

PRODUCTION ENGINEERING DEVELOPMENT OF A DREDGING ENGINEERING DISCIPLINE

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EXTENDED ABSTRACT

Introduction

Although an established engineering discipline in the manufacturing industry, production engineering is a relatively new and young field within the dredging industry. Dredge Production Engineers combine mechanical, civil, and geotechnical engineering tools to estimate, analyze and improve dredge production. The discipline of production engineering generally began its development in the industry with mechanical and civil engineers exploring, developing, and utilizing various engineering tools to estimate and eventually try to improve dredge production. Today, a number of dredging companies employ multi-disciplined and multi-functional Production Engineering Departments to model, estimate, analyze, and optimize dredging production. Some companies even staff their sites with full time field production engineers. Today's Production Engineers employ specialized, innovative, and sophisticated engineering tools including dredge process data logging analysis, centrifugal pump and slurry transport models, geotechnical sampling and analysis, cutting models, hopper loading models, cycle analysis, and dredging simulator programs.

Using the history and current status of production engineering at Great Lakes Dredge & Dock Company as a specific example, this presentation discusses the development of production engineering into a dredging engineering discipline.

A Development of Production Engineering

Production Engineers began as technical specialists within established disciplines. Mechanical and civil engineers -- in traditional company departments, on dredging sites, and in universities -- explored, developed, and utilized various engineering concepts to estimate and eventually try to improve dredge production. At Great Lakes, these began as "production interested" engineers in the Mechanical Engineering Department. Early resources and tools were centrifugal pump and pipeline slurry calculations aimed at estimating hydraulic dredge production for bids. At Great Lakes, the Production Engineer's estimate of hourly production was first recognized as a potentially interesting "2nd estimate" check of the bid estimate. In addition, early Production Engineers would act as trouble shooters, being called out from the safe confines of their department to venture into the field and assist onboard dredges that were not meeting the bid production estimates, presumably due to technical reasons. The focus was usually on pump production optimization. Applicable training was usually via experience augmented by outside institutes and short courses in centrifugal pump theory and slurry transport.

Production Engineering came of age when the its potential was recognized as a stand alone function that could apply engineering principles to analyze, estimate, and improve dredging production. At Great Lakes, a Production Engineering Department was developed with a staff of engineering specialists dedicated to estimating and improving dredge production for Great Lakes bids and projects. Great Lakes' refined their pumping and slurry production models and expanded their models to the entire dredging system. Integrating geotechnical parameters, the department developed cutting and digging models, swing and coverage calculations, and the first comprehensive clamshell (grab) dredge production estimating model. For cutter suction dredges, these tools began as basic computer models that calculated the limiting production factor within the system -- i.e. a "pump limit" or a "dig limit" or a "coverage limit". For clamshell dredges, the model integrated bucket cutting, filling, mapping and cycling analyses. Great Lakes began in-house training by rotating field engineers through the Production Department, filling the engineer's toolbox with production engineering concepts, tools, and procedures to assist them in understanding and improving the operation and productivity of the dredges on site.

Great Lakes soon fully integrated production engineering into the estimating and bidding process. No longer only providing a technical "check estimate", a dedicated Production Engineer was (and still is) assigned to each project to

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provide technical analysis and singular production estimates for the eventual cost estimate and bid. A one stop shop. The production estimating models, be they for trailing suction hopper, hydraulic cutter suction, or mechanical bucket dredges, were (and still are) calibrated to past achieved production project by project, eliminating the former practice of having two types of production estimates -- the “referenced production estimate” verses the “theoretical production estimate”. The Production Engineers had taken full responsibility and ownership of production estimating at Great Lakes.

As production engineering at Great Lakes matured, management implemented several important changes that would accelerate its potential. First, Great Lakes recognized the need for more comprehensive, detailed, and consistent information and analysis of the geotechnical properties of the soils being dredged. Thus, the department added a formal geotechnical engineering function to provide expertise in soils data analysis, to efficiently plan, manage and implement soil investigations, and to assist in understanding and managing the impact of geotechnical properties on production and operations. Second, the “production limit” concept used for estimating, analyzing and improving production was recognized as oversimplified and confining. Thus, Great Lakes integrated instantaneous production limit calculations into their programs to more realistically model the entire dredging cycle and system. These models greatly improved the Company’s understanding of the dredging process, provided more accurate production estimates, and provided a more realistic basis for trouble shooting and improving production on site. Lastly, it became clear that production process data collection and transmission from Great Lakes’ dredges could be vastly expanded and improved to provide real-time monitoring of all production parameters. Accurate, comprehensive, and real time process data could then be analyzed to enable both better calibration of production models and a basis for production analysis and improvement. Thus, Great Lakes engineers developed an onboard Dredge Information System (“D.I.S.”) that monitors and records all dredge process data in real-time. The D.I.S. system includes standardized data compilation, presentation and analysis routines for production investigation and optimization exercises both in the field and in the home office.

The next challenge for the Great Lakes’ Production Engineering Department was to organize such they could more significantly impact and improve dredge production in the field. Great Lakes’ first effort was to organize their experienced engineers into “Senior Production Engineers”, each given the responsibility of improving production for a number of dredges. The initial successes of the Senior Production Engineers when working at specific project sites prompted the notion of a dedicated Field Production Engineer position supported by yearly recruiting, hiring, and comprehensive training and mentoring. The Field Production Engineer would be educated in engineering, trained in-house in all production engineering concepts and methods, and stationed full time on Great Lakes’ project sites to report, analyze, and improve dredge production. After a single year of development, Great Lakes today employs a team of nine Field Production Engineers, stationed full time on their project sites throughout the United States working to improve the productivity of their dredging plant day in and day out.

Production Engineering Today

Today’s Production Engineering Department is multi-disciplined and multi-functional. At Great Lakes, the Production Engineering Department employs entry level, experienced, and senior engineers with diverse educations in civil, mechanical, ocean, and geotechnical engineering. Entry level engineers are recruited for the Field Production Engineer position with a minimum bachelors degree in engineering from major universities and are trained in-house in all aspects of general dredging and specialized production engineering concepts, tools, and methods via an eight week summer training program at the beginning of their employment. Home office Production Engineers provide corporate technical support, production estimating for bids, R&D, and assistance in training and mentoring the newer Field Production Engineers. Field Production Engineers graduate from their training and are assigned to project sites directly reporting to the onsite Project Engineer, with assistance from their department “mentor” in the home office and with department oversight from the Manager of Production Engineering. Field Production Engineers focus on production reporting, analysis, and improvement.

Production Engineering is a career at Great Lakes. Whether in the office or in the field, Production Engineers at Great Lakes advance through engineering levels (III / II / I and Senior Production Engineer) with increasing levels of responsibility. Great Lakes Production Engineers may advance in the field and/or home office and are also free to cross into other dredging disciplines such as field engineering, site management, estimating, surveying, or wherever their skills and interests may lead them.

Today’s Production Engineer uses a variety of sophisticated and innovative engineering tools developed for and by production engineers. At Great Lakes, these tools -- both in the field and in the home office -- include Dredge Information Systems; pump and slurry transport computer models; geotechnical sampling, testing and analysis;

cutter and digging limit models; integrated production limit and dredging cycle models; bucket production programs; hopper slurry loading and cycle optimization; and dredging simulator programs.

Conclusion

Today's Production Engineer is a dredging specialist. With general engineering and industry specific training, a specialized knowledge base, sophisticated technical resources, and clearly defined career opportunities, production engineering has truly developed into a dredging engineering discipline.

