

ON THE OPERATIONAL ASPECTS OF SUBSEA SYSTEMS

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ABSTRACT

The scientific and commercial underwater activities in the next decades primarily in 'undersea vehicles' and 'manned submersibles' will be taking place in the oceans and ocean related technology. The paper underlines some of the operational aspects of subsea systems in a systematic manner in various phases of development. The potential scientific benefits from the subsea operations are highlighted.

and 'manned submersibles'-- bearing in mind that the economy depends on the profitable operation in both the manufacturing and service sectors. In oceans and ocean related technologies we find two distinct categories of operations--one starting and continuing in the field of ocean science wherein immediate commercial return is not appropriate. The other category is where the technology has emerged already in its application to practical uses which involves the upgradation of equipments and services, resulting in a corresponding cost effectiveness.

INTRODUCTION

Remotely operated vehicles (ROV) technology began life in the imaginations of scientists decades ago. It has been a desire to explore and work underwater and to obtain the oceanographic data held beneath the sea. It is only within the past 20 years that we have been able to extract details on oil and gas from the ocean bottom. More than any other requirement, development of ROV and its related technology has been an emerging field in oceanography.

Main task of this paper is to present the overall scene into focus--particularly for the non-oceanographic related members of the offshore industrial community; to assist those, who have not so far perhaps, been deeply involved in the subject, to see some of the linkages and relationships between the many sectors of activity, and the growth potential in general.

There is of course a clear implication in the use of "commercial" underwater activities in the field of 'undersea vehicles'

The outstanding vehicle performance (remotely operated) has demonstrated the versatility of the design, expanding our thinking and planning about the future use of the oceans. It is, indeed, the key element in near term and advanced oceanographic operations capabilities for future commercial, security, earth-resource, and scientific exploitation of the sea.

We are just beginning to be aware of the vast potential that the oceans hold to help solve the growing major land resource problems. We are also aware that the ROV is a key to expanded utilisation of oceans to exploit that potential. The ROV gives us the immediate ability to move underwater operations from the realm of science, exploration, and small vehicles to operational systems that contribute to everyday life.

SYSTEM ASPECTS

The design of subsea systems and installations require very high standard of Reliability. These standards are set to reduce any intervention requirements to minimum, justified by its ability to perform unexpected complex tasks. The skilled operations team should know its capabilities and limitations acquired by training and practice (1).

functional specifications of any sub-system is complete only when the system starts taking shape. The basic parameters to be considered, in detail, for operational subsea system are:

-) system power requirements
-) propulsion system efficiency
-) power transmission voltages
-) heat dissipation and losses in the system
-) drags
-) surface and subsurface handling equipment
-) dimensions of vehicle power plant.

First phase is always to consider the requirements and the influence of related components. Using the estimate of payload, densities and drag, a model can be explored to arrive at an acceptable efficient power train. Model should then be able to verify load functional requirements taking consideration the hydrodynamical influence on the vehicle and its interaction with subsea installation. This intermediate computerised model can be used to study strategies/attitude behaviour. Performance of the system will be compared with its power requirements as far as possible, so that a detailed engineering design of the system can proceed which is influenced by operational engineering constraints.

Operational ROV system requires a high level of automated facilities for tracking and controlling the maintenance reports or housekeeping data. Realtime monitoring of stability/control is also required for variable payload capability (2). Simulations and mission control are effective if a small minicomputer is incorporated in the system.

potential user groups for operational ROV are:

- offshore industry
- defence
- coastal works
- ports and harbours
- emergency services, and
- oceanographic research

Key requirements of an operational ROV system (such as ROV) are:

- reliability and self sufficiency,
- ease of handling and transportation,
- flexibility,
- low maintenance requirements,
- high durability and ruggedness of construction,
- sufficient power for operation in hostile sea conditions.

ROV technology is currently in Phase III of a five-phase programme outlining its development in perspective:

- Phase I : Research and prototype development.
- Phase II : Introduction to the market.
- Phase III : Development of prototype unit.
- Phase IV : Advancement to mature systems; and
- Phase V : Transition to the specialisation (1995-)

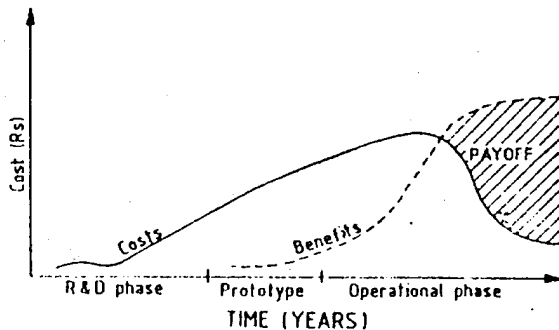


Fig.1. Life-cycle costs and benefits

It is a generally well-known fact that key problems centre around the major investment decisions made by governments or by the private sector for experiment with new technological systems and for the establishment of new operational sub-sea systems. The prospect for constructive investment decisions can be increased if a more systematic attention is given to the identification and assessment of scientific benefits that are produced by the substantial investments required.

Systematic considerations include:

- (i) Identification/definition of benefit evaluation at each stage, as projects move through the conceptual, R & D, demonstration and initial operation phases;
- (ii) Sorting out of appropriate issues at each stage;
- (iii) Ensuring the needs, interests and problems of users taken care of, on timely basis in the technical planning programme;
- (iv) Ensuring early attention to problems of market identification, and technological development;
- (v) Suggesting steps to be taken by manufacturers in innovative area of subsea systems;
- (vi) Listings of issues and responses

raised to provide a framework for justifying and securing support for investments.

As the subsea operations are now at the point of maturity more conventional investment techniques such as Return of Investment (ROI) Analysis can be used. The key investment decision points are: R & D, Prototype demonstration and operational systems (Fig. 1). The following factors will have to be taken into consideration in the analysis: Cost/Benefit analysis, Economic Market research, Technical Confidence factors and ROI analysis (3).

However, these studies and analyses do not make decisions, but enable us in providing logic for human decisions involving varying degrees of judgement.

In general, four classes of ROVs are identified:

- a) Tethered, free-swimming;
- b) Bottom-crawling;
- c) Towed; and
- d) Untethered vehicles.

Without going into the inter-comparison of each commercially available systems and advantages/drawbacks, the main problems associated, in general, are listed below:

- . Entanglement;
- . Underwater connectors and cables;
- . Visibility;
- . Support ship - sea state;
- . Vehicle damage (during launch/retrieval)
- . Navigation;
- . Vehicle payload
- . Vehicle maneuverability;
- . TV resolution;
- . Inadequate human engineering.

The shortcomings identified above indicate R & D programmes needing immediate attention as follows:

- . Cable technology;
- . TV;
- . Thruster/power module;
- . Acoustic Imaging;
- . Heave compensation;
- . Reliability/performance;
- . Underwater Instrumentation;
- . Navigation;
- . Untethered vehicle design;
- . Seafloor sampling techniques.

As operational experience accumulates, and is fed back to the manufacturers, each subsequent vehicle becomes more reliable and efficient in its operation (4).

The key to success in this endeavour will be adoption of a fully integrated design

approach, at both system and component levels, involving oceanographic institutions, oil companies, subsea equipment manufacturers and remote tooling designers. A study based on this approach will offer guidance in the design of subsea systems helping to optimize cost vs reliability curves.

The basic design constraints are:

- . Loadings;
- . Weight;
- . Handling; and
- . Space.

The integrated design will utilise trade-offs between the efficient use of space and component accessibility (5).

The broad missions/applications for which subsea systems such as ROVs used are:

- . Inspection (visual, video, photographic)
- . Survey (electronic, visual, photographic, acoustic);
- . Light work;
- . Heavy work (large payloads).

One of the greatest assets of any submersible is its potential for both horizontal and vertical mobility (6).

Two very promising developments that may have a large impact in oceanography during the coming years are:

- i) Large submersible/submarine (fully equipped to transport and support divers for several days at the sea bottom work-site).
- ii) Development of untethered, programmable vehicle (with increased effort for more data recording and transmission capabilities).

CONCLUSION

In conclusion, the author believes that a large portion of underwater activities in the near future will significantly use manned or unmanned submersibles. This will greatly influence oceanographic activities. The trend towards increased use of unmanned systems in preference to manned submersibles is expected to continue in greater operational depths and hostile environments. To achieve maximum utilisation of subsea systems, significant improvements in sensors and data handling capabilities should be developed.

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