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FUTURE DREDGING EQUIPMENT

National Dredging Meeting
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FUTURE DREDGING TECHNOLOGY

•The subject is broad and could encompass many specific technologies.

•Marine Design Center work load is part dredges, but also part (majority) other vessel workboat types.

•This presentation will identify some technical subjects that MDC has encountered both in direct dredge work, and also in work on other vessel types that may be applicable to dredges.

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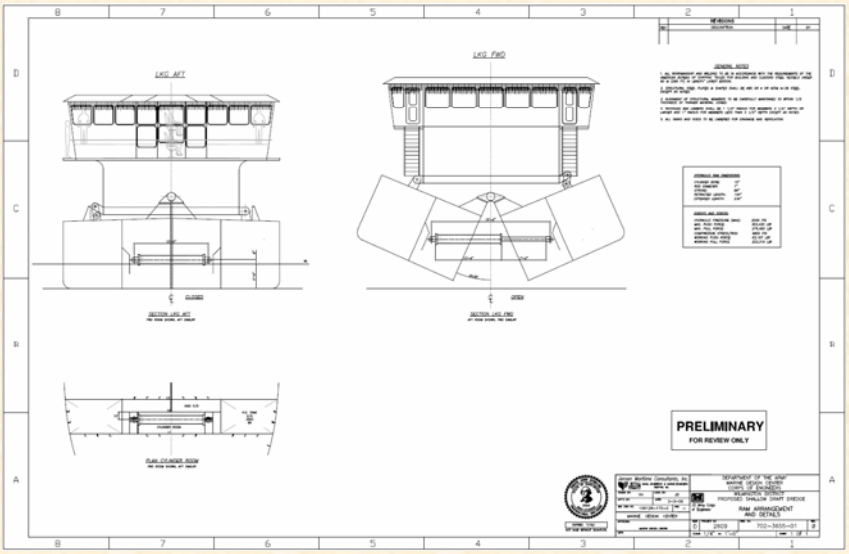

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WATER HYDRAULICS

•Corps of Engineers has a new shallow draft small, split hull, dredge under contract.

•Currituck, an existing small split hull dredge, uses oil hydraulic rams to open & close the hulls.

•Design of the new shallow draft dredge targeted improvement in environmental considerations associated with the large (16 inch) hydraulic cylinders that open and close the split hull.

•We found water hydraulic to be a viable solution.

•Two providers of water hydraulics were identified, Danfoss Nessie, and BOC Water Hydraulics

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WATER HYDRAULICS (continued)

•www.danfoss.com/North_America/BusinessAreas/High-pressure_Water_Solutions/

•www.bocwaterhydraulics.com

•BOC Water Hydraulics is providing the water hydraulics system for the shallow draft dredge. The system operates on water, at 1,200 PSI, and uses non toxic antifreeze.

•Issues associated with hydraulic oil leaking from the hull rams are eliminated.

•Water hydraulics can be expanded to other dredge hydraulic systems.

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NON-NUCLEAR VELOCITY DENSITY MEASUREMENT

•Corps dredges, hopper and pipeline use nuclear source density measurement devices.

•Recurring regulatory requirements for the use of nuclear source dredge density measurement systems could be avoided by a non-nuclear replacement.

•A multiple reflection self calibrating ultrasonic density measurement system was, recently developed and patented by the Pacific Northwest National Lab (www.pnl.gov), in Richland, WA .

•The system was developed by PNL to measure density of radioactive slurries generated in the cleanup of the Hanford Nuclear Site in Washington.

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NON-NUCLEAR VELOCITY DENSITY MEASUREMENT (continued)

•PNL has a “Slurry Lab” for this function, including a small (4” diameter) experimental slurry pump loop.

•PNL was initially tasked to evaluate the use of their ultrasonic density measurement system using dredge material specifics from ESSAYONS dredge jobs. This was done in the PNL slurry loop, and gave initial good results.

•PNL was then tasked to develop the system for the much larger 32 inch ESSAYONS dredge system, and to test it on board ESSAYONS during dredge operations.

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NON-NUCLEAR VELOCITY DENSITY MEASUREMENT (continued)

•This system was adapted and a prototype test was done on board the dredge ESSAYONS. The ultrasonic system transducers and equipment were installed (strapped onto) the ESSAYONS piping adjacent to the ESSAYONS nuclear source density device.

•The PNL ultrasonic-system-measured densities tracked well with the nuclear source measured densities, during actual ESSAYONS dredging.

•The system could be developed into an alternative to nuclear source measurements.

•The PNL does encourage public private partnerships with their technology developments.

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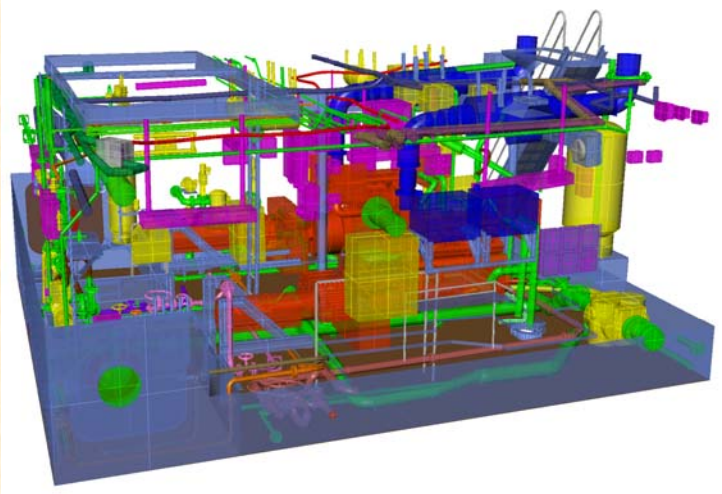

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LASER SCAN

•Vessel on board dredging equipment is frequently modified, repaired and updated.

•Accurate drawings can facilitate the engineering effort required for retrofit applications on existing dredges.

•This has commonly been a problem on existing dredges because of the high number of piping and electrical service runs, along with the many machinery components installed, and the frequent lack of accurate “current state” drawings..

•We have found laser scan to be very accurate and cost effective method for accurately generating drawings, showing true shape of all significant service runs, structure and machinery components.

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LASER SCAN (continued)

•The scan process itself does not take much time, is not very expensive, and does not require equipment shut down.

•The highly detailed drawings of actual compartments allow retrofit systems to be designed to fit, right from the start. Large time and cost savings are the result, both in design and in installation re-work.

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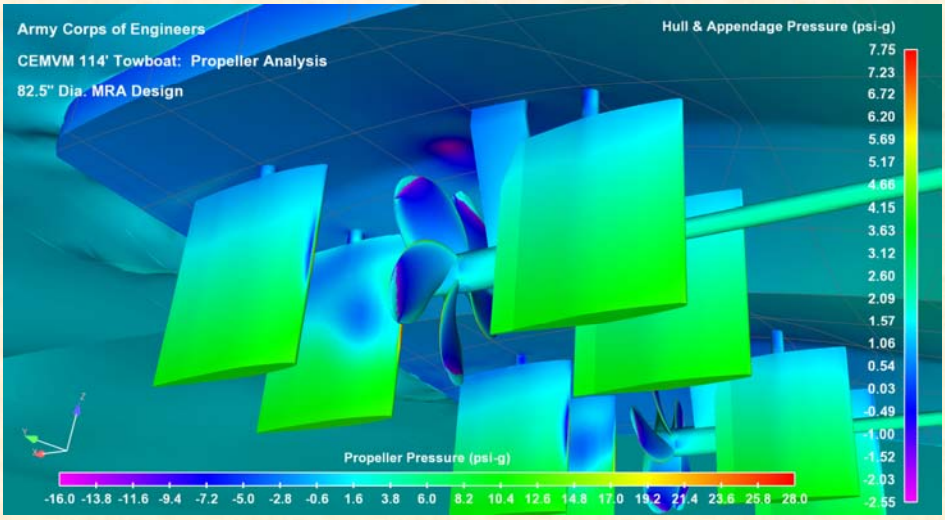

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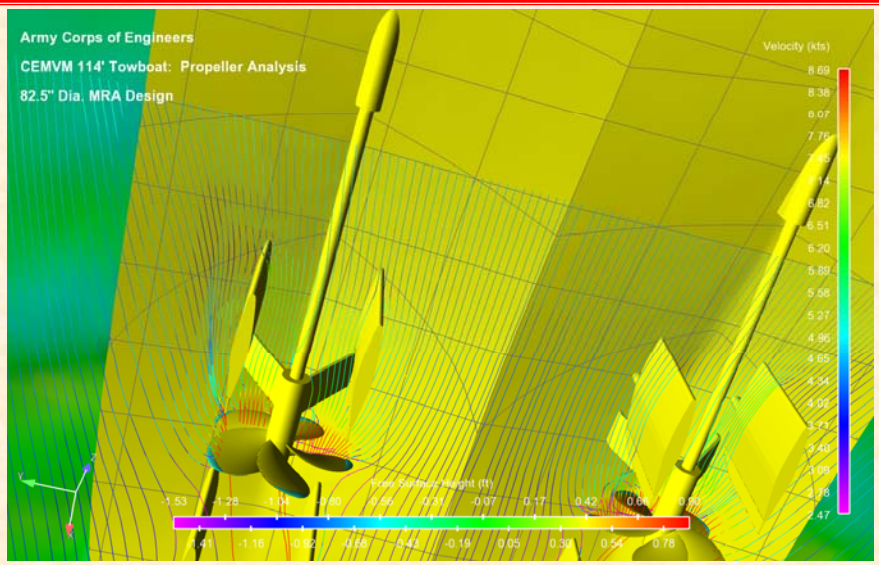

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CFD DESIGN FOR VESSEL SPECIFIC WAKE ADAPTED PROPELLERS

•Recent advances in Computational Fluid Dynamics have provided the capability to conduct hydrodynamic analyses, with accuracy comparable to tank testing in some areas.

•The areas include the capability to determine flow lines around hull stern areas, into propellers.

•This capability also then allows the design of propellers with blade airfoil shape and pitch distribution specifically matched to individual hull propeller, rudder and strut configuration.

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CFD DESIGN FOR VESSEL SPECIFIC WAKE ADAPTED PROPELLERS (continued)

•As part of this process, hull pressure pulses can be calculated, which allows propeller blade tip clearance to be selected from direct calculation instead of rule of thumb percentages.

•Current 5 and 6 axis computer controlled milling machinery provides the capability to manufacture propellers with blade shaped as determined by the CFD analysis.

•Corps of engineers has applied this process to towboat design. We will also use the same process to provide new propeller blades for the Wheeler, as part of the repower.

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CFD DESIGN FOR VESSEL SPECIFIC WAKE ADAPTED PROPELLERS (continued)

•This procedure will identify if the Wheeler propellers can be increased in diameter (reduced tip clearance).

•Overall we believe this process can result in efficiency improvements on the order of 2% if blade diameter is unchanged, and upwards of 5% if blade diameter can be increased.

•The cost for this evaluation is modest, and can be a reasonable step to take if new propellers or propeller blades are needed for normal wear or damage.

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CFD DESIGN FOR VESSEL SPECIFIC WAKE ADAPTED PROPELLERS (continued)

•POC for the CFD analysis is:

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Principal Research Scientist
Maritime Research Associates, L.L.C.
202 East Ann Street
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DREDGE HULL RESISTANCE IMPROVEMENTS

•Commonly thought that bow bulb retrofit to existing vessels will not provide sufficient resistance reduction to justify the installation cost.

•Retrofit bow bulb was evaluated for ESSAYONS as part of an ERDC study on ship squat in confined waterways.

•The retrofit bow bulb shape was optimized by Friendship Systems. (www.friendship-systems.com)

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DREDGE HULL RESISTANCE IMPROVEMENTS (continued)

•The existing bow and the retrofit bulb were tested in the towing tank at the US Naval Academy.

•The tank results showed overall average resistance reduction of 10% for the working time distribution between transiting, return hoppers empty, and to dump hoppers full.

•Shows that retrofit can work on existing hulls, and initial CFD evaluation can provide good results, at modest cost.

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TRANSOM PLATFORM SILENCERS

•On smaller boats with large engines, silencers often take up considerable room in the engine space. Maintenance is made harder from the need to work around the silencers.

•Many small boats, especially if powered by Waterjets, have transom or diver's platforms.

•The pictures show transom platforms that were built into boxes, and internally fitted with baffles and acoustic resonator perforations to function as wet exhaust silencers.

•These have the advantage of getting the silencers out from the engine room, and freeing up space around the engines and jets.

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TRANSOM PLATFORM SILENCERS (continued)

•Space is then made available for better working room, or for added exhaust components such as exhaust after-treatments.

•Silencer performance is as good as the best stock wet exhaust silencers.

•This silencer would not be applicable to most dredges, but could be applicable to many dredging auxiliary boats.

•The silencer designer, Joe Sullivan of Sullivan Consulting Services, Linden, Indiana is an excellent resource for any type of silencer design – which may find applicability on dredges or dredging support vessels.