INSTALLING "OFF THE SHELF" SURVEYING SYSTEMS

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INTRODUCTION

Between deciding to acquire an automated surveying system and actually seeing such the device installed and working there are many things that can go wrong. This paper reviews the experience of the UK Royal Naval Hydrographic Service in installing Survey Information Processing Systems (SIPS) in its coastal survey vessels and shore establishments. "Off the shelf" commercial equipment was used to avoid the expense of a bespoke system development programme. Competitive tendering was employed as the means of selecting a system.

Three main stages in the life of a project are considered: defining the user's requirement, examining the claims made by manufacturers for their systems, and dealing with the problems that occur once a system is finally set to work.

It should be noted that the views in this paper are based on the author's own experience, and should not be taken to represent official UK Ministry of Defence procurement policy.

STAGE 1 - ESTABLISHING THE REQUIREMENT

Before considering what features are required in an automated surveying system, it is vital to know what is available on the market. Without this knowledge, the system specifier is ignorant of new capabilities and risks asking for impossible or very expensive features. As many systems as possible should be seen in use and operators asked for their opinions on how these systems perform.

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Scope and Purpose

In defining the scope and purpose of the system, many suggestions will need to be examined for their affordability, practicality and necessity. Also, it should be noted that when the system is delivered, the users will expect it to meet their current needs rather than the original specification.

Technicalities

There are many technical issues to be addressed, which have been comprehensively reviewed elsewhere (WEEKS, 1981). These include:

- The timings of the various data inputs need to be handled correctly. Lines of position and other sensor information are not all received at the same time, and thus refer to different positions on the ground. When operating at large scale or at high speed, this may significantly affect the accuracy of the results.
- The system should process input data at least as fast as it is received. There must be no possibility that data, possibly referring to a shoal peak, could be overwritten in the echo sounder interface buffer before being processed.
- The accuracy at which the various geodetic parameters should be held, used in processing, and displayed should be stated. The requirements for handling pitch, roll and laybacks also need to be clearly set out.
- The system should provide alarms and warnings that are equal to the complexity of the processing algorithms. The user must be able to understand how computations are actually carried out, else he or she may be forced to treat the system as a "black box".
- Data editing requirements to cope with real situations should be specified. A simple ability to insert or delete data may not be sufficient, especially if recomputation from raw data is required.
- Interfaces between the system itself and other items of equipment must be specified properly. If this is not done, responsibility for any problems will be unclear and the user will pick up the bill.
- Any requirement to supply data to other computers needs to be stated. Output files should clearly identify any invalid data that has been deselected during editing.

Writing the Specification

The specification should focus on the functions that the system is to perform, and avoid describing any particular manufacturer's current model. Even such a functional specification can be lengthy, some 200 pages being required for the Royal Navy's SIPS-2 multi-user system.

Among the points to be borne in mind are:

- Mandatory items that are essential to the proper working of the system should be clearly distinguished from those that are not essential, but are nevertheless desirable.
- Performance criteria should be stated, otherwise a manufacturer could supply software which carries out the required functions, but in an inefficient manner.
- Details of the vessel into which the system is to be fitted should be given, and whether the system is to be a permanent fit or should be transportable.
- The sizing of the system must cater for the maximum volumes of information to be encountered. This does not apply simply to the size of the survey in hand: the operators may be working up a second survey, and answering queries on a third.
- Trials requirements should be clearly stated. Factory trials should check that all components are present, including software functionality. Installation trials should test the fitting in the ship and links to other equipment. Sea trials should test all the functions that could not be tested on land, and include a trial survey.
- Target figures should be stated for the availability, reliability and maintainability (AR&M) of the system as a whole. Manufacturers should be asked to give figures for the Mean Time Between Failures (MTBF) and Mean Time to Repair (MTTR) for each component of the system.
- The amount of spares needed, both on board ship and back at base should be stated. Just where each type of repair is to be carried out should also be considered.
- List the consumables required, if these are to be supplied with the system.

Risks

It is important to be able to assess the risks associated with a particular manufacturer's system. Among the questions that need to be asked are:

- How much software will need to be created or modified?
- Has the system been proven in actual use - and by whom?
- Can the manufacturer cope with the cash flows entailed by the contract?
- Does the manufacturer have adequate quality control procedures, especially as regards software?
- Who are the manufacturer's key personnel? Do they have sufficient experience in this kind of system?

Checking the Specification

Ideally, the specification should be checked by someone who has not been closely involved, someone who can bring a fresh mind to the requirement. It is very easy to overlook important points, as well as matters of detail.

Once the specification is complete, an Invitation to Tender may be issued.

STAGE 2 - EVALUATING MANUFACTURERS' CLAIMS

The second stage in the exercise is to examine the tender responses. There are two main things to remember:

- Any claims made by a tenderer must be regarded as theoretical until no reasonable doubt remains;
- A fundamental change has taken place - the project is now being driven by what is on offer rather than by what is in the specification. Hopefully, if the original market survey was conducted properly, and the specification took its findings into account, then any differences should not be critical.

Marking the Proposals

If the specification was thought to be lengthy, then the tender proposals will seem positively frightening. The first task is simplify matters - it is not possible to examine every single sentence of every proposal, or the job would never be completed. So, there are some initial questions to ask before looking at the detail:

- Is the proposal affordable? If it is much outside the available budget, forget it. The chances are the tenderer has misread the specification, or has not asked questions where things were not clear.
- Does the proposal meet the functions indicated as mandatory? If it does not, forget it. The tenderer should have taken the project seriously.
- Are the risks (see above) associated with the proposed system too high? If they are, forget it. The project will otherwise end up in trouble later.

The surviving proposals are then assessed and marked to give an overall comparison of the systems on offer. When marking, read what is said carefully, bearing in mind that it is up to the tenderer to prove that his system can do the job, and every statement should be closely questioned. In particular, beware of:

- Ambiguity - a typical remark would be "the interface can accept all commonly used navaids". Does "commonly" include those that will actually be used?
- Obscure statements - if the answer cannot be understood, assume that the system does not meet the specification.
- Distractions - something pretty is offered instead of what was really requested.
- Omissions - assume that the tenderer does not want to discuss these areas. On no account assume an oversight.
- Vague promises such as "we will be pleased to discuss this area further". In practice this means that the tenderer will ask for more money.

Trials

After marking the proposals, there should be no more than two or three systems which are worth seeing demonstrated. This should take place at sea, as it is only there that it is possible to assess true performance.

When on trials, bear in mind that the tenderer will be aiming to impress. Typically, there are two key personnel in this exercise - a talkative sales representative who can distract attention while his assistant, the company's top computer expert, puts together a show which bears little resemblance to how the system works in real life. So, try to keep things simple, and note the following points:

• The things that will be shown without asking will be the system's good points and the prettiest displays, even if not required by the specification. Have a check list for all the important facilities.
• Prepare test data that can be used to evaluate system accuracy. Take sample output away for examination.
• A demonstration should be conducted smoothly, but not too quickly. Make time for awkward questions, especially when things seem to be going too well.
• Carry out cross-checks between different parts of the program, such as checking that a logged position plots in the right place.

Selecting a System

After assessing the results of the trials, it should be possible to select one system and go to contract. The contract may embody the tender proposal as the system definition, so take care to clarify any outstanding points before signing.

The signing of the contract may be a significant point in the overall project, but, as far as evaluation is concerned, things have not changed. Nothing else has been found out about the system's eventual likely performance, and this will largely remain so until the first outfit goes for its sea trials. Evaluation continues with more trials, tests and discussions with the chosen supplier.

The supplier is now "part of the team", and a good working relationship needs to be established. Generally, it is best to be open about as much as possible and encourage the supplier not to hide any difficulties that he may encounter.

More Trials

The most important document at this point is the trials schedule, which should be relied on to cover all matters of detail. Trials are typically as short as possible, and hence very intensive. Anything that can be done to relieve the pressure on the personnel monitoring the trials should be done, leaving them free to follow-up important problems.

A basic schedule of tests should be compiled from the functions referred to by the contract, taking care to combine the testing of as many functions as possible. If this is not done, then the trials will go on forever.

Additional tests may be needed to prove that the system works in the way it is intended to be used, including tests of links between systems. It will be impossible to exercise every route through the software, so make sure that the tests cover the sequences that will normally be used.

During trials, keep in mind the big question: "Can this system be taken to sea and used for surveying?" There will be all kinds of bugs detected, and numerous points that will require discussion with the suppliers. If the "big question" is not continually asked, then it is easy to get lost in the detail. By concentrating on this main question, the Royal Navy's permanently-fitted ship systems were put into operation without any major unexpected delay occurring. The initial versions of software did require some care in their use, but the major asset - the expensive survey ship - was not unduly affected and was able to resume surveying immediately on completion of post-refit trials.

STAGE 3 - IN-SERVICE TROUBLE-SHOOTING

At this point, a second fundamental change occurs. Only when the system actually goes into use is it really fully tested - with real volumes of data, with all the vagaries of shipboard life and, most importantly, with real users working unassisted.

It might be assumed that, given the work carried out to date, the system should be well-nigh perfect. This is never the case. All that has been done so far is to trap all the obvious problems. Real life is infinitely more variable than any trials schedule.

The requirement at this stage is to detect any problems that are found with the system, and take steps to put them right. Again, as with the trials, it is important to trap the detail in a systematic way, so that effort can be concentrated on those problems that cause the most trouble to the users.

The key resource is the user - his feedback is needed to complete the loop and get some idea of the system's performance. But remember, he has his own job to do and will not take kindly to putting in effort if there is nothing in it for him. He will not do it at all if he thinks the whole exercise is a waste of time. So keep the requirement simple, keep the paperwork to a minimum and, above all, keep the user involved and informed.

There are three sets of paperwork that can be used to monitor equipment when in service: defect report forms, a list to monitor defect reports, and an event log.

Defect Report Forms

Experience has shown that defect reports are best recorded in a uniform way. If each problem is reported in a different way - verbally, by letter, as loose notes, comments in minutes of meetings, etc - then it is difficult to keep track of exactly what is happening.

The surveying ships of the Royal Navy use a simple A4-sized form (Fig. 1) to report system defects. The user fills it in, keeps a copy for himself and sends the original, with any supporting printouts, plots, lists or sample digital files to the office. Users sometimes have to be encouraged to send in the supporting evidence, but it is often essential if the supplier is to be able to diagnose the cause of a problem.

It is essential that only one defect is recorded on each form. If not, it is easy to lose an item when action on something else on the same form is completed.

On receipt in office, the report is given a unique number (since reports may be received from more than one ship), and initial thoughts and test results recorded in a "for office use only" section on the form. The form and any enclosures are then copied into an office file, and the original despatched to the supplier with an appropriate enjoiner to action.

Monitoring Defect Reports

The number of reports received will depend on many factors, including the maturity of the software, the number of users, and the motivation of the users. A small number of reports does not mean that the system is working well - it could be that the users just complain among themselves. Conversely, a large number of reports does not mean that the system is poor - there may be some keen users who are full of bright ideas, or take the trouble to report minor bugs.

It is best to prepare for a deluge of reports, especially at certain critical times: in the early life of the system; when the equipment is being used to do a type of job not attempted before; and when the main users change. Experience shows that several hundred reports can be generated over the first couple of years of a system's life, and it is vital to have some means of tracking them.

The control list (Fig. 2) has one line for each defect report. It is subdivided into a number of categories according to the action taken. The format is designed to fit a standard 132 character wide computer printout, and can easily be manipulated by a simple text editor/word processor, although a database package could also be used.

Columns

The first column on the list is divided into two parts. The first indicates amendments to the document, and the second holds the unique office number.

H449

AUTOMATED SURVEYING SYSTEM - SOFTWARE REPORT | Ho No: / |

SIPS 1   ☐   Logging System ☐   Ship/unit . . . .
SIPS 2 (All Variants) ☐   Charting System☐   S2022 Cross-ref . . . .
SIPS-S   ☐   Documentation ☐   Ship's Sequential No . . . .
SIPS-B (Boats)   ☐   Volumetrics   ☐   Date . . . .
SIPS-V (Volumetric) ☐   Reversionary   ☐   Severity (1=low 9=high) . . . .
. . . . ☐   . . . .☐   Software Version . . . .

DESCRIPTION OF THE PROBLEM / SUGGESTED IMPROVEMENT

Process being conducted: . . . .
Error message displayed (if any): . . . .
Intermittent, occasional or permanent problem? . . . .
Discs/Tapes/Plots/printouts enclosed? . . . .
The description should include, where appropriate, the sequence of events followed,
the result from the system, and the action taken by the operator to recover:

Rank & Name in Block Letters: Signed:

COMMENTS BY HYDROGRAPHIC OFFICE	FOR CONTRACTOR'S USE
	IR No: . . . .
	Approved by: . . . .
Signed: .... Date:	Date: . . . .

FIG. 1.- SIPS software defect report form.

	HO Use	SHIP or UNIT				Sub-system /Doc	Process - Description of problem	Severity
	SR No	Name	Seq No	Date Raised	S2022 No.			
	307	RNHS	203	08-90	A517001	CHART	Fairsheet setup - logo sometimes cannot be displayed or plotted	4
	310	RNHS	206	08-90	A517001	CHART	Digitising (manual QPF) - 1st and last depths not reaching QPF	8
	318	HO	-	09-90	-	CHART	Listing QPF files - sounding rejection/selection flags not shown	3
*	344	BULL	046	11-90	A578781	TRAC	Alarms - cannot suspend as detailed in Op Instructions 9.7.3	3
	362	BULL	055	11-90	A578782	TRAC	Clock looses approx 30s in 24h. Reboot to reset	9
*	378	BEAG	010	11-90	A428929	TRAC	Uploading databases -error 20 integer overflow but no app harm	1
*	383	HO	-	01-91	-	CHART	Dig echo trace - midnight defects	7
*	387	BEAG	002	01-91	A408969	TRAC	Downloading data - random freezing	4
*	395	BULL	065	03-91	-	CHART	C-O Model - editing defects - should work as in TRAC	9
*	397	HO	-	03-91	-	CHART	DEM edit -cursor freeze on selection of next/last screen	9
*	406	FAWN	C03	04-91	-	CHART	Recalculation -setup display defects	5
*	409	FAWN	C06	04-91	-	CHART	Media Utils -accessing tape drives - intermittent failure	7

	HO Use	SHIP or UNIT				Sub-system /Doc	Process - Description of problem	S/ware versn no.
	SR No	Name	Seq No	Date Raised	S2022 No.			
*	273	BULL	029	07-90	A578779	CHART	Data Prep - core dump on saving bathy edit	C 1.11
	274	BULL	030	07-90	A578779	CHART	Tape Drive 2 - occasional problems (Hardware)	n/r
	275	BULL	031	07-90	A578779	CHART	Tide file - user friendly editing required	C 1.12
	276	BULL	032	07-90	A578779	CHART	Plotter - parts falling off (Hardware)	h/w
	283	BULL	036	07-90	A578780	TRAC	On-line TRAC - error 159 - numeric data not received	data
	285	HO	-	08-90	-	CHART	Plotting - should be able to poly clip DEM plot	SR322
	287	HO	-	08-90	-	TRAC	EOL printout - Hyperfix histogram to show 100ths of a lane	T 2.07
	293	RNHS	189	08-90	A517001	CHART	adding to a DEM - cannot escape from setup display	SR290
	300	RNHS	196	08-90	A517001	CHART	PAM - terminal freeze on MOREing directory contents (n/r)	unix
	303	RNHS	199	08-90	A517001	CHART	Plotting - 13mm shift on referencing .OO5 media	u/p
	308	RNHS	204	08-90	A517001	CHART	Fairsheet - the option to delete panels should be available	C 1.12
	311	RNHS	207	08-90	A517001	CHART	Plotting - drying heights plotting as depths	u/p

FIG. 2.- SIPS-2 Software Report List
above: example listing of "live" reports
below: example listing of cleared reports

The information contained in the second column is extracted from the original defect report form, and shows the originator of the report, the originator's reference number, the date (month-year) the report was raised and, in this example, a cross-reference to the Royal Navy's centralised reporting system.

The third column indicates the sub-system involved, and gives a precis of the problem. The precis is a good indication of whether the problem can be defined or not: if it is impossible to describe the problem in a dozen words, then it is most likely that it is not understood.

The last column initially contains the severity rating given on the original report, this being amended as necessary at review meetings. A date in this column can be used to indicate an event by which a fault must be fixed. When the report is cleared, this column records the authority for so doing.

Division into Sections

The list can be divided into sections as required, with all reports being placed initially into an "outstanding" section. As the problem is investigated, it may be moved elsewhere to show its current status. Other sections can cover:

- Reports that are not understood, or where the supplier cannot reproduce or isolate the problem. These are referred back to the ship for clarification.
- Suggested enhancements and reports which may require extended consideration before action.
- Where it is more appropriate to amend the documentation to agree with the software than vice-versa.
- Software amendments that need specific testing before the original report can be cleared. Should an item not pass testing, then a fresh report is prepared describing the new situation. Reinstating an old report causes confusion.

Cleared Reports

Once a report is cleared, the usage of the last column changes from "severity" to the reason for clearing the report. There are a number of entries that can be made:

- Issue number of the software version that cleared the report.
- The number of another defect report that supersedes or duplicates the report.
- n/r = Not Reproducible: no one - supplier, office, nor originator - can reproduce the fault.
- u/p = User Practice: the user has pressed the wrong keys, tried to do something impossible, etc.
- h/w = Hardware: the fault was caused by a hardware defect.
- o/s = Outside Specification: the report is a suggested enhancement that has not been adopted.

- Data = The problem has been caused by errors in the data. Another defect report will probably have been raised to cover the problem that generated the erroneous data.

Extra annotations are added as new situations arise.

As more and more defect reports are cleared, the list then becomes a history of the development of the software.

Distribution and Review

Each time a major change is made to the list, it is sent to the supplier. Regular review meetings are held where the situation regarding all "live" reports is monitored, and particular problems discussed.

The list is circulated to all users to keep them informed, even though they may not have the time to study it in detail. User representatives are invited to the review meetings, since they are the people who know what happens in practice - the supplier knows only what should happen.

Event Log

The list described above is a good way of monitoring the character of software problems, but it does not show the frequency with which they occur. Another difficulty is that the defect report form method is not suitable for dealing with hardware problems. Typically, these require a quick response or engineer attention, but do not need detailed investigation once a repair has been made.

One way to track both the frequency of occurrence of problems and to record hardware faults is to keep an event log for each machine, one for the bridge logging system, and another for the processing system in the chartroom. Once life settles down, it may be unnecessary to continue the log, but it is invaluable in the early stages.

Analysis of the log can be subjective, as each entry will need to be examined to see if the problem has been caused by the system or the user. System defects are assigned to a particular item so that weaknesses can be detected - either because they are minor difficulties that occur often, or are potential major problems should they recur.

Another reason for keeping such logs is to calculate AR&M figures, both MTBF figures for individual system components and an overall system MTBF. These can be compared with the MTBF required by the specification, and weak links demonstrated.

Evaluating each Report

When evaluating each report, there are few general rules that can be followed, because each situation will be different. Four "tips" are worth bearing in mind:

*   Do not get distracted by detail. Once a problem has been defined, leave it to be tracked by the control list. Concentrate on the problems that matter.
*   Make sure that the report is sent to the person who is able to action it, and he or she knows about it.
*   If a potential "no action" situation is detected, take steps to clear the report as soon as possible.
*   Do not automatically blame the system. Some users have to be watched closely.

Putting Things Right

Within the warranty period on the software, it is up to the supplier to correct defects. So get busy detecting them, as time is of the essence. In practice, the effective end of the supplier's interest occurs not at the end of the warranty period but after the final stage payment has been made, so do not pay the final amount until the important bugs have been fixed.

In addition to defect reports, suggested enhancements will be raised, though in some cases the distinction is not at all clear. Since the supplier pays for the defects and the owner pays for the enhancements, take care before deciding on an enhancement - the supplier will rarely refuse a subsidy to correct a defect.

When it comes to handling enhancements, it is vital that a good specification is prepared before the job is costed by the supplier. This means drafting something that makes sense in the way it can be implemented on a computer system, and then getting the users to see if it is workable in operation. The supplier should then be given a chance to comment and suggest better ways of implementing it before costing takes place. If all parties agree on the design, then nothing too drastic should go wrong. Where things will go wrong is if there is no allowance for enhancements in the original budget.

CONCLUSION - JUSTIFYING THE EFFORT

It may seem that the work outlined in this paper is excessive, and will occupy too much of someone's time. Indeed, it is not uncommon to hear people who have no first-hand experience of surveying or computers wondering if the work is necessary at all, especially if all they hear about are the problems. It is helpful to ask what is the alternative.

If the first two stages are not carried out adequately, then it might be necessary to modify the users' requirements to meet the limitations of the system (assuming that it works at all). Considerable costs could accrue in inefficient procedures, or modifications to the system could be expensive. Either way, the cost could be more than that of a purpose-designed system, completely defeating the reasons for going for an "off-the-shelf" product in the first place.

For the third stage, the cost of the officer doing the trouble-shooting has to be balanced against possible ship downtime - a few days ship time saved soon pays a person's salary for a year.

Reference

WEEKS, C.G. (1981): Selection Criteria for Shipboard Automated Systems. *International Hydrographic Review*, LVIII(1), January (pp 29-38).