PROJECT FOCUS RETENTION BY CAD ASSIMILATION IN ENGINEERING EDUCATION

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ABSTRACT

The Introduction to Engineering classes is the one stop in which freshmen settle on their decision to pursue their future carrier as engineering. Many start up studying engineering to please their family or hoping to get reputed job while not anticipating the depth of the engineering determinations. Therefore, Introduction to engineering course is an important stage for the students to comprehend and accept engineering. Such classes require a whole heap of information and tasks to be thrown at the students which can sometimes be frustrating to some and dreadful to others. In an attempt to reduce the impact of such encounter, the Introduction to Engineering course (ENGR 101) is split into two courses; the first course (ENGR 110) focuses on defining and explaining all aspects of engineering then seeding the trust of being engineers through teaching ethics, sustainability, management and other skills. On the other hand, the second course (ENGR 150) aims to apply engineering using real world problems and assign the students to use engineering methodologies to solve them. Hence, for students at the Petroleum Institute in Abu Dhabi, it was favorable to dedicate the ENGR 150 to tackle Gas and Oil Industry problems. One challenge faced here is keeping the students focused when teaching multi-stage projects such as the oil exploration process. This work aims to employ CAD visualization to keep the students fixated on the final objectives and see the connection that connect the incremented yet intricate steps that are followed to effectively achieve the final project.

INTRODUCTION

The Introduction to Engineering classes in its proposed secondary phase focusses on engineering teaching via applying solutions to industrial or social problems. ENGR 150 commences by explaining the origin of oil and the necessary conditions that permits the needed transformations of hydrocarbons into petroleum. The students are then given semester long projects assigned in subdivided tasks that a bridge the learning of the engineering methodology. Although the projects are administered in sequenced steps, the students seem to follow the tracks but mess the station. Losing their grip on the project's goals, the students seem to belie that they are doing well as long as they successfully achieve each task. Linking the outcomes of the tasks seem challenging to most of the student even with continuous guidance from the instructor. Many methods are used to steer the students' attention to the overall project but still inadequate. One of these methods employs periodic project review sessions to have the students discuss their progress and work to achieve the final outcomes of the project. Another method recommended is timed examinations to test the students'ability to conceptualize solutions that fulfil the project's objectives. Exams were useful to keep the students focus on understanding the engineering methodologies but not keeping them thinking systematically, i.e. the ability to link the separated tasks to the final success of the project(Brown, T., & Parker, S., 1989).The outcomes accord to the finding of many previous works suggesting that the human brain finds it difficult to model complex problems that consist of multiple conceptions that interact by either support or oppose each other (Murawski, C., & Bossaerts, P., 2016). In efforts to keep the students linked to the project's objectives some use social related project to keep the students immersed in the project counting themselves as engineers and stakeholders in the same time(Kraglund-Gauthier, W. L, 2015). Sketching and graphics visualization is important to help the student communicate their ideas especially when trying to explain new technique of a system with multiple interacting components. It also helps keeping records to prove the students 'accomplishments and saves proprietorial rights. Furthermore, studies agree that sketching and visual modeling helps tracking the progress of the project and assuring that every step leads to improvements and avoids redundancy(Helps, R., & Helps, C., 2016). Computer Aided Design or CAD takes visual modeling into a higher level of accuracy and speed. Employing computer for engineering work opens endless doors and resources to the students including computer sketching which pursues two dimensional representations of the parts with accurate dimensions and interactions. CAD also allow for 3D modeling of parts and systems allowing the user to visualize the entities from 360 degrees prospective. Furthermore, CAD is also recognized for facilitating animation and simulation which give the students great advantage for prototyping with correct interaction among components and systems (Rene, A. (2015). Finally, CAD is to thank for the implementation of finite element analyses when seeking engineering analyses for the model reaction to loads and stress. It was obvious through the outcome that CAD has broken the ambiguous barriers for students in ENGR 150 to see the bigger picture of the overall system and its interacting components which were achieved through consecutive tasks.

METHODOLOGIES

The project assigned to the students consists of eleven main stages that begin by the oil exploration processes learning about the primitive and sophisticated techniques that lead to the prediction of oil existence. Afterward, the students were assigned to identify the location of the oil prospect and study the possible impacts to the surrounding environment. The next step guides the students to learn how to use contouring tools to create three dimensional visualizations of the rock layers inside the prospect and absorb the desired formation that allow for oil accumulation (Theodoropoulos, D. T., 2011). The students are then taught to estimate the amount of oil placed in the regions and create and economical plan to manage and market the findings (Grace, R. D., 2013). CAD managed to connect every task making it easier for the students to link the outcomes to the objectives.

CAD for the Lease Base map Recognition

The first step of the oil exploration process is to get the students to understand the lease significance and rights, i.e. the priority for Oil Company to drill in a specific region and protect it from compotators by law. Google earth pro was used to set boundaries of the lease for the oil exploration and measure its area and its location away from regions of interest. The base map also included the seismic data lines which represent trajectories that the seismic ships follow when obtaining seismic graph.

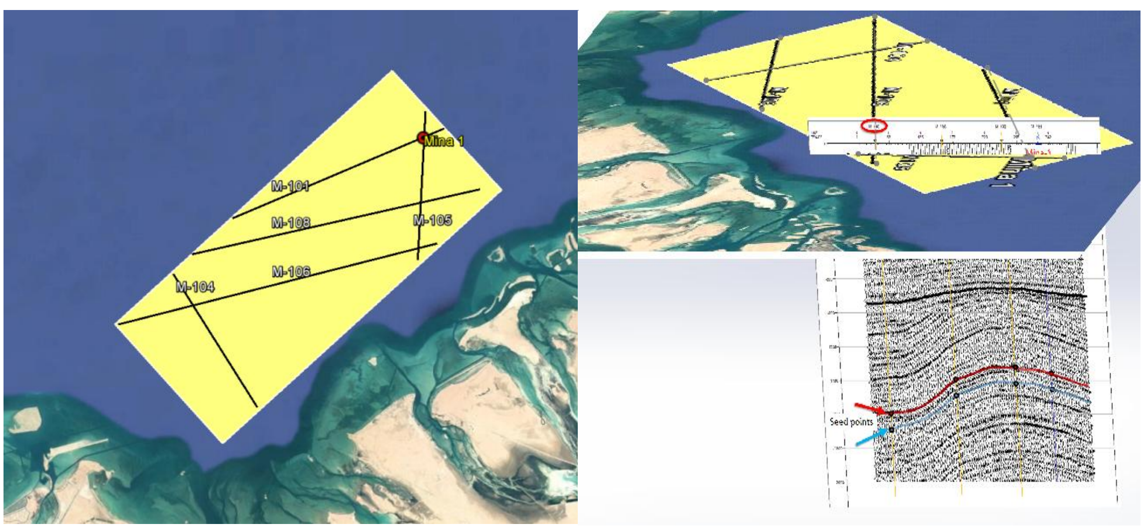

Figure 1: CAD is used to relate the graphs obtained from the seismic readings to the rock location in the lease basemap to facilitate the construction of the 3D model of the rock layers.

As elaborated in the upcoming section, the seismic graphing is an important tool used to obtain an image of the rock layers under the area of the prospect. Hence, understanding the location of each seismic line on the base map is important to create a three dimensional image of all the rocks layers (Grace, R. D., 2013). CAD tools were very useful to clarify the connection of the position of the seismic lines from the top view to its depth when showing from the side views making it easier to create the 3D model of the rock formation. Lack of proper visualization seems to veer the students, attention away from understanding the significance of seismic graphs and its role to embody the oil field.

In a nut shell, seismic graphing uses sound vibrations that penetrate through the rock layers but when they go through different layers, they reflect echo at different depth. Computers are then used to relate the times it takes the echo to be received by the receptors to the distance of the particular layer. The outcome usually consists of a two dimensional graph the shows a continuous reading of the seismic reading along the path of the seismic source (Onajite, E., 2014).

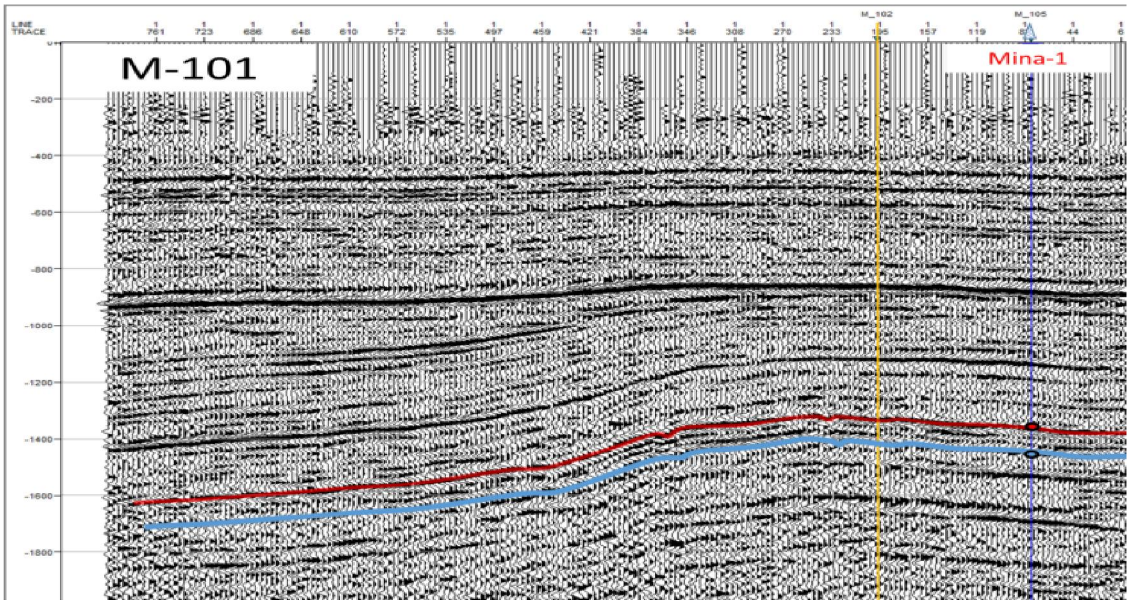

Figure 2: Seismic graphs show 2D representations of the depth and boundaries of the rock layers.

CAD for the Seismic Interpretation and Reservoir Modeling

The 2D seismic graph is useful to understand the depth and shape of the targeted rock layer which has properties that makes it proper storage for oil and gas. However, other conditions are necessary to the trapping of oil in a reservoir and it is important to gather all the bits and pieces of information and connect them to have a clear manifestation of the possible oil reservoir. The students now know that petroleum travel upward through porous and permeable rocks and get trapped when hits a tight layer of rock shaped in a matter that keeps it in place (Grace, R. D., 2013). Practically, teaching and recognition of such conditions is challenging especially when trying to get the students to create 3D images of the reservoir from the multiple seismic graphs at different depths. CAD is very useful when creating a solid model of the intersecting seismic graphs then connect the upper and lower bounds using the provided tools such as lofts and sweeps.

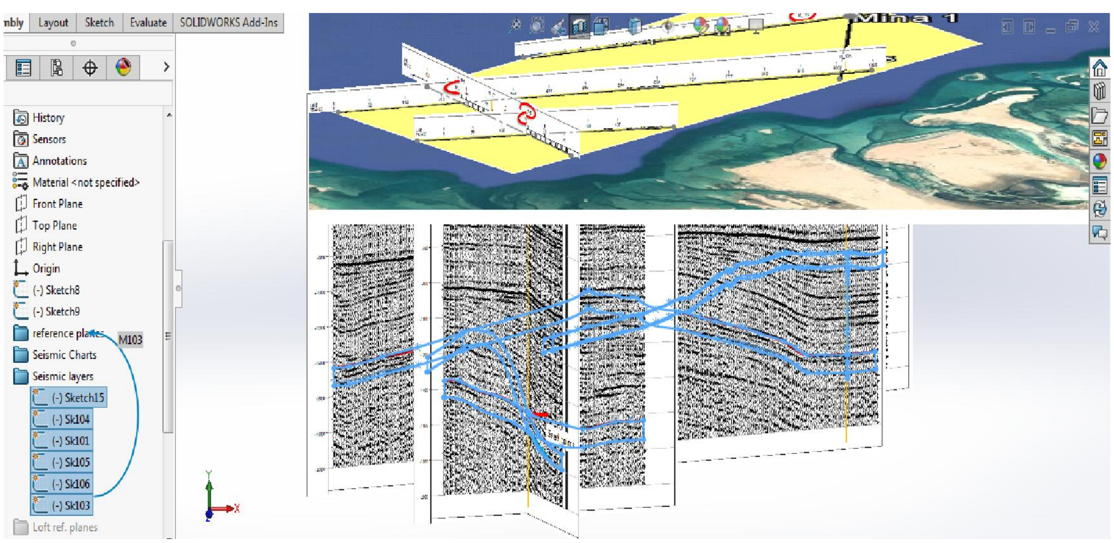

Figure 3: Intersecting seismic graphs is easier to understand with CAD tools

CAD for Contouring and Reservoir Depth Perception

The students are first assigned with a task to identify all the points depicted on the top view of the map that refer to regions of interest in the rock formation. Then they are asked to connect these points based on similar depth share depth. Such task is called contouring given that contour lines are the lines that connect all the point that share the same value such as depth. These contour lines expose the depth and shape of each phenomena occurring in the targeted rock layer such as existence of aquafers or oil accumulation. The next step is carried out to depict the significance of the contour lines by using CAD to model the contour lines in three definitional sense given the students the freedom to rotate the contour lines and see the relationship that lay them out inside each other from the top view. This is important to overcome the challenge of accepting contouring to students who haven ever been exposed to such tool. The distances that separate each contour line from each other represent inclination whichrelate to the steepness of the lines with different depths. CAD tools provide arbitrary reference planes which were used to have the contour lines sit on top of each other. Nonetheless, these lines are further important to the students to create solid bodies and surfaces to embody the rock layers and hence, the oil reservoir. The students learn in this class that oil is most likely trapped in an anticline rock formation which represents a hill inside the rock layers. Figure 4 shows an accepted shape of an anticline discovered from all the analyses performed throughout the steps of oil exploration.

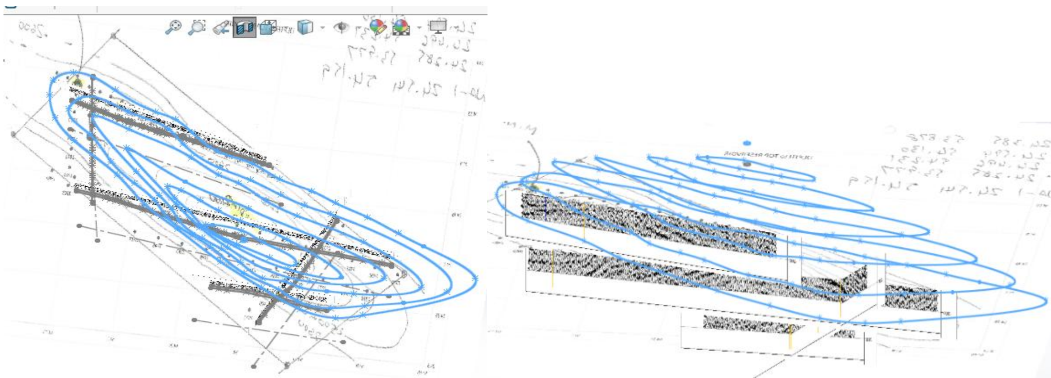

Figure 4: Contour lines in 2D helps visualize the depth of rock layer at different locations (Left image). CAD makes it possible to rotate the contouring lines to further explain the Contour lines to the students (Right image).

The next step employs CAD surface tools to create three dimensional solid bodies of the rock layers making it easier for the students to understand the carbohydrates accumulation process in the reservoir. As demonstrated in Figure 5, the students can then turn and rotate the rock formation and understand the importance of all the steps taken in the process to recognize and discover oil in place.

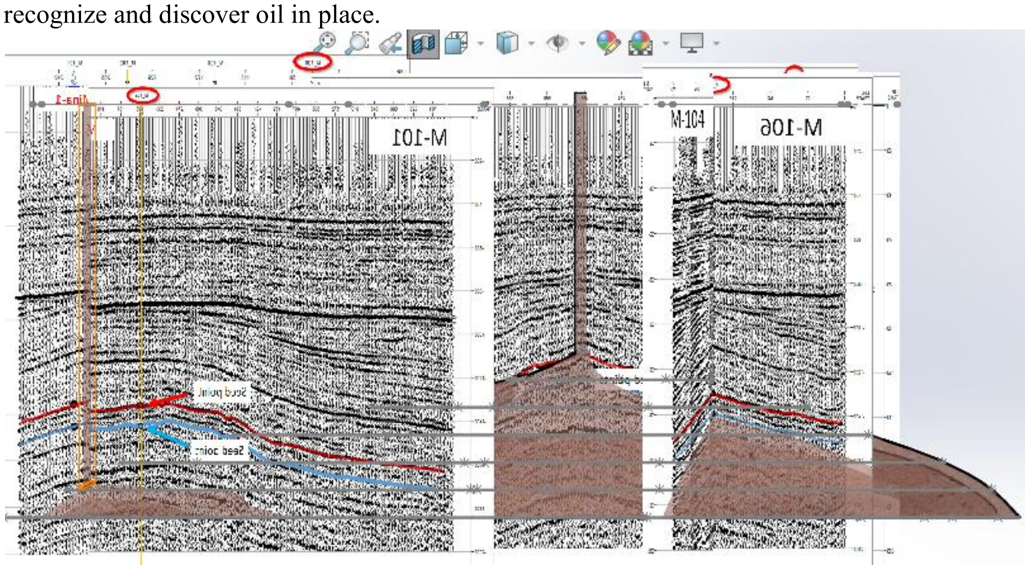

Figure 5: CAD is used to demonstrate and link all the tasks of the oil exploration in 360 degree visualization

The model is then trimmed from all the constructioncomponentsin order to expose only the reservoir rock and the section that contain all the carbohydratesas shown in Figure 6. These construction components represent the stepstaken in the subdividedtasks. The reservoir rock fluids may include water, oil and gas and it is the students' responsibility to estimate the amount of oil and gas placed in the rock.Students are taught to find the original oil in place by dividing the area that contains oil within the lease into even squares that can be easy to calculate then multiply it with its depth.The total volume is then estimated by adding these partitions then the outcome is converted intoBarrels (BBL) which is the conventional unit used by the industry (Grace, R. D., 2013). Computer aided engineering capabilities in the CAD software allows for many types of measurement and estimations such as volumes of irregular shapes; hence, CAD was helpful to estimate the volume of the reservoir rock that contains oil simply by few clicks.

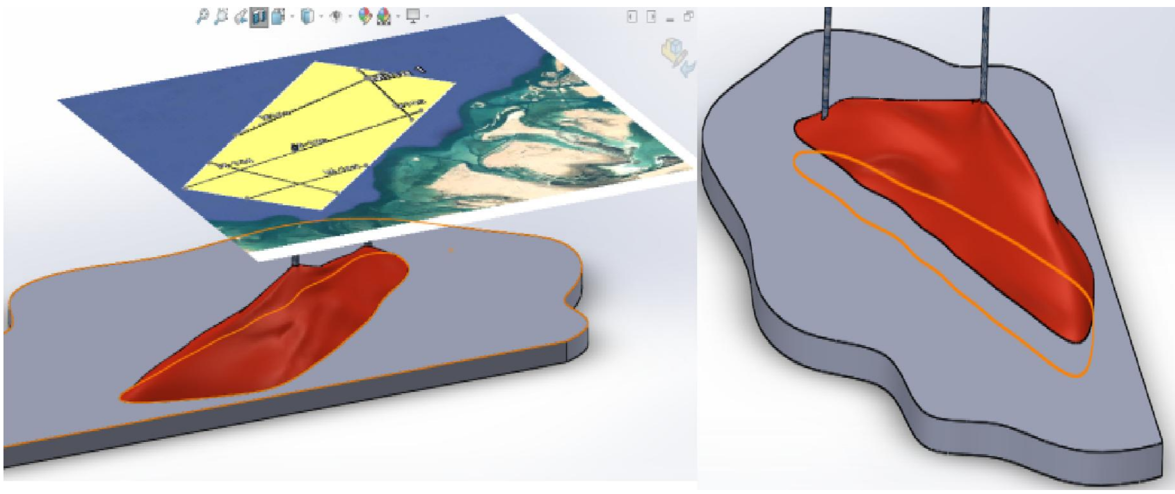

Figure 6: CAD makes it possible to expose the shape and size of the reservoir rock as well as the section that contains fluids.

RESULTS AND DISCUSSIONS

Due to the high level of intricate relations of the steps required for the oil exploration project, the level of consistency among the teams was significantly low. Comparing the outcomes of the conventional methods to the ones obtained from the CAD methods, it is evident that CAD helps the students stay focus on the project goals among the team and throughout the semester.Showing in the figure below, hand sketching contouring requires interpolating which increase the level randomness,consequently,reducing the level of perception. Attempting to document the challenges faced by the students in ENGR 150, a review study was carried out targeting a class with thirty studentswho were assigned to perform two projects of oil exploration then were asked to answer open ended and multiple choices questions.The outcomes shown in Figure 7shows that 78% of the students admit to lose focus on the objectives of the project as they complete the intermittent tasks. 25% of the students blame the instructor for failing to clear the bigger picture when adopting the conventional method. 43% find it hard to communicate with the team due to the vagueness of their goals. Additionally, 54% of the students blame their failure to successfully finish their tasks on missing the connections with final goals of the project.

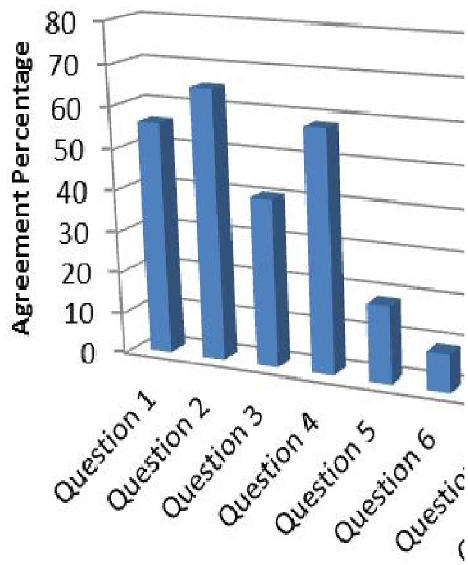

Figure 7: Survey outcomes by the students reflects their attitudes on the CAD methods to visualize oil exploration process

Upon employing the CAD method, the students gave more positive feedback toward understanding and directing their efforts to achieve clear and predefined goals. As the chart in Figure 8 concurs, 87% of the students agree that CAD made it much easier and more exciting to finish the tasks. 97% show gratitude to the instructors for going the extra mile to help them understand the project. 64% were interesting in the CAD software and expressed their passion to the industry. Finally, comparing the grades of the team's project review sessions before and after employing CAD proved significant improvement to the students' comprehension of the tasks.

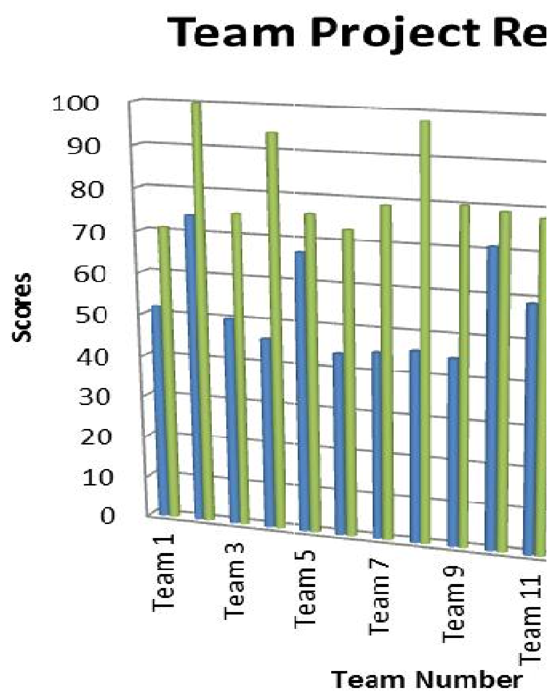

Figure 8: Students show improvement and positive feedback toward the task and the class after CAD was implemented.

CONCLUSION

Engineering is undoubtedly one of the most excited and rewarding profession, yet, many of the freshmen students seem to lose interest in their freshmen year due to some challenges that can throw them out of focus. One of the main challenges noted in the Introduction to Engineering classes is keeping the students attentive to the inclusive objectives and retain that the tasks that are periodically performed are building blocks used to achieve the semester-long project. ENGR 150 is an introductory to engineering class that focusses on the petroleum and oil industry at the Petroleum Institute in Abu Dhabi. A semester-long project is assigned to the students to complete an oil exploration process by completing weekly tasks that ultimately helps that students complete the final project. Although the tasks were completed in time, many of the students showed low motivation and weak performance due to their lack of focus on the ultimate goals. Oil exploration requires techniques that continuously bring the finding into mind images that help the students locate, estimate and plan for future oil wells. This study tested and proved that employing CAD capabilities as visual aids is helpful to keep the students on tracks and always directed towards the final goals while achieving their periodically assigned tasks. CAD was able to provide clear connection among the subtasks and how the building process of the outcomes feed into achieving the goals. Results show that students' attitudes were highly positive to the proposed and tested methodology. Nonetheless, comparing the progress of the student without CAD assistance shows that the proposed methodologyhelps keeping the students motivated and focus on the project. Finally, it was clear to the instructors that the teamwork was enhanced when using CAD by allowing the students to effectively communicate among each other's and with the entire class.

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