Petroleum Exploration and Product Solutions

As the important energy resource, the exploration and production of oil and gas is essential for the development of a country. Oil and gas is stored hundreds or thousands meters underground. Thus, high technologies should be applied for exploring more oil and gas.

The process of petroleum exploration is as follows:

Geological exploration—cementing—perforation—production—workover, increasing production, transportation and processing. The above parts are interdependent and inseparable.

1. Geological exploration and geophysical prospecting

The aim of geological exploration is to find oil and gas field by observing the surface strata and rocks to get know about the formation structure and feature, and find out the generation, accumulation and distribution pattern of oil and gas, with the tools such as compass, hammer, etc. While most of the surface is covered by sediment, which limits the process of geological exploration. But this process is indispensable, for it narrows the area of geophysical prospecting and saves cost.

Surface geological survey includes general prospecting, general exploration and detailed exploration. In the process of general prospecting, the expected oil-bearing area based on the geological map. General exploration focuses on "selecting". In this process, the oil-bearing area and structure is further approved. In detailed exploration process, the approved oil-bearing structure is determined, with the aim of finding oil and gas field.

Geophysical prospection is to find oil by deducting underground geological condition by observing the physical phenomenon with different physical instrument according to the principle of geology and physics. Geophysical prospecting is a new technology including gravity prospecting, magnetic prospecting, electrical prospecting, seismic prospecting and nuclear prospecting.

Currently, our company hasn't developed the relating software to simulation the two processes.

2. Drilling

Before drilling, much preparations need to do, such as, building road, site flatting, laying foundation, running pipes and then assembly and commissioning rig equipment. Based on this, our company develops CEIEC**-LRI2 Land Rig Installation Simulation Training System.** This system demonstrates the whole process of land rig installation in the form of HD animation (the animation is exactly the same as real rig installing process), to realize the standardization, normalization and securitization in installing process. The hardware devices of the system provides operations to control mast and substructure raising and lowering, tripping and drilling. Mathematical models simulate various parameters in the operation process, such as pressure, discharge rate, torque, drilling rate, etc. The 3D animation based on the technology of virtual reality projected on three-channel circular-screen or displayed on LCD or LED screen, combined with lifelike sound effect, makes up an immersive training environment. See **Appendix 1** for technical solution of CEIEC**-LRI2**

Land Rig Installation Simulation Training System.

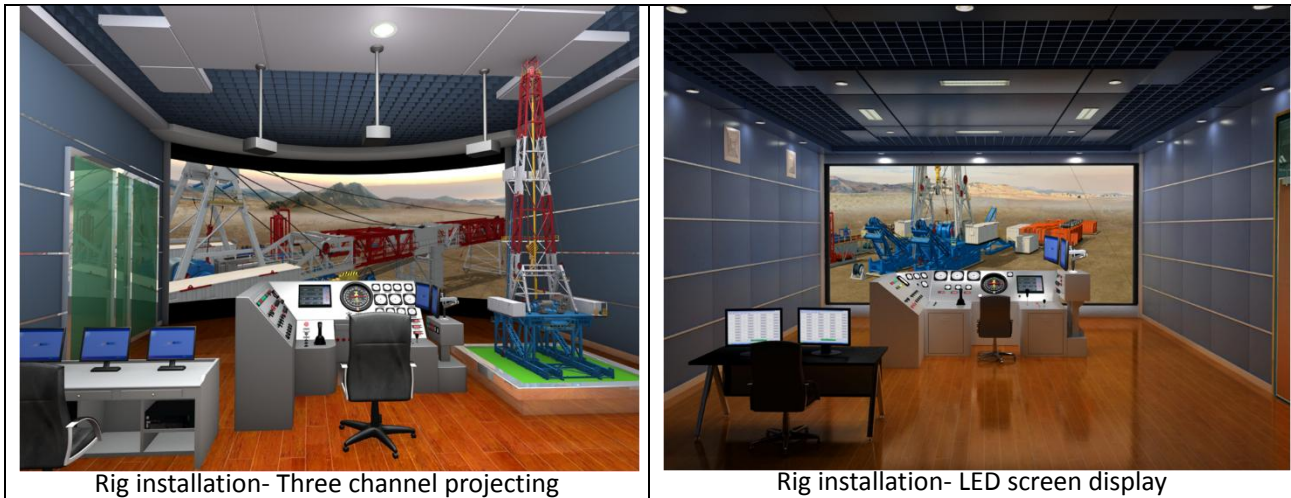| Rig installation- Three channel projecting | Rig installation- LED screen display |

Figure 1 Land rig installation simulation training system

Drilling is the most important process in petroleum exploration and development. Our company makes much effort to develop systems in this field. The drilling simulation training system developed by our company was rewarded in the industry for completed functions, excellent performance and competitive price. At present, our drilling simulation system takes over 95% of domestic market, and was exported to Kenya, UAE, Columbia, Venezuela, etc. The best quality and excellent service was highly praised by customers. For over 10 years hard working. Over 20 items of software products has been registered. And the products also got 18 items of invention patent in China and abroad, over 50 items of utility model patent and design patent. The system was also rewarded the 3rd prize of Technological Progress in Sichuan Province. The related products includingCEIEC**-D1000 Drilling Simulation Training System,**CEIEC**-D900 Portable Well Control Simulation Training System,**CEIEC**-PSO2 Portable Snubbing Simulation Training System,**CEIEC**-PWS3 Portable Down-hole operation and Well Control Simulation Training System,**CEIEC**-SO2 Full Size Snubbing Simulation Training System,**CEIEC**-WS3 Down-hole Simulation Training System.** See **Appendix 2~7**.

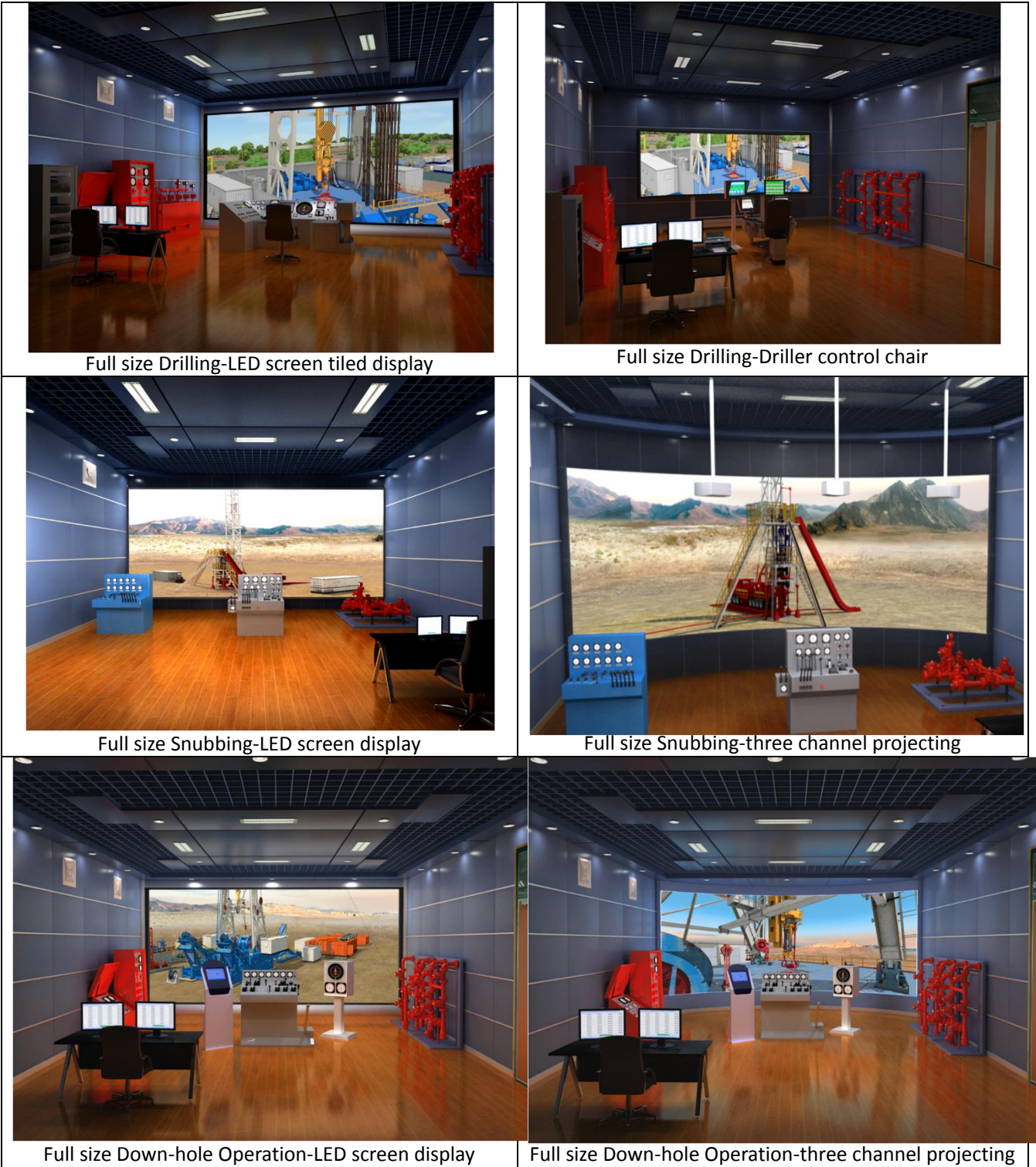|	
Full size Drilling-LED screen tiled display	Full size Drilling-Driller control chair
Full size Snubbing-LED screen display	Full size Snubbing-three channel projecting
Full size Down-hole Operation-LED screen display	Full size Down-hole Operation-three channel projecting

Figure 2 Drilling and well control related simulation training systems

3. **Logging**

Logging is a process providing drilling information in petroleum engineering, through observing, collecting, analyzing, recording the information of return objectives such as solid, liquid, gas while drilling by the means of geochemistry, geophysics and rock-mineral analysis, to establish logging

profile, discover oil and gas evidence and evaluate hydrocarbon reservoir.

LS2 Logging Simulation Training System, developed by our company adopts the full size logging room, sand table of well site model, sensor model, and advanced logging software, as well as the accident simulation software and sensor detecting software developed by our company, provides overall demonstration of compound logging process. Students can also master various operation skills and get experiences on treating drilling accidents. For the technical solution, please refer to **Appendix 8**.

Figure 3 Compound logging simulation training system

4. Well Testing

Well testing is a process to get related data from the logging instrument connecting to wire which is put underground. The measured results are delivered to surface lab or computer system though wire.

Well logging operation is a complicated project which requires much inputs and high technology. Thus, the technical level and operation skills of the technical persons and operators on well site is essential. Traditional training takes long time and is insecurity. Also, it cannot reappear accidents and special working condition, and cannot give objective evaluation on students' operation.CEIEC-**WT2 Production Well Testing Simulation Training System** developed by our company uses the technologies of virtual reality, network technology, graphics technology, multi-media technology and well logging theories to solve the problems of training and evaluating

well logging technicians, and makes training and evaluation satisfy the requirement of technical progress and production requirement. Synchronic 3D animation and lifelike sound effect makes up an immersive training environment. For technical solution, please refer to **Appendix 9**.
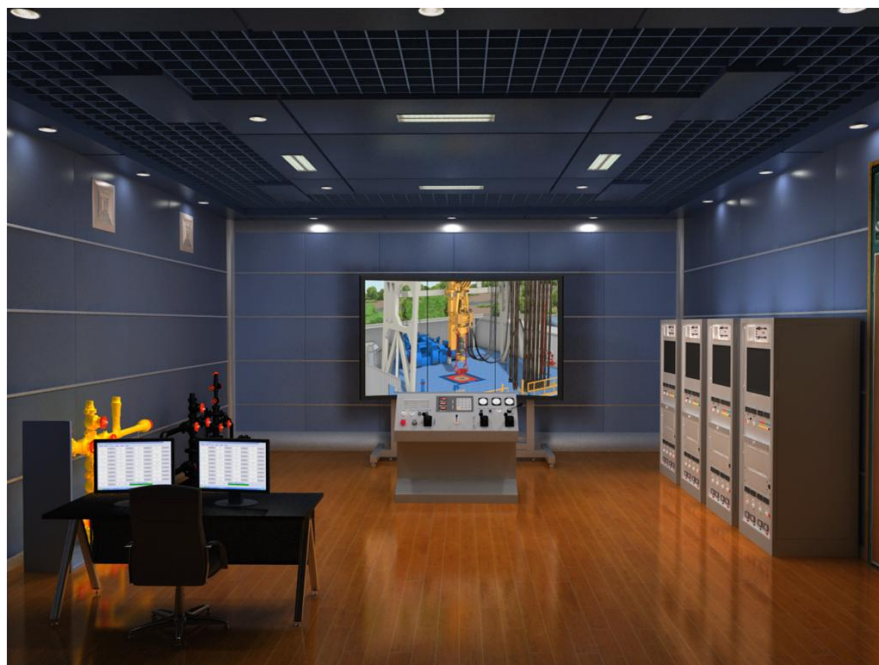

Figure 4 Well testing simulation training System

5. <u>Cementing, Perforation and Completion</u>

Completion is a relatively independent project but bridging drilling and production. It's a process from topping the oil sand, running casing, inject cement, perforation, running production pipe, unloading liquid, to put into production. The aim of completion is to establish path from production zone to borehole and stabilize and increase the production of oil and gas field. Rational completion ways should be selected according to hydrocarbon reservoir type and the features, in order to lengthen the lifespan of oil and gas well and increase production. The common well type including vertical well, directional well, horizontal well and multilateral well. The most common completion ways including perforation completion, liner completion, open hole completion and gravel pack completion, among which perforation completion is the most popular way.

Cementing is one of the most aspect in establishing oil and gas well. Its aim is to isolate the oil zone, gas zone and water zone in the well, to avoid communication between zones, protecting casing and increase the lifespan of the oil and gas well. After running casing, connecting circulation pipe and cementing injection pipe, to prepare well before injecting cement. First, pump needs to be started to circulate drilling fluid. As the interval between casing and well wall is narrow, the drilling

fluid with high up load velocity flushes the mud cake on well wall. Meanwhile, adjust drilling fluid properties until the circulation pump pressure is stable. During this, the works should be done such as starting cementing pump, supplying cement ash, supplying water, magma, and suction. The liquid required in cementing process mainly includes prepad fluid and slurry.

So far, our company has not developed the related simulation systems.

6. Oil and Gas Production

Oil and gas production is the key part in petroleum engineering. Our company, cooperating with Southwest Petroleum University, develops theCEIEC-**OR3 Oil Recovery Simulation Training System** andCEIEC-**GR3 Gas Production Simulation Training System** adopts the technologies of petroleum engineering, oil and gas storage and transportation, computer technology, and virtual reality. These two systems are currently most advanced systems with completed functions, which satisfy the real oil and gas production requirement.

The two systems adopts the method of "flow coupling" to calculate the pressure, flow and temperature of fluid in pipe. The systems have the function of presetting accidents and devices fault. Instructor can insert the accidents and faults at any time during students' operation. Through the phenomenon, students can judge and handle the accidents, and therefore their skills are improved. The working condition of the devices are displayed on the screen, which presents the whole process. The training systems save the training time improve training efficiency. For technical solution, please refer to **Appendix 10 and 11**.
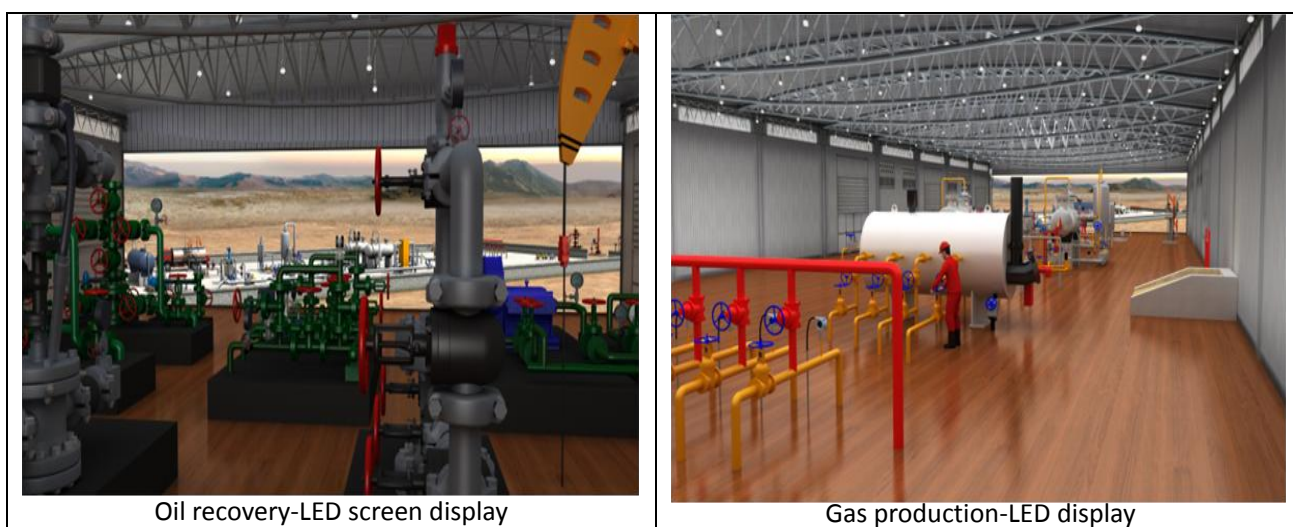

| Oil recovery-LED screen display | Gas production-LED display |

Figure 5 Oil recovery simulation training system and gas production simulation training system

7. Workover, Increasing Production and Follow-up Processing

As for increasing production, our company developsCEIEC-**FA2 Fracturing and Acidizing Simulation Training System**, using the technologies of petroleum engineering, computer technology, virtual reality and network technology, which is an advanced system, satisfying the training requirement of oilfield companies. This system contains various training modules such as training on fracturing devices, fracturing design, fracturing construction, fracturing process, acidizing fracturing, fracturing accidents analyzing, etc. It is mainly used for training new personnel, fracturing and acidizing workers and technicians. Through the training and testing of this system, students can master the operational method of the devices, and learn the process of fracturing and acidizing and common treatment of fracturing accidents. The system adopts mathematical models to simulate various parameters in the process of fracturing and acidizing, such as pressure, discharge rate, etc. It can also reflect the relationship between these parameters so as to reach the same effect of the real operation. Virtual reality technology is used to construct the lifelike environment; synchronic 3D animation, large size projecting system, and the highly emulated sound effect makes up an immersive environment for the users. For the technical solution, please refer to **Appendix 12**.

Figure 6 Fracturing and acidizing simulation training system

As for the process of the follow-up transportation, our company developsCEIEC-**OGS2 Oil and**

Gas Gathering and Transportation Simulation Training System, It is a system with advanced technology and complete functions which can satisfy the training requirements of oilfields. The system consists of joint station, crude oil pipeline, natural gas boosting and distributing, LNG receiving station, oil depot and other accessory software. The appearance of the consoles is the same as the real equipment. The layout of panels, operation methods and parameter displaying are the same as those in real site. The hardware system is designed according to industrial standard; data acquisition and controlling system is constructed by PLC, which ensures the stability of the equipment. The system has the advantage of low input and maintenance cost with no security risk. For the technical solution, please refer to **Appendix 13**.

Figure 7 Oil and gas gathering and transportation simulation training system