# The Implications of Adaptive Speed Management (ASM) for Fast Ferries

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***ABSTRACT***

*Profit is the difference between revenue and expenses. Fast Ferry operators earn revenue by providing high-speed service. The revenue formulas are clear and well behaved. Expenses, however, can be well defined or can be completely unanticipated – and occasionally quite dramatic. For example, recent highly publicized mishaps have given a "black-eye" to the Fast Ferry industry [“Fisherman dies”, 1999]. Collisions with marine mammals and other vessels, bank erosion due to vessel wake, excessive near-shore smoke, and speed limit infractions have all contributed to unanticipated difficulty and expense – both in real terms and as a public-relations challenge.*

*Less sensational perhaps, but certainly important, is the management of expense with strategic planning. Maintenance of propulsion equipment, reduction of emissions and improvements in fuel efficiency all provide a different challenge. The author proposes that the use of "adaptive speed management" (ASM) can contribute to the mitigation of these problems and challenges by*

- *managing speed in real-time,*
- *optimizing engine-propulsor system performance, and*
- *documenting actual vessel speed to prove compliance with regulations.*

*This paper introduces ASM, and how it can be deployed and effectively utilized within the Fast Ferry industry. Results of a case study are also presented.*

## WHAT IS ASM?

*Adaptive speed management*, or ASM, is the ability to maintain a desired operating speed under any loading or environmental condition. An *optimizing ASM* system has the further ability to maintain speed in as efficient manner as possible. ASM has not traditionally been an important consideration in the operation of most vessels, but in a segment like Fast Ferries, which is driven by departure and arrival schedules, ASM can have direct and in-direct benefits.

As loading and environmental conditions changes, the propulsion control must be changed to maintain speed. Upon entering a speed-restricted area, the helm must be vigilant that he does not exceed the speed limit.

The initial perception is that the helmsman can adequately manipulate the controls to manage speed. Unfortunately, this is rarely possible with manning levels being reduced and helm responsibilities extending to navigation, visual spotting of marine mammals and other targets in the water, and responding to a growing list of communication sources (e.g., voice, weather, USCG). It is further unlikely that a helmsman can optimally forecast the best overall speeds for the transit.

In short, companies operating Fast Ferries are ultimately responsible for their vessels' operation. Both strategic and tactical operating benefits can be realized with ASM.

## TACTICAL USES OF ASM

The tactical, or on-board, utilization of ASM allows the helm to meet the voyage requirements under the existing loading and environmental conditions. The "adaptive" nature of ASM is an investigative learning process, where the vessel's performance under current conditions are monitored, evaluated and used to optimally maintain a target speed.

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### Controlling speed in limited visibility

Avoiding collisions, groundings and other accidents is always a good idea. The notion of an accident with a fully loaded Fast Ferry is frightful. During periods of limited visibility, such as in fog or darkness, prudent reduction of speed is required.

Operators can reduce the risk of accident by initiating strict speed limit guidelines during periods of limited visibility. A speed limit is an effective guideline for the helmsman because it removes all subjective decisions and gives a clear instruction of the desired objective. The helmsman can then set the desired speed into the ASM system, and not be distracted manipulating controls during such periods of heightened operational stress.

### Complying with speed restrictions

There are many circumstances where speed limits are required by municipalities and other agencies. Fines for excessive speed can be quite large, and the subsequent bad press of such an incident keeps an operator from being seen as a "good neighbor".

Certain species of marine mammals [“Avoiding collisions”, 1998] are protected in designated critical habitats. These zones have a number of "rules of conduct" when transiting the designated habitats, including reducing speed, securing spotters and changing course. In some instances, these regulations are applied when mammals are sighted outside of the designated habitats. As with periods of limited visibility, ASM can automatically maintain the reduced speed while the crew devotes their attention of spotting and navigation.

### Improving fuel efficiency

The greatest interest in ASM often comes from its potential for saving fuel. Savings can be achieved in a number of ways – by maintaining a consistent speed, by offering new control options and by doing so in the most efficient way possible.

Simply reducing the variation during a run saves fuel. For example, operating 10% too slow then 10% too fast uses nominally 3% more fuel than if constant speed had been maintained over the run. Matching the speed to the distance of the run is perhaps even more important. Traveling 5% too fast only to wait at the dock can waste as much as 10% fuel.

One interesting benefit is the consideration of single-screw operation during legs requiring reduced speed. By loading one propulsor and engine into a more efficient range, a sizeable fuel savings is possible.

An ASM system can potentially extend this savings by carefully balancing the propulsions systems and limiting engine operation during periods of high thermal loading. For example, a suitable ASM system can alter pitch to avoid low RPMs, which might overload the engine.

The most exciting capability of an *optimizing ASM* system is the ability to identify modes of optimal fuel efficiency during a run of constant speed. The improvement in fuel efficiency with control optimization can be remarkable (see CASE STUDY below).

## STRATEGIC USES OF ASM

Strategic benefits of ASM are those that are principally for shore-side consideration. These are strategies independent of daily operation, and might include data logging, voyage planning and reduction of emissions.

### Data logging

While data logging is not a wholesale part of ASM and can be performed in a variety of ways, it can be directly employed as a part of an ASM system. Data logging is important for two principal reasons – it allows management to learn about each vessel's performance "personality", and it can be used to prove proper operation and compliance with regulations when questioned.

Through comparative trend analysis, an operator can identify many cost-saving opportunities. The data logged can help determine the best route plan or to confirm whether the propulsion system is unbalanced.

To some, data logging has ominous undertones of "Big Brother". We can all appreciate that management oversight of ship captains is a delicate issue, and one that operators do not take lightly. Unfortunately, it only takes one major mishap to put everyone out of work. When an accident does occur and the vessel was operated properly, a data log can be a critical piece of evidence when confronted with litigation or indictment.

### Voyage planning

Once a ship has the ability to properly manage speed in any operating condition, the trip can be planned to define optimal speeds over each voyage leg. Voyage planning can then utilize past trip information from the data logs to experiment with various speed-route options. For example, as currents and sea conditions change seasonally or even day-to-day, knowledge about the vessel response can yield

opportunities to alter speeds over voyage runs to mitigate rough-water effects on passengers and crew.

**Emissions**

The Environmental Protection Agency is under constant pressure to reduce exhaust emissions, particularly ground- and sea-level ozone pollution. Nitrous-oxide (NOx) reduction in the marine industry is a primary EPA objective. Engine manufacturers are currently under direct fire with new rules being developed to lower emissions standards. The consumer of fuel (and ultimate generator of emissions) has not yet been targeted, as current thinking believes that market forces will naturally motivate consumers to save the cost of fuel. It is only a matter of time, however, before the concrete regulations will directly affect operations.

ASM offers an ideal management and documentation tool when confronted with a regulated mandate to reduce emissions. The direct way to reduce emissions is to reduce fuel use. An indirect way is to burn that fuel more completely. An optimizing ASM, by its design, can point the propulsion system into modes of improved fuel efficiency. An ASM system with the proper capability can also keep a system from operating in RPM ranges which exhibit inefficient combustion (e.g., by single-screw operation or modifying the pitch-RPM relationships).

## FUTURE REQUIREMENTS FOR ASM

Again, the ability to manage speed will promote new opportunities to exploit these capabilities. One significant potential for ASM is its integration with Vessel Tracking Systems (VTS). Ports around the world are seeing increased vessel traffic and the only way to insure safe passage for all vessels is by monitoring and regulating their movements via VTS.

Hong Kong harbor is a notable example of the challenges confronted by traffic planners. The Hong Kong Marine Department documented that there were in excess of 130 vessels specifically defined as "high-speed craft" in the waters of Hong Kong [Chan, 1995]. VTS is looking more-and-more like aircraft traffic control systems, and we believe that VTS requirements for precise speed management are only a matter of time.

## CASE STUDY

In August 1998, testing was conducted on an 80 meter, 7000 HP, twin-screw ship with CPP propellers to determine the potential fuel savings using an optimizing ASM system. A new control system was installed which incorporated HydroComp's *SmartEngine* Control Optimizer software.

A schematic of the control system is shown in Figure 1 below. The commercial throttle/pitch controller managed all data collection and exchange, and responded to the control requests from the software.

The vessel was operating in moderate seas, with periodic swells. (It actually was running from Hurricane Bonnie.) A number of before-and-after tests were conducted, with fuel savings varying from 5% to as much as 18%, depending on the speed and operating condition. Two representative tests are displayed in Figures 2 and 3.

The operating speeds were maintained for over an hour to a precision within 1.5%. Fuel rate is represented in terms of fuel efficiency (liters per nautical mile).

The tests demonstrated significant fuel savings under optimized ASM control. The cases, some of which resulted in improvements of 18%, were beyond our best expectations. The amount of benefit, of course, depends on the capabilities of the existing control system and the operator.

It is precisely in cases of fixed control technology where optimizing ASM is most valuable. The adaptive real-time analysis of vessel, engine and propulsor performance optimally managed throttle and pitch for the ship's current condition – right here, right now.

## CONCLUSIONS

The opportunity now exists for Fast Ferry operators to take advantage of "adaptive speed management" to control speed in limited visibility, comply with speed restrictions, and to log data to prove compliance. This capability can then be integrated with the voyage planning process to plan the best speeds for each leg of the voyage. Growing congestion in the world's ports will undoubtedly require ASM to become part of future vessel traffic control regulations.

With an optimizing ASM system, significant fuel savings are possible, as are the potential improvements in engine loading and emissions. An optimizing ASM system should be part of every Fast Ferry control system.

## REFERENCES

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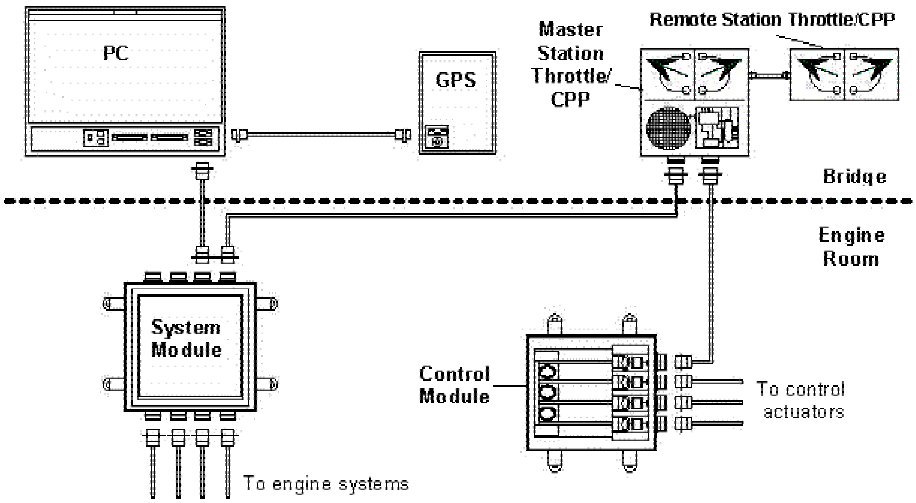


*Figure 1 – ASM control system schematic*

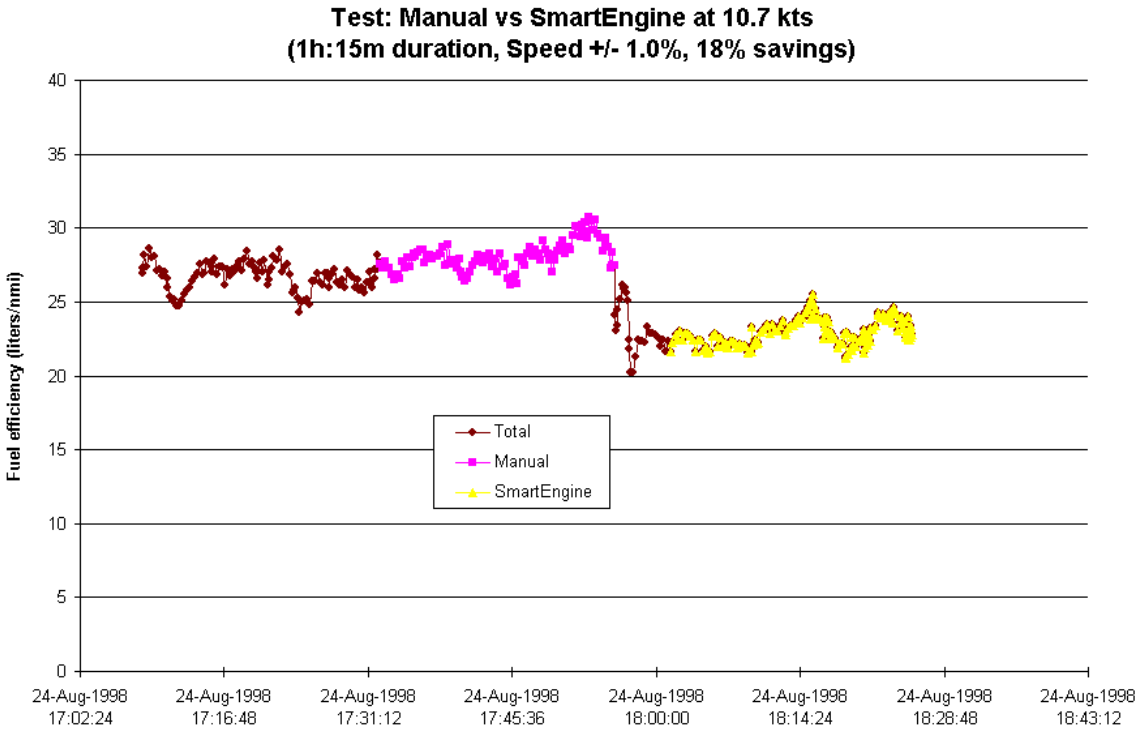


*Figure 2 – Test results at 10.7 knots*

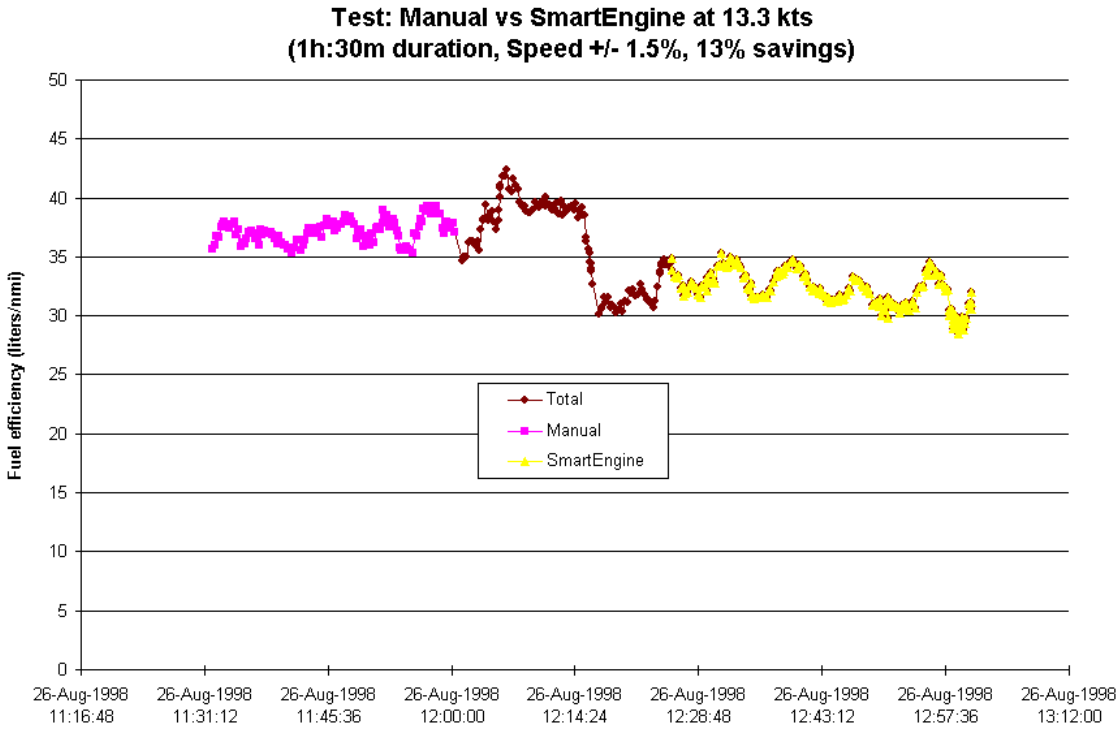


*Figure 3 – Test results at 13.3 knots*