PLAN FOR NATIONAL IMPLEMENTATION OF SILENT INSPECTOR

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ABSTRACT

The evolution of the Silent Inspector (SI) into a Corps wide dredging quality assurance system is described. Adoption has been nationally mandated to include all hopper dredges and dump scows. Regulatory dredging also requires implementation so that *always on* monitoring can be assumed. The Corps has partnered with the dredging industry to develop national standards for automated reporting.

Keywords: Silent inspector, quality assurance, dredge monitoring, dredge instrumentation

INTRODUCTION

This paper discusses the Corps deployment of a dredging quality assurance system based on the technologies currently known as the Silent Inspector. The system is comprised of standardized functional specifications that are included in dredging contracts; computer based tools that automatically acquire, analyze, and archive Quality Assurance (QA) data; and business processes that deploy, maintain, and assist QA functions.

The paper provides information on the next phase of the deployment by documenting the present status and changes in the technical and business processes to support Corps goals.

Based on adoption rate (Figure 1) the *SI* has reached an inflexion point in diffusion within the Corps organization. Assuming the S-shaped adoption curve of E. M. Rodgers (Rodgers, 1995) the technology is poised for rapid diffusion.

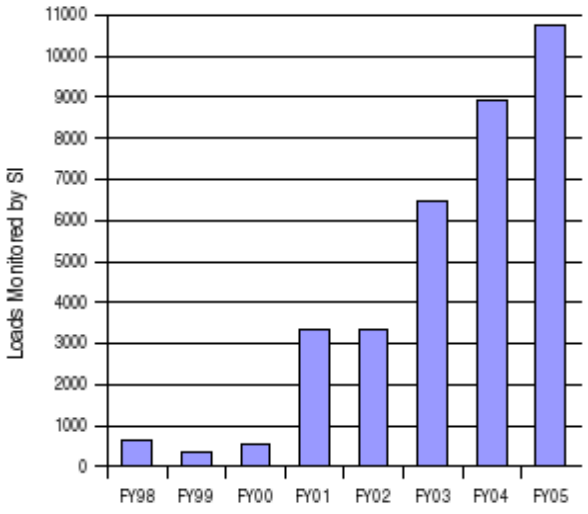

Figure 1. Number of loads monitored by SI.

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Managing this transition effectively will determine the extent that the Corps realizes potential benefits.

The Corps R&D community developed the SI in close coordination with innovators and early adopters in Corps districts.

Because of this origin the adoption mechanism has been optional by district opinion leaders or collective-consensual (Rodgers 1995) by district dredging teams. Today, operations personnel face increased pressures due to staff shortages and environmental constraints. There is increased awareness of the *SI* capabilities from network effects of the early adopters. New adopters questioned the optional adoption strategy and stimulated the decision to transition to mandated adoption by the organization. The Corps Director of Civil Works recently authorized nation wide deployment and enhancement of operationally ready components of the SI system.

BACKGROUND

History of SI

1986 Robert Hopman publishes the original concept of the Silent Inspector. (Hopman 1986).
1989 *SI* development started under the Dredging Research Program.
1990 The *SI* requirements analysis report published (Beeman 1990).
1992 The hopper system initial operating capability was demonstrated on the Essayons.
1995 *SI* user and technical manuals were published by the DRP.
1998 The Dredging Operations Environmental Research (DOER) Program funded development of the *SI* for Pipeline dredges and extending the hopper dredge *SI* for further investigation of the Tons Dry Solids method of payment.
1998 Process Action Team of Corps and Industry formed to discuss implementation of the SI
1999 First use of the Hopper *SI* on a contractor hopper dredge (Mobile District)
1999 Demonstration of the Pipeline dredge *SI* initial capability on the Government pipeline dredge William A. Thompson.
2001 Hopper *SI* first used in New Orleans District (Howell and Clark 2002)
2002 Hopper *SI* first used in Portland District
2003 *SI* scow system demonstrated at Wilmington Harbor.
2003 Hopper *SI* used on Essayons on a full time basis.
2004 *SI* used in Jacksonville District
2005 *SI* scow system first used as a contractor requirement by Seattle District
2005 SI hopper use mandated for South Atlantic Division
2006 National Implementation Directive

Technical Description

The SI is an automated dredge contract monitoring system comprised of both hardware and software developed by the Corps of Engineers. The Corps developed the *SI* as a low cost, repeatable, impartial system for automated dredge monitoring.

The hopper, scow and pipeline dredge *SI* systems integrate various automated systems to record digital dredging and disposal activities for both government-owned and contract dredges. These systems collect and record measurements from shipboard sensors, calculate the dredging activities, and display this information using standard reports and graphical displays. The hopper and pipeline SI systems have three major computer components: the Dredge Specific System (DSS), the Ship Server and the Shore System. These components and their functions are described as follows:

- Dredging contractors use computer-based systems for positioning and control of their dredge. These systems comprise the *SI* DSS. The DSS collects various dredge sensor data, and formats and displays these data to the dredge crew to provide quality control of the dredging project.

- The DSS sends data in near real-time to the Ship Server (in a standard format). The Ship Server is another computer on the dredge loaded with Corps *SI* software. The Ship Server then performs tasks that include automated review of data for quality assurance, data archival, report generation, and graphical displays of data. The Ship Server system is not used for scow implementations.

- The Shore System provides the same functionality as the Ship Server, but has greater data storage and data reporting capabilities. Data (which may include daily reports) are taken from dredges either by wireless data link or magnetic media and are archived on the Shore System.

The DSS and all shipboard sensors are the property of the contractor, who is required to maintain them. The contractor purchases the Ship Server computer hardware for the Corps, and the Corps installs *SI* software on the Ship Server computer. The Shore System consists of Corps supplied hardware and software. The Corps *SI* software on the Ship Server is similar for both hopper and pipeline *SI* systems. Both hopper and pipeline dredge *SI* systems monitor dredge position and dredge state, and report (Figure 2) and manage these data for Corps dredging contracts. However, each system collects data and computes measurements specific to each dredging type. Additionally, the hopper dredge *SI* system computes Tons Dry Solids (TDS).

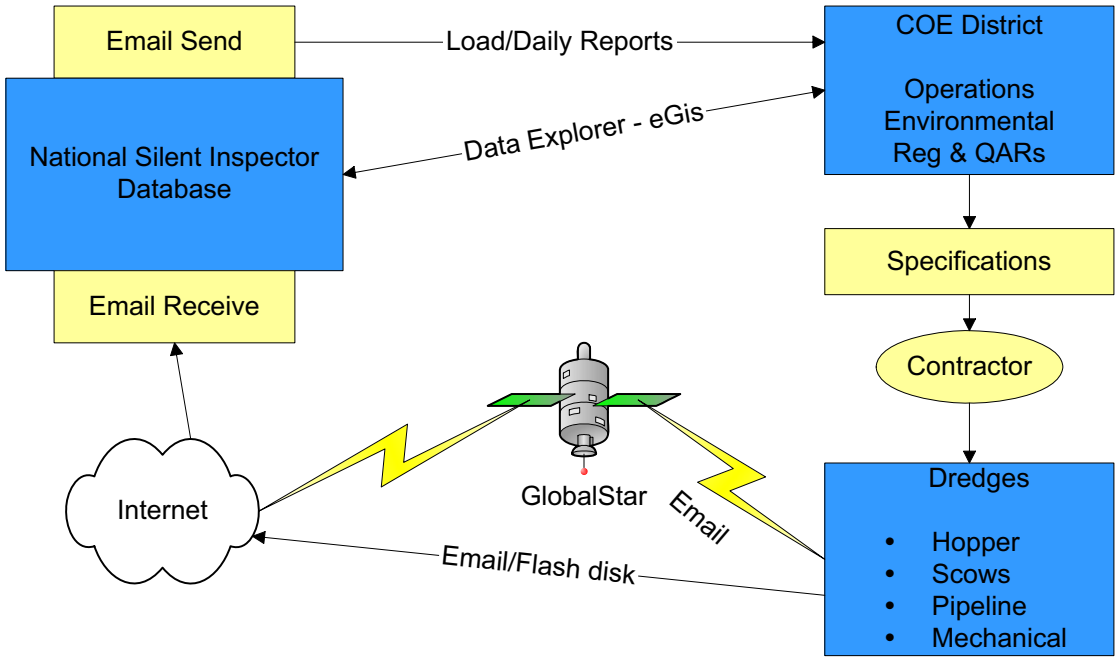

Figure 2. SI data flow description.

Organization Mission

To provide Corps-wide technical support of dredging through automated tools and services and to evolve these capabilities to meet our growing needs. Operational support includes tools and services to assimilate, analyze, and report dredging quality assurance data at the national, watershed, and project levels. Evolution of these capabilities includes developing, integrating, and diffusing dredging data and decision support tools and services throughout the Corps.

Organization Concept

"The national dredging technical support team will be dual role with operations and R&D components. The team will be based in Mobile district as the Decision Support section of the Spatial Data Branch of the Mobile District Operations division. The team will continue the support and diffusion of dredging technologies developed under the

DOER program of the Corps Engineer Research and Development Center (ERDC). These are technologies developed by ERDC in close coordination with District Operations Divisions, but that have reached a level of development such that their operation is no longer R&D. They include the hopper dredge Silent Inspector and related dredging quality assurance tools. The team will have an R&D role to continue development of the tools and to apply them to the solution of other R&D problems such as dredging optimization, dredge material management, and regional sediment management. To perform its dual roles, the organization will require multidisciplinary activities and specialists in Operations, IT, and R&D. The organizational concept is a team made up of district and division subject matter experts, Mobile District staff, and ERDC staff. A board of directors made up of District, Division, and Corps Headquarters representatives will set goals, priorities, and monitor performance.

The Mobile District will operate the national infrastructure of the Silent Inspector and dredging quality assurance tools in support of the goal of nationwide always-on operation. "Always on" means that all contractor and government dredges will be monitored for all dredging projects. These include regulatory jobs performed for non-Corps clients. The implementation is time-phased beginning with hopper and bucket contracts followed by pipeline dredges.

NATIONAL MANDATED IMPLEMENTATION

The USACE Director of Civil Works recently authorized nation wide deployment and enhancement of operationally ready components of the SI system. For the Corps to reap the full benefits from the *SI* technology is mandated to all hopper and scow dredging in the US.

These include direct benefits in personnel savings as well as important indirect benefits such as the availability of dredging data to operations, planning, and regional business centers. Previous SI experience by some COE Districts resulted in diffusion and application to those Districts that have both visible benefits and the necessary opinion leaders and change agents. The obstacle to adoption for other districts occurs because of the organizational disconnect between the potential beneficiaries and the potential change agents. For adoption to proceed the Corps raised the adoption decision to the level that can address both benefits and change requirements by a directive for mandated adoption at the national level.

Reduced Administrative Overhead - Standard Performance Specification

A major impediment to *SI* deployment is implementing the system on a per-contract basis. The administrative overhead for the districts, *SI* support, and the contractors is reduced when *SI* operation is administered by dredge rather than by each District and contract. A single performance based specification is attractive to contractors who do not have to change their reporting on a contract-by-contract basis as they travel between Districts. The dredge certification mechanism allows the dredges to show they are compliant with the SI specifications.

Always on Benefits

If a District could assume that all hopper dredges and scows always had an operational *SI* system they could realize more of the potential benefits. Direct benefits would include the use of the system for short duration contracts. Dredge swapping by contractors during the course of a contract would have no effect on monitoring plans. Short contracts benefit from reduced inspection costs if *SI* is always available. Though many dredging districts use pay-by-survey, the other benefits of digital data storage, enterprise tools, T&E species monitoring, and dredge management optimization would accrue.

RSM and DMMP Data

New management requirements such as Regional Sediment Management (RSM) and Dredge Material Management Planning (DMMP) have developed dredge data requirements beyond the traditional contract QA and payment requirements. For the Corps to manage its sediment resources objectively, digital data on the source and disposition of sediments during dredging is imperative. These requirements could be met by always-on *SI* operation on hopper dredges and mandatory minimum monitoring of dump scows and in the future pipeline discharges where needed.

Threatened and Endangered Species Response

Part of the Corps response to Threatened and Endangered (T&E) species protection could be met by use of simple additions to *SI* capability. First, turtle monitor reports would benefit from the existing database and real-time communications infrastructure provided by the *SI* computer on board hopper dredges. By storing the reports as additional fields in the *SI* database, environmental experts would have access to all of the other spatial, temporal, and operational context associated with T&E incidents. This context data is invaluable in helping the expert recommend an operational response. This capability is currently undergoing testing by endangered species observers. Second, the Corps and contractors could work together to develop turtle safe operating procedures. *SI* monitoring of these procedures could be used for both a real-time and post-load management. Monitoring provides resource agencies confidence that procedures will be followed.

CURRENT STATUS

Hopper Dredges

12 of 16 active contractor hopper dredges have *SI* installed. The data required from contractors have been stable for nearly three years.

Hopper Dredge Certification

To assure that dredges are compliant with the SI specifications, a certification process has been implemented. First, the contractor submits a Dredge Plant Instrumentation Plan (DPIP) to document how the contractor collects the dredge data, the physical dimensions of the dredge, and how quality control is preformed. Then the Corps or their duly authorized representative conducts quality assurance checks on at least a yearly basis to assure that the data are reported properly. Based on the DPIP and QA check information, a certificate is issued to the dredging contractor that is transportable between jobs and Corps Districts.

Nine contractor dredges have been certified to conform to the *SI* specifications. Of the 4 reserve fleet hopper dredges, only the *Essayons* has *SI* certification.

Dump Scows

Dump scow specifications and implementation are complete. There have been successful test deployments at Wilmington and Jacksonville Districts. The scow implementation was developed with functional requirements to permit competitive multi-source implementations for dredge contractors. The dredging contractors and their instrumentation suppliers broadly support it because, in their view, it would allow them to develop and maintain their own systems and use the same system nation wide.

A successful project deployment used a contract vendor for the Seattle district's Pacific Sound Resources project sponsored by the Environmental Protection Agency.

Pipeline Dredge Deployment

Pipeline dredge SI deployment has lagged hopper dredges. The technology, implementation, and specifications are available. The new COE dredge *Goetz* has *SI* in its construction specifications.

Interface with District contract Management Business Process

The district POC is either in the Technical Services Branch, Operations Division or the dredging operations managers or similar organizational roles. In practice the *SI* support personnel interface with plans and spec writers, resident engineers, project engineers, and quality assurance representatives (QARs) formerly known as dredge inspectors.

SCHEDULE

The contractor dredges will be SI certified as they work on jobs with SI specs. Recertification will be on yearly basis. Table 1 describes the implementation schedule.

Table 1. SI implementation schedule.

FY	2006	2006	2008	2009
Hopper	Always-on	Always-on	Always-on	Always-on
Scow	Always-on	Always-on	Always-on	Always-on
Pipeline	Goetz, Oregon	2 – > 30in	All > 30″	All > 18″
Mechanical	TBD	TBD	TBD	TBD

IMPLEMENTATION GOALS

Enable a Bigger Market for Instrumentation Contractors

A larger market for instrumentation services should allow for greater choice of instrumentation options and competion between vendors. Reduced instrumentation costs for dredging contractors should help reduce dredging costs.

Performance Based

Wherever possible the specifications describe only the data to be provided by contractor. The means and methods to acquire the data are left up to the contractor. This enables minimum cost implementations especially for dump scows.

Provide Standards

The SI guide specifications provide standards for dredge monitoring. The most important of these standards is the data transfer standard, which varies by dredge type. The use of eXtensible Markup Language (XML) based standards allows for additional capabilities while retaining basic functionality. Standards regarding dredge system documentation and QA procedures are also enabled by the SI.

Enable Good Environmental Stewardship

Further enhancement of SI is aimed towards addressing critical and urgent problems and needs of end-users, which are impediments to performing channel maintenance dredging at present, and are growing with time. Key problems are the lack of comprehensive and consistent nation-wide operational QA/QC and associated documentation practices of: (1) advanced maintenance and over depth dredging, (2) dredged materials disposal at designated sites, and (3) threatened and endangered species conservation and protection.

Regulatory agencies have placed great importance on these issues in recent years, demanding establishment of: (1) consistent practices nation wide, (2) real-time accountability/reporting of actions, and (3) real-time execution of corrective measures. Without rapid action by the Corps to address these problems, critical channel maintenance dredging has and will continue to be halted by regulatory agencies at the detriment of the nation's navigation movements. Due to the close tie between national and international economics and reliable flows of waterborne commerce, navigation interests urge the Corps immediately enact measures that resolve these problems.

RESEARCH AND DEVELOPMENT

The *SI* system is a mature technology for hopper dredges so a legitimate question is what if any R&D is required. Examining the history of the *SI* (see Background), the system has evolved from the original concept of a hopper dredge data logger into a comprehensive dredging QA system. The original design implementation for hopper

dredges has been stable for more than 5 years. Additional functionality and systems have grown up around it. The system has been extended to dump scows and pipeline dredges. The *SI* moniker has come to describe the combination of several distinct systems that work together to provide comprehensive management of dredge contracts. The others are applications of the data or use of the system to solve specialized business process problems. Here are some of the R&D issues that are being addressed.

Interface to Regional Sediment Management Business Process

The *SI* database is organized temporally. It models the progress of a dredging contract from award to payment. From an RSM and DMMP view it contains valuable information about the quantities of sediment dredged and placed. To best use this information it must be integrated spatially with survey data and project boundaries. To meet this need the SAM/SAD developed eGIS/eCoastal spatial database connection with the *SI* database. Users can make maps that show both dredged and placement volumes superimposed on bathymetric volume differences derived from surveys. Future R&D should yield powerful tools that will help make regional sediment management more quantitative.

Interface to Decision Support

The Dredge Operations Decision Support System (DODSS) is an effort to develop a high level system that can analyze past and present data to make recommendations to dredge operations managers. It will connect to the *SI* database and perform analyses that are too time-consuming and repetitive for human managers or their staffs. It can also integrate the temporal data with survey data and historical weather and climate data. Support of DODSS is explicitly mentioned in the paperwork supporting this transition.

Monitoring Environmental Constraints on Dredge Operations

More Districts are under severe constraints from environmental resource agencies that restrict the location and depths that they dredge and place material. The Portland district requested that *SI* be enhanced to provide real-time alarms and archival logging of drag-head position outside of pre-configured boundaries and depths. Recently T&E experts have requested that similar monitoring of operations in turtle and other T&E sensitive channels. Also human turtle monitor reporting could benefit from the existing *SI* infrastructure on hopper dredges to transmit and store their incident reports. The objective is to provide quantitative support for negotiations with resource agencies and potentially avoid unnecessary operational constraints.

Paperwork Reduction

The original *SI* database design was oriented around the recording of data from the dredge and providing reports to the QARs. As Districts deal with increasing personnel shortages, they would like to eliminate steps in the flow of paperwork required for the existing contract monitoring business process. Using principles of PMBP the *SI* data explorer and database can evolve into a workflow automation system that will both save time and capture more business data.

Data Archive

The *SI* database is an enterprise system that holds all dredge data nationwide. It automatically stores data acquired from the on-dredge *SI* systems, but years of older dredge data remains in various formats spread around districts and project offices. Loading historical data is costly, but R&D can help achieve consensus standards and develop common tools that will reduce the cost of populating the database.

Production Payment

Providing objective data that could form the basis of a production payment contract was an early goal of the *SI*. The system has a proven ability to measure Tons Dry Solids (TDS)(Welp and Rosati, 2000). Implementing a production payment system requires business and contractual changes that so far have not been risked for existing contracts. In spite of this, districts with large rental contracts have established goals to evaluate production payment contracts and are actively working to resolve the outstanding issues. The current business process addresses technical issues but so far has been ineffective in addressing all the issues.

CONCLUSION

The Silent Inspector National implementation is a public-private partnership between the Corps of Engineers, the dredging industry, and stakeholders at the local, state, and federal level. "Full implementation will provide continuous accountability of our dredging operations for contractual and environmental stewardship" (Riley, 2006). Nationwide data standards will enhance competitive opportunities for instrumentation and dredge monitoring software. Data from the system will be used to better manage dredging from business processes to environmental sustainability.

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