The revolutionary efficiency of the tipper barge system

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Introduction

Despite Singapore’s global reputation as an international port city, it has yet to claim responsibility for any significant innovations in the area of port-related technology. This, however, may begin to change as Singaporeans, having gained extensive technical experience, are now reflecting upon the limitations of existing technologies, mainly originating from the West.

In the previous edition of Port Technology International (PTI 43), Foo, Loke and Graham outlined the distinct possibility of the emergence of a simple, yet dramatically cost-effective mobile ‘port-in-ocean’ system. This system is made possible through the integration of the Singaporean tipper barge with an Australian conveyor system. With the highly competitive nature of the supply chain industry, there is every possibility of there emerging a port-in-ocean system integrated into the supply chain, which is designed for the global mining industry.

In this article we will focus mainly on how Loke’s tipper barge system may change bulk carrier technology, which at present, has remained largely unchanged for the last 50 or more years. The reason why the tipper barge system may dramatically transform the approach to bulk carrier systems is through its realization of highly competitive, revolutionary levels of efficiency.

We have structured this paper into the following areas:
1) Background on the breakthrough in innovative thinking that led to idea of the tipper barge system. The system may be seen as a newly conceived technological system for application in coastal waters, for refilling sand more rapidly. Faster sand refill means a shorter lead-time – and thus improved cost effectiveness.
2) Prior technology and the breakthrough in design concepts that have led to the tipper barge system, consisting of multiple tilting on a flat, floating barge. What is most surprising is how nobody had previously thought of this system, and importantly for commercial reasons; no one had the concept patented.
3) The application of the tipper barge system for land reclamation is explored here. The most exciting preliminary finding, based on estimations and technical assumptions, is the revolutionary efficiency that may be realized through the tipper barge system. Imagine a completion period of three years via the tipper barge system versus the 30 years it could take using the current methods of sand refill in land reclamation.
4) We conclude the article by suggesting that there should be many more corporations in Singapore and Asia that focus on accumulating patents as intellectual assets. One of the key roles of these firms is to concentrate on investigating the revolutionary efficiency of the tipper barge system.

Figure 1. The inventor during the incubation period for his idea. Inventive context: 1) Kalimantan coal, iron ore mines 2) Living in forest 3) Transportation by river 4) Transference of ores to a bulk carrier.
potential viability of new technologies, either as a stand-alone technology (tipper barge system) or integrated with other technologies, as in the port-in-ocean systems.

**Background**

According to Mr Loke, he spent many years reflecting on the problem of transhipping ores from mines to ocean-going bulk carriers, in this case in Kalimantan, the Indonesian part of Borneo. This is documented in the series of photographs in Figure 1.

As far as the theory of innovation goes, this case clearly reinforces the notion that the root of an innovative idea lies in confronting a problem. This, perhaps, is one of the reasons why professors in universities are rarely able to conceive of innovative, patentable concepts with industrial applications.

The new tipper barge system has the capability of offloading cargo at a breakneck speed, for conceptually it is similar to a land-based tipper truck (see Figure 2). The tipper truck has for many years been, and still is, in use for uploading, transporting and downloading sand and other aggregates. Based on this fact alone, it is envisioned that the tipper barge system, if adopted by the industry, would likely also remain in use in the long term. The concepts for both of these systems share similar core control mechanisms: discharging laden cargo through pushing a button resulting in the tipping of containers.

Next we explore in detail the sorts of technologies used before the advent of the tipper barge system.

**Prior technology**

For many new technical concepts, there will often be technologies that came before, and the tipper barge system is no exception. Prior technologies are identified in Figure 3. These are: the bottom split hopper barge, the flat top cargo barge and the trailing suction hopper barge.

As shown in Figure 3, the tipper barge is far simpler in concept and design, yet offers far more efficient means for managing the loading and unloading of bulk aggregates such as mineral ores (coal and iron), sand and gravel etc. Profile and bird’s-eye perspectives of the tipper barge system are provided in the follow-up diagram (Figure 4).

The tipper barge requires a tugboat for propulsion. One of its most intriguing features lies in its scalability in construction. The quantity of tippers aboard the floating barge could range from a pair to a dozen.

Even though the tipper barge concept may appear simpler than other systems, the technology incorporates the merits of earlier vessels. Synergistically, the system includes the many positive attributes expected in a marine transport vessel, including:

- Multi-tasking with the ability of diverse applications
- Large holding capacity and self-discharge capabilities
- Scalable and modular
- Beach-able
- Easy to maintain as all key mechanisms are above the sea-level
- Carriage of differentiated loads
- Size and mobility capabilities customisable
- Inexpensive as a hardware vessel and asset can be privately owned and tracked

**Efficiency for land reclamation**

Tipper barge technology conceivably has a much wider application aside from its role as part of the port-in-ocean supply chain solution for the mining industry. For an emerging technology to replace current methods, there obviously has to be substantial economic gains. Whilst it is clearly outside the scope of this article to discuss sand refill technology in land reclamation as applied in Singapore (see Figure 5), it is necessary for us to highlight the extrapolated, plausible efficiency gains.

In a preliminary feasibility study on tipper barge system application, the analysis, which was based on a certain operating environment and in prevailing conditions, suggests a possibility for a breakthrough in efficiency (see Table 1). If this system is
introduced and operated, the time for project completion may well be shortened by as much as 90 per cent. Even if half this level of anticipated efficiency was realised, it would be sufficient to justify the system’s use, particularly for relevant governmental authorities with the responsibility for efficiency in land reclamation projects in and around their ports.

International sea-land innovations

Upon realisation of just how new, patentable technology has the potential to better port operations or land reclamation, this information should be shared with the community. Any corporation would be interested in reviewing new technologies and seeing how they could improve the current state of affairs. With the tipper barge system for example, innovations in control systems may result in better mechanisms for tipping sand or other aggregates.

Indeed with the concern for rising sea levels, it may just be timely to re-think the whole idea of coastal management. To solve these problems, new thinking and ideas are required. As such, there is a need for well-funded corporations to actively and routinely review and identify appropriate new technology.

Once found, these patented innovative concepts may then be tested in proofs of concepts. For only then may the practical benefits be best assessed.

### TABLE 1: COMPARATIVE STUDY OF PRESENT VS. TIPPER METHODS

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<thead>
<tr>
<th></th>
<th>Present method</th>
<th>Tipper method</th>
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<tbody>
<tr>
<td>1 Cost of discharging</td>
<td>same</td>
<td>same</td>
</tr>
<tr>
<td>2 Holding capacity</td>
<td>same</td>
<td>same</td>
</tr>
<tr>
<td>3 Travelling speed</td>
<td>same</td>
<td>same</td>
</tr>
<tr>
<td>4 Time taken to discharge 3000 MT of sand</td>
<td>3 hours (using small vessel equipped with conveyor offloader)</td>
<td>10-20 minutes</td>
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<tr>
<td>5 Time taken to discharge 10,000 MT of sand</td>
<td>6 hours (using cargo barge with shovels and backhoe excavator on board)</td>
<td>10-30 minutes</td>
</tr>
<tr>
<td>6 Time taken to complete project</td>
<td>30 years</td>
<td>3 years</td>
</tr>
</tbody>
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### ABOUT THE AUTHORS

**Prior to becoming an academic, Dr Foo Check Teck** had held senior positions as Manager with ABN Bank, Project Manager with a major German MNC, Klockner Industrie Analagen and Assistant Director, Strategic Planning of National Productivity Board, Singapore (now SPRING). Besides NTU where he is Associate Professor, Systems Engineering and Management, he is concurrently Honorary Chair of Competitive Strategy with University of St Andrews and Distinguished Professor of Finance, City University of New York. He is globally renowned for his research on art of war corporate strategy and was selected one of the Straits Times ‘Movers and Shakers in Asia’, who also named him as Singapore’s ‘Man of Renaissance’.

**Loke Siew Fai** is a Singapore building professional, having spent three decades in the management of building and civil construction projects and also as a consultant on design and build projects, specialising in industrial buildings, factories and facilities. The last ten years in the marine construction industry as a shipyard owner and operations manager have led to his invention of the tipper barge. His invention has been patented in several countries including the USA.

**Dr Low Seow Chay** has a PhD in Mechanical Engineering from U of Manchester. In 1981 he helped kick-start Nanyang Technological Institute (renamed a University in 1992), becoming Associate Professor in 1992. He specializes in clean energy, desalination, wastewater treatment and polymeric membrane, and has published more than 100 papers for various journals and conferences.

Since 1988, Dr Low has served a total of 18 years as an elected member of parliament, in a variety of appointments: Chairman of the Government Parliamentary committee (GPC), District Chairman of the ruling party, Vice-Chairman of Town Councils and Board member of the Housing & Development Board. He was also the Vice Chairman of Singapore Preparatory Committee for World Climate Change Summit in 2002.

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