DEVELOPMENT OF A WATER MANAGEMENT SYSTEM TO IMPROVE MANAGEMENT AND SCHEDULING OF WATER ORDERS IN IMPERIAL IRRIGATION DISTRICT

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ABSTRACT

Over the last decade, distribution system operations at Imperial Irrigation District (IID) have evolved, driven by internal water-user needs and external pressures to conserve water. The result is increasing flexibility in deliveries to water users. However, associated distribution system operations have resulted in fluctuating water levels, varying delivery flows, increasing canal over toppings and other issues – leading to the need for fine-tuning of the ordering, tracking, and delivery processes.

IID's goal is to manage water flowing from the Colorado River to the delivery gate in a single, integrated environment. Presently, management of water from the river to the farms is performed by series of processes that are part digital and part paper. While the system works well relative to current needs, system improvement and integration is needed to facilitate higher levels of service and efficiency and to meet increasing requirements for operational flexibility. This improved system is referred to as the Water Management System (WMS).

This paper provides an overview of the functional requirements for the WMS, the anticipated software and hardware architecture, and the process that will be used to ensure IID staff's full ownership of the system.

INTRODUCTION

IID needs a more clearly defined and responsive water operations environment that allows effective management of the water from the river to the farm gate. This will require the ability to integrate water user, lateral operations, main canal operations and river operations within one information management system.

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Water users have also indicated the need for a user-friendly tool that allows on-farm irrigation scheduling and the placing of water orders directly with the IID. Additionally water users want to be able to track the status of their orders, charges to the delivery gate and historic water use with an easy-to-access and operate interface. This improved system is referred to as the Water Management System (WMS).

The WMS must be able to allow IID staff to efficiently receive orders from farmers, schedule deliveries based upon orders, crop types, water supplies and delivery capacity, and compute appropriate delivery charges based upon field data obtained by Zanjeros[5].

In addition, the plans are for the WMS to eventually allow farmers the flexibility to directly place orders over the Internet, rather than call or walk-in orders to IID Division offices.

The WMS will be implemented in four distinct phases, one of which will be developed immediately:

1. Water Order Entry Migration[6]

As operations and needs become more defined during implementation and initial operations of the first phase, three other phases will subsequently be implemented:

2. System Management Integration
3. Water Conservation Issues
4. Customer Service Improvements

To understand the needs of the WMS, an initial effort was initiated to define functional requirements for Phase 1 and to define the supporting software and hardware needs.

USE-CASE SPECIFICATIONS

The following section provides an overview of the intended functional requirements to be created during Phase 1 of the WMS implementation. The sampling of "use cases" listed in Table 1 include the functional task and the "actor", or intended user of the system. Thirty use-cases were defined for

[5] A Zanjero is an IID employee tasked with opening and closing gates to deliver ordered quantities of water to IID customers.
[6] As of the writing of this conference paper, IID is initiating contracts for the first implementation phase. Completion is expected in mid 2005.

implementation during Phase 1. Use-cases are the core building blocks of the WMS, and will be built upon during the latter implementation phases.

Table 1. Sampling of Use-Cases to be Implemented

Category/Ref. No.	Task	Actor(s)
Water Order Scheduling and Recording		
C001	Create/Change/Display Customer Water Order	Division Coordinator
C002	Schedule (line up) Water Order with Pre/Final Allotments	Division Coordinator
C009	Submit to WCC Estimated Orders for Master Order	Division Coordinator
C010	Enter yesterday's tailwater measurements	Zanjero/Hydrographer
Main Canal Operations (Water Control Center)		
M003	Develop/Adjust Main Canal Scheduling Plan	Dispatcher
M005	Create Hydrographer Lateral Heading Run Sheet	Dispatcher/Hydrographer
M007	Reports from Daily Water Record (DWR)	Dispatcher
Lateral Operations (Division)		
L001	Set/Change canal reach capacity limits (provide warnings)	Division Coordinator
General Administrative Functions		
G001	Display Tenant and Owner Information	All
G002	Create/Change/Display Crop Master List	Delivery Analyst
G004	QA/QC and Migrate Record to Water Information System (WIS)	System
G005	Create regular crop reports	Delivery Analyst
G008	Information Queries and Reports	All
G011	Canal Cut Out Notification	Dispatcher/Division Coordinator

Use-cases capture requirements as they are first identified and are used to update requirements as they change. Each of the 29 use-cases has been detailed using a combination of text and graphics to articulate its functional requirements. These details allow the intended actor to check that the appropriate functionality is being addressed, and act as instructions for use by programmers when writing the actual software code. Details developed for each use-case primarily included:

1. A listing of preconditions – the state of the system that must be present prior to a use case being performed, i.e. the Water User placing an order must not have a delinquent account, and necessary details for a water order must have been provided
2. A brief description – an overview of the use-case that can be quickly reviewed to understand the intended functionality
3. Detailed description – explicit details indicating the steps of the use-case and the associated data. Graphic "process flow" and "data flow" diagrams were also created. These diagrams schematically depict the functional process for a use-case and the accompanying vital data (see Figure 1 for a sample process flow diagram).

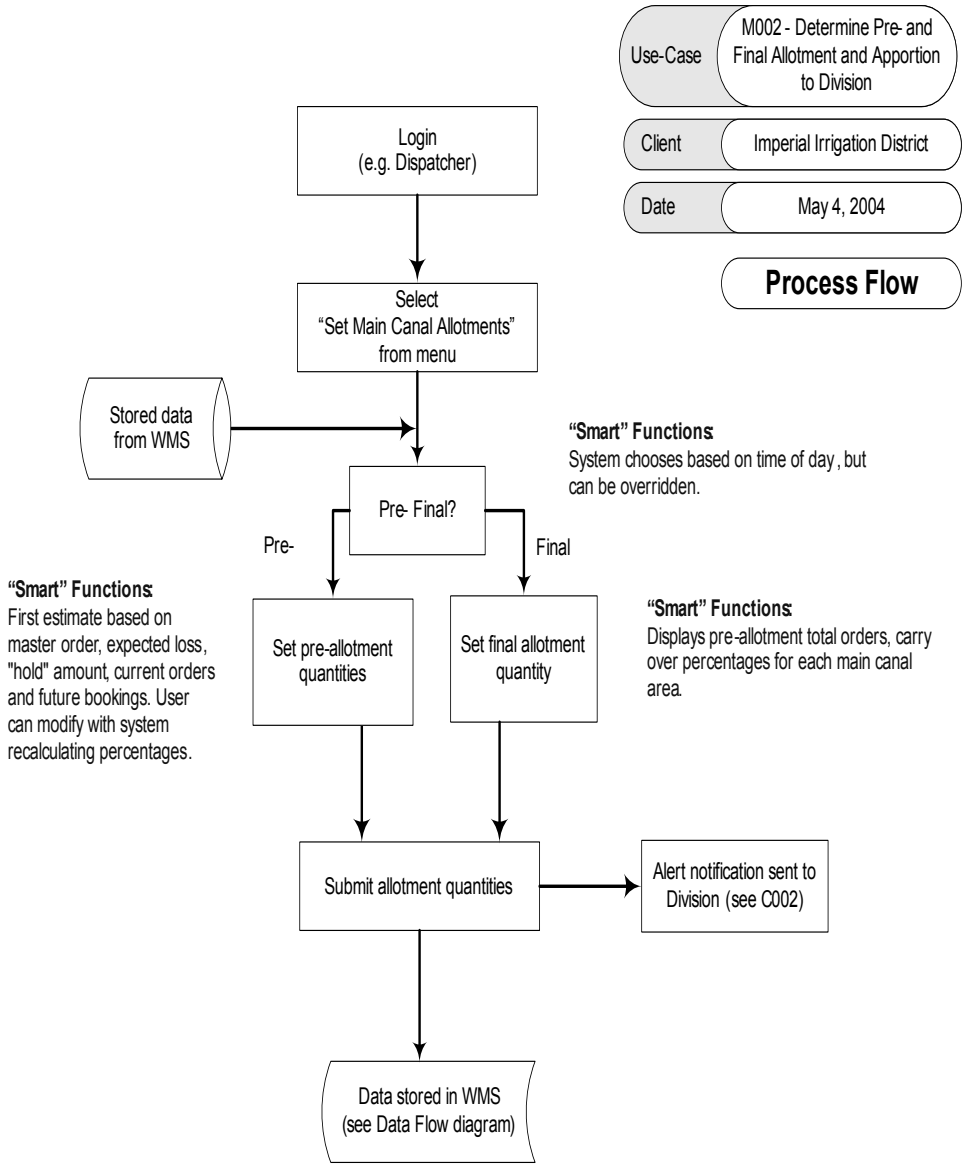

Figure 1. Sample Use-Case Process Flow Diagram

PROPOSED TECHNICAL SOLUTION

IID currently operates a custom water order entry program within its SAP[7] enterprise solution, along with many spreadsheets and hand-recorded paper tables. The main objective of the project is to migrate the current Water Order Entry functionality running on SAP to the WMS, adding certain enhancements identified by the Water Department and automating paper dispatching. The target solution will also host other functional requirements that will be implemented during Phase 2-4.

The WMS will be a fully web-based application; IID staff – and in the future, IID customers – will access it using their browsers. In parallel they will be able to access other IID applications (SAP, etc) using those current interfaces. One of the major constraints and a requirement of the project is to keep the billing functionalities on SAP; hence the proposed technical solution for WMS is based on a scenario requiring the integration of WMS with SAP R/3.

Overview of the solution

Figure 2 describes the two main components of the solutions:

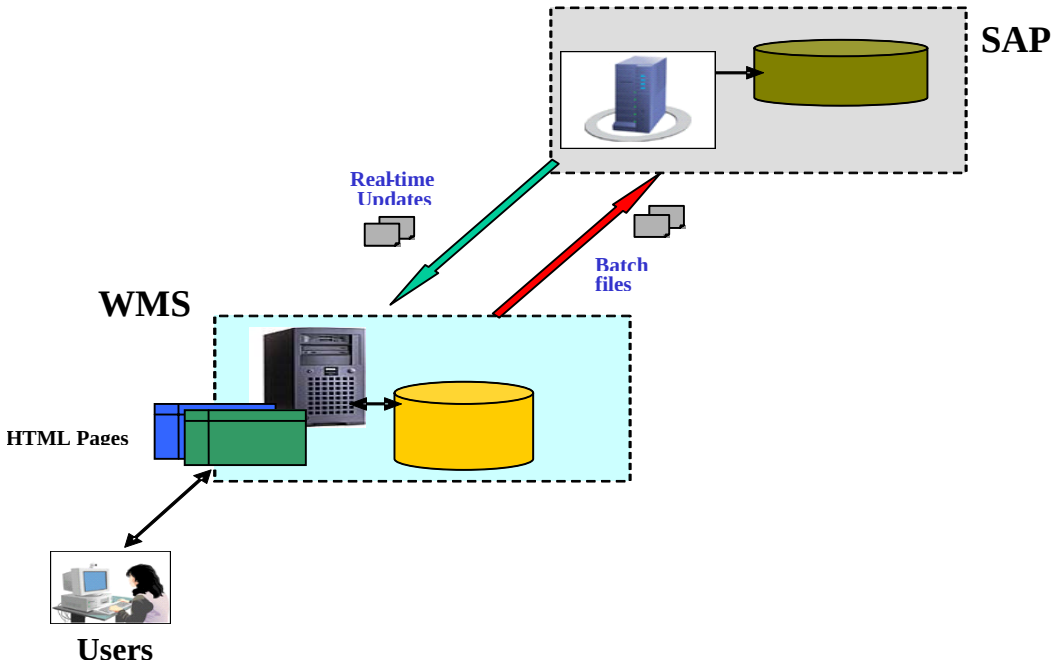

Figure 2. Primary Components of the WMS Information Architecture

[7] SAP AG (NYSE: SAP) is a leading provider of inter-enterprise solutions. IID's financial and other business functions are built within the SAP solutions.

WMS will allow water users to perform all the operations specified in the use-cases included in Table 1. The WMS will store data in its own repository, which will need to contain all the data required to perform the necessary water operations. For the WMS to perform the water operations, however, real-time data is required from SAP. This data transfer from SAP to the WMS is mandatory to allow creation of an order within the WMS that can subsequently be submitted back to the SAP system to perform billing, invoicing, and payments services.

Interfacing from SAP to WMS: SAP will remain the referential database for the data shown in Table 2. This data is required in real-time on the WMS repository to allow water operations. At the end of each SAP update-transaction, a file containing the updates will be generated. This file will be transmitted to WMS (via ftp); the reception of these files on WMS will trigger a Java program that will update the data on the WMS data repository.

Optimized versions of this transmission mechanism will be defined during the development phase. These will allow the transmission of several concurrent updates and also define the procedure in case of SAP or WMS downtime.

Table 2. High-level data transfer requirements from SAP to WMS

Data Type	Data	Transactions	Transmission
Master data	Tenant & Owner Contract accounts Plots	Create / Change / Retirement / Delete	Real-time
Notifications	Maintenance Notifications	Create / Change / Delete	Real-time
Delinquency	Delinquency status Blocked orders	Change	Real-time
Other ….			

Interfacing from WMS to SAP: The primary water operations functions (see Table 1) will be performed on the WMS. However, specific data (Table 3) generated by the WMS application is required by SAP in order to perform billing, invoicing and payment operations. This data is shown in Table 3.

SAP billing is a batch activity (completed once a month), so the need for data is not real-time. Based on discussions with IID staff, transferring this data once a day is recommended. During the development phase, this recommendation will be reviewed and revised if necessary or if a different frequency is found to be optimal (to reduce the buffering of changes and thus, limit the impact of downtime data handling on SAP). The updates will be transmitted from WMS to SAP in a batch file that will be mapped to the appropriate SAP elements to directly update the data on SAP.

Optimized versions of this transmission mechanism will de defined during development phase to potentially handle the transmission of several updates and also to accommodate potential SAP downtime.

Table 3. High-level data transfer requirements from WMS to SAP

Data type	Data	Transactions	Transmission
Orders	Water Orders Periodic Contracts Credit debit memo Prorated orders	Create / Change / Delete / Confirm	Daily batch file from WMS
Deliveries	Deliveries Zanjero charges Carry Over Good Issues	Change / Charge / Confirmation / Delete / Cancel	Daily batch file from WMS
Crop Maintenance	Crop allocation	Changes	Daily batch file from WMS
Other ……			

IID STAFF ACCEPTANCE

The successful implementation of the WMS is fully dependent on the acceptance of the application by those that must use it on a daily basis. To this end, the development of the use-cases and the proposed software and hardware solution have been grounded in a user-intensive, iterative approach referred to as the *Rational Unified Process* (RUP). The RUP has a "bottoms-up" orientation that focuses on the perspectives and tasks of each WMS user.

This approach ensures that every solution is designed to meet the needs of IID's users, rather than forcing IID's functions into pre-packaged solutions and applications. The RUP affectively forces the development of an application to undergo iterations – thus recognizing that a solution cannot be fully defined at the beginning of a project and must undergo refinement throughout the process. Figure 3 depicts the general structure of the RUP.

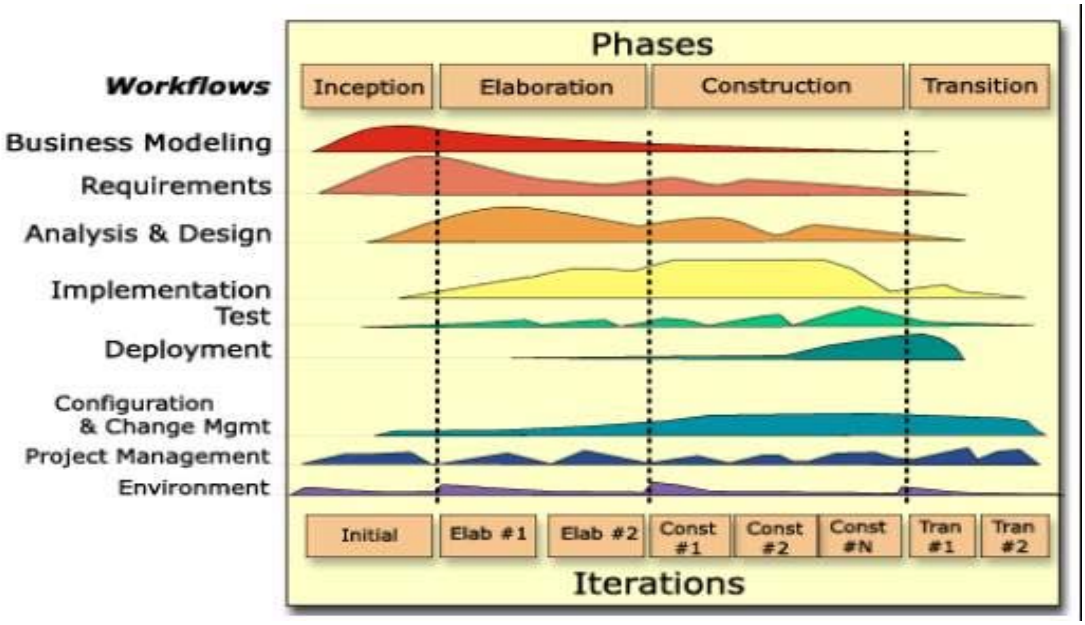

Figure 3. Graphic Representation of the Rational Unified Process

Several user committees will be formed by IID to interact with the WMS development team as required by the RUP. For the Phase 1 implementation, focused committees will be formed for:

1. Growers
2. Zanjeros
3. Water Division Coordinators
4. Assistant Superintendents for Water Operations
5. Water Control Center Dispatchers
6. Management

The cornerstone to successfully achieving ownership by the staff at IID will be the combination of face-to-face user committee meetings and a project web site to test user interfaces.

CONCLUSION

Once implemented, the WMS will improve IID's ability to meet the changing needs of its delivery system and its customers while increasing the efficiency of data management. The key to the successful WMS implementation is ultimately the acceptance of the IID staff who will use the system to perform their everyday tasks more efficiency and effectively. For the WMS to successfully enhance the

performance of IID staff, their involvement and acceptance of the application is critical. The development team sincerely believes that listening to the experiences of IID staff and involving them in the development of the interfaces and routines that they will be using will result in an improved long-term return on investment. Achieving the efficiencies desired will require IID staff to abandon the paper parts of their system and move to a fully integrated digital system. This in turn requires that the IID staff have complete confidence in the digital system to perform the required functions quickly and accurately.

This underscores the importance of the RUP process implemented through the user committees to (1) develop the user committee trust in the development team and the application, and (2) to employ these committee members as the application "sales persons" throughout IID.

All too often these projects fail due to the lack of confidence in the application by the staff that will use the application. IID is to be commended for the foresight to embrace a development team and process that involves the IID staff in the interface development.