracturing, acidizing, and perforating resulted in this increment. I understood that a well with negative skin would manufacture more than its capacity, hence reducing the pressure drop close to the wellbore indicating an improvement in the inflow area and an increase in the productivity index.

CE 3.10 In the third phase, I performed a detailed modeling with iterative analysis to understand the dynamic behavior of the well under several operating scenarios. I performed the simulation using the PROSPER software to capture all operations of the well and to maximize the production potential. I gathered and validated essential input data in terms of reservoir pressure, fluid properties, geometry of wellbore, and completion specification. I assessed numerous factors such as temperature gradient, GOR, water cut, and formation characteristics as they can impact the momentum of production.

CE 3.11 I also performed the sensitivity analysis by varying the Gas-Oil Ratio (GOR). I had prior knowledge that the GOR affects the performance metrics of a simple oil well, such as IPR and VLP. An increased GOR can cause an increase in the production of gas, which will result in the reduction of the viscosity of the fluid mixture, increasing the production from the well. However, increased gas can also result in gas interference, causing a reduction in the total liquid flow rate. Contrary to this, a reduced GOR indicates that production of primary oil is taking place by the well, which may cause an increment in pressure drops and fluid viscosity. To optimize well performance, I balanced the GOR as it directly impacted the overall efficiency and flow dynamics of the well.

CE 3.12 I also suggested modifications and enhancements to be conducted across the workflow, processes, and equipment to improve the performance of a well. I recommended an upgradation for the equipment such as utilizing highly developed artificial lift systems, more efficient pumps, or implementation of real-time downhole monitoring tools. I based my recommendations on my analysis that these upgrades could increase production by providing better data acquisition and control. I further proposed changes in process such as optimization of the production schedule, carrying out regular treatments for well-stimulation (like hydraulic fracturing and acidizing), and implementation of better techniques for oil recovery (like thermal recovery, water flooding, or gas injection), to improve fluid flow and reservoir contact. I also suggested optimization of workflow by real-time monitoring, improved data analysis, and predictive maintenance as it could lead to quicker problem-solving and better decision-making. Incorporation of digital technologies like automation and machine learning can further reduce the cost of operation, increase operational efficiency, and decrease downtime. This could extend the productive life of the well and maximize its output.

CE 3.13 In the fourth phase of the project, I conducted the economic assessment of the well to determine if it was marginal or lucrative. I conducted this analysis to ascertain if the well was producing enough oil that could bring enough influx of cash to afford its operation and drilling or if it should be closed off and abandoned. I forecasted oil volumes for monthly and yearly production through the expected life of the well, using created production profiles in PROSPER. I estimated revenue by factoring in historical data of dynamic oil price models and a possible decline in productivity that would occur with time due to depletion of the reservoir, as well as changing operating conditions. I analyzed the crude oil rate according to West Texas Intermediate at 83.16 USD/bbl with the different tubing sizes used in the well and generated a cost analysis table with a bar graph. I concluded that the tubing size of 3.5 inches had the potential to generate revenue of 165238.92 USD. I understood that daily oil revenue is not the only important factor in determining profitability. I knew it was important to consider other costs as well before planning well operations.

Tubing Size (inch)	Oil Rate (stb/day)	Price (USD)
2.441	1888	157006.08
3.07	1976.5	164365.74
3.33	1982	164823.12
3.5	1987	165238.92

FIGURE 7 COST ANALYSIS USING DIFFERENT TUBING SIZES

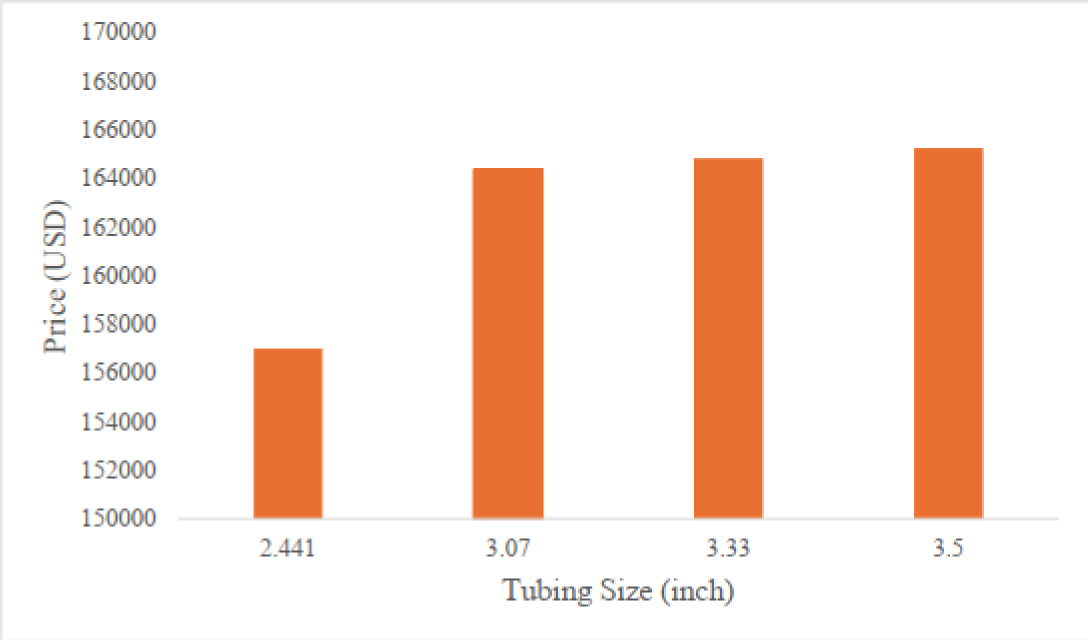

FIGURE 8 GRAPHICAL PRESENTATION OF COST ANALYSIS

CE 3.14 Throughout the project, I worked along with my team to plan a well-rounded approach to the analysis and optimization. I held combined sessions with the team for reviewing the input data and for validating the simulation results. I ensured that the team was aligned on project milestones. I frequently communicated technical findings from PROSPER simulation to our course and lab instructors so that the team can make informed decisions. I facilitated brainstorming sessions to discuss issues such as sensitivity analysis parameters and equipment recommendations. I ensured open communication and teamwork to efficiently incorporate all the various individual contributions to achieve the intended objectives of the project.

Summary:

CE 3.15 This report's objective was to provide documentation on how production optimization techniques may be used to maximize oil well productivity. In this sense, an oil producer was included in the well model that was created using Integrated Production Modelling (IPM-PROSPER). To replicate the well's real behavior, the model was updated with real-time well data from open sources. Suboptimal flow rates were caused by problems in the production system, which were found and fixed using well model analysis. This technique's successful implementation demonstrated how well it may optimize the production of oil and gas, leading to increased production rates and enhanced efficiency.

CE 3.16 The project fared well in achieving its objective. I demonstrated application of effective engineering principles toward optimization of oil and gas production, not only improving projected well output but also contributing to better understanding as to how integrated production modeling can enhance decision-making in the oil and gas industry.