Research project – Safinah Ltd.

Project RECCOMS

1. Aim of this white paper

The aim of this white paper is to gage interest in the creation of a consortium to carry out collaborative development of a commercial system for the remote inspection of coating and corrosion of marine structures. The aim is to develop a system to be further adapted to carry out a range of inspection services for maritime structures and vehicles and in particular to address H&S issue when carrying out inspection of complex internal spaces such as ballast tanks.

As a starting point, the project will use commercially available technologies already in the market place which is addressing complex industrial and military scenarios as well as the film industry and applying these technologies to steel structures such as ship’s tanks, enclosed spaces and hard to access areas providing minimal need for humans to enter these areas where the H&S risk is high or unacceptable.

This implies an autonomous vehicle to be piloted beyond line of sight collecting sufficient data to allow a proper assessment of coating and corrosion and if necessary transmitting the data and images to remote office based personnel and experts for interpretation, analysis and feedback. This could be done either on a computer screen or in virtual reality mode.

2. Background

Large maritime structures such as offshore platforms and ships are made of mild steel and are subjected to a corrosive environment in the ocean resulting in corrosion.

The control of structural corrosion is predominantly achieved by the application of anti-corrosion coatings of the barrier type. The structural life of a marine structure is normally designed to be in the region of 25-30 years, however life extension programmes are increasingly being undertaken for offshore structures while for ships the desire to reduce OPEX is increasingly important to minimise subsequent coating repairs (e.g. under the IMO PSPC for Water Ballast Tanks) and to maintain asset value and sustain higher levels of utilisation.

Once in service, the access to these often poorly lit enclosed spaces for inspection results in considerable health and safety concerns for personnel on board as well as surveyors, independent inspectors, asset owners, operators and insurers.

It has been highlighted by a number of P&I clubs that there is regular loss of life while conducting surveys of marine structures. The Marine Accident Investigation Branch (MAIB) identified the problem as a result of accidents on vessels e.g. Viking Islay 2007, Sava lake 2008, Siga Rose 2008. The
MAIB safety bulletin of 2008 indicated that accidents in enclosed spaces continue to be one of the most common work related fatalities on board ships.

The marine industry has initiated a number of projects to investigate the use of drones that could be used to navigate these enclosed spaces and in particular one company has already undertaken early research work with universities to identify suitable drones for inspection of enclosed spaces such as water ballast tanks.

A number of other projects e.g. Meyerwerft shipyard and the US Navy have looked at a range of solutions for remote assessment of corrosion and coating performance in these difficult to access areas. A search of the Internet reveals many other such initiatives for a variety of end uses including military uses as well as civil engineering uses for pipeline surveying etc.

A number of recent magazine articles and EU funded projects (FP7) as well as asset owner and ship owner driven projects have highlighted the use of drones in external areas and cargo holds where line of site navigation is possible. The challenge of enclosed space assessment is within grasp using the latest navigational systems and sensors coming to market. This is an opportunity to integrate this technology to a commercially viable autonomous mobile platform for carrying out inspections in such areas thus minimising the H&S risk and improving the quality of inspections in service by providing access to all areas of a tank or structure.

3. Key aim of project

The aim of this project is to assess what are the latest surveying and modelling tools and techniques currently available that could be used quickly to enhance the current methods of surveying coatings and corrosion in marine structures and in particular those with difficult access that pose health and safety risks to humans. To do this the project will use these tools to build a SUAS (Small Unmanned Aerial Systems) with enhanced duration to conduct surveys. Current drone solutions can generally provide battery life sufficient for up to 30-40 mins of inspection time. This limits many inspection operations to line of sight navigation, i.e. the pilot has to be in sight of the drone. This may be suitable for some areas but limits the amount of work that can be done and the payload of sensors carried.

The project will use latest technology to maximise flight time and a payload of multiple sensors for surveying purposes while keeping the SUAS small enough to navigate in enclosed spaces.

In its first phase the development of the SUAS platform should:

- Be able to carry multiple sensors and exceed payloads of current drone technology,
- Be able to survey for at least double the current periods of time,
- Be capable of operating in tight access areas such as ship tanks,
- Be able to operate either autonomously or by a pilot out of line of sight,
- Minimise the potential H&S risks of operating drones with high-energy propellers that pose a risk to workers,
- Be able to provide data from poorly lit spaces.
The system should at the least be able to assess:

- Coating integrity,
- Effectiveness of repairs,
- Extent of degradation,
- Percentage of area affected,
- Collect image data and either record it or feed it in real time to remote locations,
- Enable transfer of data into 3-D models and use those to track the integrity of the coatings/structure over its life.

*Note: It may be possible to use it to measure steel thickness but that is to be evaluated.*

Early work has shown it possible with current technology to scan these surfaces and create 3-D models allowing shore based engineers to undertake a virtual tour of maritime assets and not only map the above factors but consistently assess degradation or changes over time. These surveys can be done either by video or stitching together hi-resolution still images to re-create the environment being inspected enabling assessment remotely over the internet if required by specialist engineers to view on screen or in a virtual reality scenario.

Such accurate survey data would enable enhanced inspections and better use of data that would, for example, enable the assessment of alternative repair and maintenance procedures as well as providing valuable time series information with regard to the degradation rates of these structures and coatings.

### 4. Proposed scope of research and development

The work will be based on commercial systems already available or at least in prototype with an advanced Technology Readiness Level of 8 (TRL) (as per NASA and US DOD scale) focusing as much as possible to minimise research and development time. Should non-standard features be required then their adoption will be dependent on the time it would take to get them to market. A modular design will be considered to allow for integration of new technology in the future.

At present the most promising surveying technology would seem to be SUAS based. After undertaking some research Safinah Ltd has identified the following key issues need to be resolved:

- Navigation of SUAS out of line of sight,
- Payload capability for multiple sensors,
- Battery life,
- Manoeuvring within an enclose space with limited size access holes,
- Ability to repeat survey in a consistent manner over time.

The majority of current drone technology solutions in use present other key challenges:

- H&S risk of high power/high speed propellers,
- Impact/collision issues,
- Ease of flight control,
- Retrieval in event of a collision.
The development work would be based on a specific SUAS development from Drone Ops Ltd. Drone Ops engineers have developed SUAS for a range of end users from the film industry to defence and industry applications. The plan is to select appropriate survey tools already available for these solutions (laser scanning, digital imagery etc.) and look to supplement the available tools with those that can be commonly used for coating and steel assessment as and when needed or the technology allows. Drone Ops personnel have also developed a number of solutions for the civil engineering and surveying sectors such as pipeline and industrial storage facilities. It is proposed that the project work will focus on the following key aspects:

- Technology available to conduct surveys
- The ability of existing technology to operate in and around marine structures (in particular tank spaces)
- Modelling the area to be surveyed
- Manipulation of the model to enable an adequate representation of degradation to shore based staff/engineers to enable M&R decisions to be made and evaluated.
- Location recognition between surveys to enable consistent assessment of the areas and relating that survey data to the model accurately
- Selection of attributes to be measured during the survey.
  - Visual assessment
  - Coating condition
  - Extent of any defect (e.g. corrosion percentage of total area or coating breakdown over a particular area).

This would provide a package of survey tools available from current technology to achieve the survey requirements. This would enable an assessment of the load capacity that could be placed on any remotely operated vehicle leading to identification of both viable and non-viable solutions.

The project work would examine near-to-market technologies that may be able to enhance either the type of data collected (e.g. steel thickness) or options for other remote vehicle configurations.

**Drone Ops Ltd**

Drone Ops Ltd was incorporated in May 2015 as a spin off from CBRNE Ltd (www.cbrneltd.com) which has a background in R&D of chemical, biological, radiological, nuclear and explosives (CBRNE) related issues including sensors to bring together technicians with experience in drone technology for the specific purpose of combining sensors into SUAS and robotic mobile platforms. Up until recently the industry has been largely “toy driven” but the founders of Drone Ops Ltd forecasted a speedy leveraging of the technology for commercial and industrial use through innovation and system integration.

Drone Ops Ltd case studies include a partnership with IMITEC Ltd to integrate the latter’s radiological sensor onto a Drone Ops Ltd flying platform for participating in the semi-finals of https://www.dronesforgood.ae/semi-finalists competition in Dubai in February 2016 and the integration of the Cobham Amulet IED/mine detector http://www.cobham.com as part of FP7 Project D-BOX (https://d-boxproject.eu/). Drone Ops Ltd has also presented at the Royal Military Academy in Shrivenham regarding the use of Drones for forensic purposes, undertaking a terrorist
Drone countermeasure debate session at a presentation to the MoD and intelligence personnel regarding the use of drones in a military capacity at a fraction of existing costs. References are available.

Drone Ops Ltd employs a team of drone constructors and electronics’ specialists, well versed in the technology and manufacturer of all consumer drones. The team has worked in the drone business since its early days. Drone Ops Ltd evaluates drone products and its experts have manufactured over 300 drones during their careers in the industry. They have built Small Unmanned Aerial Systems (SUAS) and trained pilots so they understand the skills, aptitude and mentality of a good pilot and can decipher the differential between a good drone builder and that of a hobbyist.

Drone Ops Ltd is a return merchandise authorisation (RMA) repair and service centre for the main manufacturers of consumer drones such as DJI, Ehang and Yuneec and it therefore understands the technology as its experts’ work and problem solve every day.

5. Project outline and duration draft proposal

The current proposal is to have a three-phase project with Stop/Go decisions built into each Phase.

Phase I – workshop and demonstration:

This FREE workshop will be held on Tuesday 22nd March 2016 at The Core, Science Central, Bath Lane, Newcastle upon Tyne NE4 5TF - UK and would last one day (from 9.30 am to 4.30 pm) broken down into 4 sessions:

- Session 1 – Overview of SUAS technologies and broad capabilities based on current technology and near market solutions.
- Session 2 – Demonstration and presentation of drone capabilities and examples of mapping and 3-D modelling as well as VR simulation.
- Session 3 – Presentation of the problem to be addressed and outline solution for the inspection and survey of large marine vehicles internally and externally and potential solutions.
- Session 4 – Interactive session to identify any existing lessons learned and any additional needs and requirements to be considered as well as identification of other challenges end users may face.

Output from the day would be a revised and more detail project proposal for Phase II if the concept proves viable and if there is sufficient industry support for the on-going effort.

At the end of Phase I potential project partners would be required to register formal interest if they wish to take part in the subsequent phases.

Phase II – Development of SUAS solution to meet the objectives discussed in Phase I with current technology and successfully demonstrates the prototype to project partners.

Phase II will start as soon as all the formalities of establishing the partner group are completed (2-3 months)
Based on current estimates it is expected to be able to develop the first drone prototype solution within a 12-month period with an additional 6 months to conduct tests and trials.

**Phase III – Start production of commercial SUAS solution**

This will start immediately on completion of successful tests and trials.

**Phase IV – Product development**

Develop a plan to release upgrades as technology allows additional features to be adopted.

6. **Project modus operandi**

**Phase I – Workshop**

The aim would be to hold the Phase I workshop on March 22nd 2016 on the receipt of a suitable number of positive responses to the workshop (we require a minimum of 10 attendees to make the initiative worthwhile). The aim is to familiarise attendees with the state of the art for SUAS development and current capability of the latest solutions already available commercially. This will include a flight trial of current technologies and an explanation of the challenges that may be posed by the enclosed space problem.

In addition to the flight trial, the project team (Safinah and Drone ops) will engage with attendees to agree an outline requirement specification. The flight test will be used to identify current system capability gaps and unique challenges for operating in this environment.

The output from Phase I will be a summary report from Safinah Ltd and Drone Ops Ltd indicating what further development would be needed in Phases II and III to enable the system to deliver the needs of the project and provide a timescale and cost estimates for the development work.

Participation in Phases II and III will be agreed with Safinah Ltd after the feedback from Phase I.

**Phase II – Development of prototype SUAS and test and trials with interim and end of project workshop and report. Estimated time frame of 18 months**

Estimated costs will be provided should there be sufficient industry interest to progress but will be a shared cost basis and hence ultimately depend on the number of project partners. On the assumption of a favourable response to Phase I then a number of possible activities would need to be carried out for Phase II that would culminate in the development of a suitable prototype that could be run through test and trials and result in a viable commercial solution:

**Phase III – Commercialisation**

This phase would result in a commercially available system with an associated development programme to upgrade the system as new technologies enable this to be undertaken. Project partners would get preferential access and support on all developments.
It is intended that the project outcome would be a system, which would:

- Enable assessment of coating and corrosion conditions in an enclosed space or around a marine structure.
- Enable modelling of the area under consideration
- Enable mapping of defects on that area
- Enable on shore engineers to make decisions from that information
- Map changes in conditions over time
- Enable the assessment of different M&R strategies over time
- Enable proper assessment of structures in a timely manner to enable development of suitable M&R plans and intervention.

### 7. Desired outcome

The desired outcome would be to:

- Enhance the capabilities of human surveyors by introducing new surveying tools and techniques and
- To ultimately reduce the need for human surveyors to attend hard access areas that pose significant H&S risks.
- To provide timely and accurate surveying data that can track changes in the fabric of a structure in a reliable and consistent manner over time.
- To improve the quality of data available to develop asset integrity management through life and reduce OPEX and risk.
- To develop a platform that allows enhancement as new sensor technologies emerge.

### 8. Partners

Current partners to this project are:

Safinah Ltd - [http://www.safinah.co.uk](http://www.safinah.co.uk)
Drone Ops Ltd - [http://www.drone-operations.com](http://www.drone-operations.com)

It is hoped to include a suitable range of partners to take part in this commercial enterprise and these could include:

- Oil or Gas companies,
- Asset/ship owners,
- Paint companies,
- Major classification societies,
- Loss adjusting and surveying firms,
- Insurance company and P&I clubs,
- Instrument manufacturers.
9. Estimated project costs

The Phase I Workshop - The one-day workshop will be FREE to those attending (excluding travel costs etc.). The target will be a minimum of 10 attendees. Time and cost for subsequent phases will be determined based on the outcome of Phase I.

10. IPR and use of data

The aim of the project is to improve the H&S of personnel carrying out surveys on marine and offshore structures. To that end the foreground IPR developed during the project in the form of reports, survey data and coating analysis should be shared among the partners.

- Background and foreground IPR relating to SUAS technology will rest with Drone Ops Ltd.
- Following Phase I partners contributing to the project will have free access to the results of the trials and a final report of the workshop with recommendations resulting from Phase II.
- Phase II project partners will attract a discount should they wish to purchase the developed system or employ Drone Ops Ltd to conduct surveys etc. on their behalf.
- Background data into the project will remain the property of the introducing party.

11. Management of the project

Safinah Ltd who will be responsible for ensuring that proper budget control is maintained and the project timeline sustained will manage the project. This will be done through monthly management team meetings and regular meetings with project partners at key milestones in Phases II and III with the purpose of:

- Refining and developing the work plan and milestones,
- Meeting when there is an appropriate milestone but at least once a year.

12. Registration of interest

All parties that register interest in the project will be invited to attend the Phase I Workshop to develop the outline project plan and timings. This meeting will be hosted at the “Core” facilities in Newcastle Upon Tyne enabling the demonstration of flight and data gathering and imaging technologies. If you wish to express your interest in being a partner in this project then please complete the attached form and return it to:

Raouf.Kattan@safinah.co.uk and cc Bruno.Ravel@Safinah.co.uk

For further details please contact Raouf Kattan Tel: +44 1670 519 900 -
Project RECCOMS
(Remote Evaluation of Coatings and Corrosion on Offshore Marine Structures/Ships)
Registration of interest to attend the one-day workshop at The Core, Science Central, Bath Lane, Newcastle upon Tyne NE4 5TF - UK on 22nd March 2016; 0930 hrs–16.30 hrs

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<tr>
<td>Partner Contact:</td>
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RSVP Please respond by February 20th 2016 – Workshop will only take place if there are more than 10 attendees. This will be confirmed by February 26th 2016.
# Project RECCOMS

(Remote Evaluation of Coatings and Corrosion on Offshore Marine Structures)

## PROPOSED WORKSHOP DETAILS

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<tr>
<th>Date</th>
<th>Tuesday 22nd March 2016</th>
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<tbody>
<tr>
<td>Location</td>
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| Parking       | Within 5 minutes walk | [http://www.ukcarparks.info/grainger-town-car-park-newcastle-upon-tyne#sthash.sRN3zVN4.dpbs](http://www.ukcarparks.info/grainger-town-car-park-newcastle-upon-tyne#sthash.sRN3zVN4.dpbs)  
| Agenda for the day | Registration | 09.30 am – Tea coffee on arrival |
|               | Workshop start | 10.00 am |
|               | Lunch break | 13.00 pm – Buffet lunch will be provided |
|               | Workshop end | 16.30 pm |