Optimising Manning & Machinery

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'Those who cannot remember the past are condemned to repeat it.' Let us reflect upon a true story of a very famous ship, which was the turning point in the history of shipping.

The ship was built in the USA and later expanded in Japan. It had a Sperry gyro & autopilot, which made a clicking sound while turning. It's owners were a subsidiary of Union Oil, Liberian registry, chartered to BP and had Italian crew. On 19th of February it left Kuwait with full cargo of oil, bound for the Atlantic. Destination unknown. Only on 14th of March, when they were off Canary Island, were they told, the destination was Milford Haven where they must reach by 6PM on the 18th of March to catch the tide or else the ship would have to wait for six days.

On the early morning of 18th March, the Captain who had slept at 03.30 AM, was woken up at 6 AM as per his own instructions. The ship was about to make its first landfall. At 06.30 Scilly Isles appeared on the radar but on the left, not right. The Master decided to go in between the Scilly Isles and Land's end, as it had a 7 mile wide channel for deep draft, that he had transited 18 times before.

The Captain came on the bridge at 7AM. The junior officer was assigned navigation duties; ship was on autopilot and the helmsman on lookout in the wings. At 08.15 a.m. an alteration of course was made on the autopilot to avoid fishing boats in the channel. The autopilot made clicking sound as usual.

All was fine till 08.40 a.m. when a plotting error was discovered. The junior officer had been plotting positions by 'bearing & distance'. Quick re-plotting revealed they were only 2.8 miles from the 'Seven stones' reef. Autopilot was switched to manual temporarily and course changed to North.

After some time, position was plotted again and to their surprise they were still heading for reef. Emergency course change to 340 was ordered. Steering was changed to manual, the wheel turned, but there was no course change. The Captain went into the chartroom at the back of the bridge to view the chart. Helmsman shouted that he couldn't hear the clicks; the captain couldn't hear him.

Then the captain realised he too couldn't hear any clicks from the steering stand. Suspecting that the fuses may have blown (as this had happened before), he opens the fuse box to find they were OK; therefore the oil pumps must be at fault (this too had happened before). He rings the engine room; by mistake, dials the wrong

number and gets the galley. The cook picks up, "Oh, captain, your breakfast is ready." Captain glances at the autopilot control lever; realises the problem; changes course.

But it was too late. At 17 knots, Torrey Canyon hit a rock, which ripped open 6 tanks, resulting in the first big oil spill. There were no plans to combat this.

Was it human error or machinery assisted error or both? After all if the steering had worked this disaster would not have occurred. Was it a result of bad designing of equipment or procedures? When systems function well few seem to appreciate the human factors input that has led to the smooth operation. When disaster strikes people say it is human error. Are machines error free? Several lessons on optimisation of man & machinery can be derived from this incident.

The meaning of optimising

Let us first understand what do we mean by optimising. The root of the word is the Greek word 'optimus', which means optimism, a positive outlook. Any criticism with negative overtones or pessimism about the existing manpower cannot lead to optimisation. Optimising means

- To make best use of
- To make as efficient as possible by analysing or planning processes.
- To strive for the most favourable condition for the achievement of a result or aim.

Thus optimising has 3 essential elements- a positive outlook, an aim to achieve and the involvement of analysis. (See Figure-1)

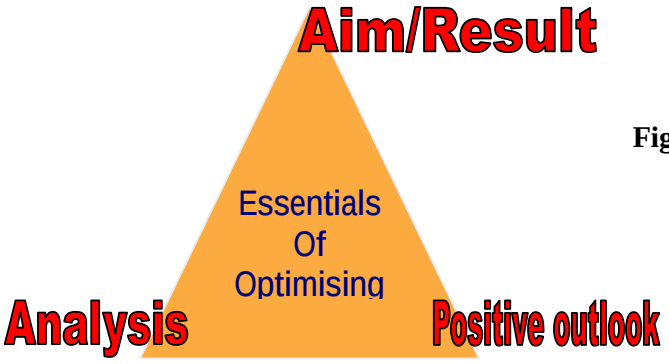

Figure-1: Optimising Triangle

The Aim of Optimising

Let us consider the aim first. Why do we want to optimise? What are our goals? Some say maximising commercial gains. True, ultimately the economics of a venture should be sound. But in what time frame are we talking about? Do we optimise to achieve short-term profits or we have a long-term vision for this industry? Immediate profits is the not the yardstick to evaluate optimisation efforts. In fact this route is dangerous. Sometimes what may seem commercially apt may be a preparation for disaster as we saw in this case. Going round the Scilly

isles meant extra 2 hours and missing the tide. Hence, our larger goal is to optimise for sustained profits.

Ship's performance is a direct contribution by the flag state, company, the crew & the individual in the varied circumstances. *The common immediate objective is safety & welfare. Sustained profits will automatically result if safety & welfare is achieved.*

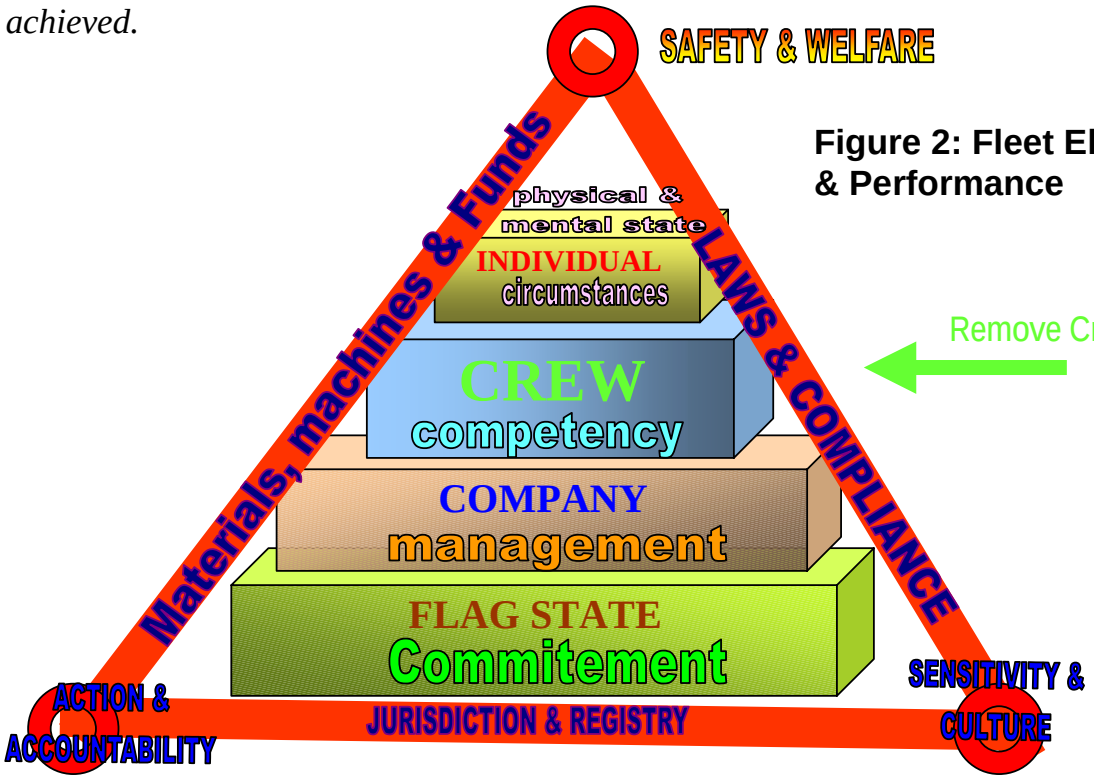

Figure 2: Fleet Elements & Performance

Machines are just one of the means to achieve these goals. But can the slot where the crew fits, be totally removed? No. because there is human interface with the means at every level. *Optimising means every element has a role to play. Optimising means using the means effectively.*

Those dreaming about unmanned ships citing examples of unmanned spacecrafts are not taking a full view of the shipping as a system. Ships should be viewed as sociotechnical systems, consisting of technologies, personnel, organizational structures, and an external environment.

Even if an efficient unmanned ship were possible technically it is not desirable as it would be an unwise economic decision, restricting the profits to few select individuals only. In the global economy the prosperity of people must remain interconnected, it is therefore incumbent upon all of us to ensure that seafaring remains a profession. Pythagoras has said 'man is the measure of all things.'

Time to talk about optimising?

If profits alone are the criteria to talk about optimising manning, then the time is not right. The freight rates are on a high for all type of operators. Very good profits are being earned in most segments. The graph of cargo orders shows a positive outlook for 2004 & 2005. Isn't the industry already responding efficiently to the increased demand? Are we not already optimising manpower & machinery? On the other hand just one disaster may wipe off the current rosy picture of profits. So should we proactively reduce manning?

Well! The problem is our perception about optimising. We think of optimising as replacement of manning with machines. We are wary of the human error. But optimising means increasing the efficiency of the existing manpower. Eliminate that human error, not by eliminating humans but by focussing on them.
In fact, with no resource crunch, there is no better time to talk about human issues than today. Yes, it is time to train for better efficiency, to achieve greater safety and quality, modernise and therefore lift the image of this industry.

Optimising for quality:

Results taken from DNV Maritime Solutions reveal that:
-25 percent of all ships represent 51 percent of all ship accidents
-Small shipping companies, with poorer safety culture, often own these
-Safest 25 per cent cause only 7 per cent of the world's total ship accidents.
-These often belong to the biggest and oldest shipping companies, are of 15 years age or less and do not belong to FOC.
-More ship accidents occur in periods of decline (when manning is squeezed) than in periods of expansion.

If we lift the quality of the rest of the shipping to the same level as the best 25%, we can have 72% reduction in the accident rates. Will machines lift the quality or trained humans?

In fact optimisation means differently to these two sections of the industry.

Substandard shipping has overworked crew, unreliable old machines, non-existent transparency and compliance. With Untrained managers in their shore team there are unreasonable deadlines for a job without going into the task analysis. Messages read ' fail to understand' or 'reply by return' for general matters. Fear of victimisation prevails for not faking the rest hours or logbooks.

Optimisation in substandard shipping means training shore mangers in proper management practices and human aspects. Train the company executives to interpret and appreciate systems, to perform task analysis, to create a culture of compliance and to eliminate fear or undue risks or time pressures on the ship staff. More automation or machines will simply not enhance efficiency here, as the culture in the organisation, right from the flag state upwards is disaster oriented.

Companies with a safety culture and a human face (in reality and not merely on paper) can afford to increase efficiency by introducing more machinery & automation based on sound ergonomic principles. Such ship managers need to be trained to design processes and reorient the ship team.

History of crew reductions and automation:

Even though optimization doesn't mean crew reductions, some people advocate it on the basis of advances in automation or mechanization, as was done from 1960 to 1980. Diesel engines, separate maintenance department, containerization and engine room automation had made this possible.

What is now worrying is our trying to replicate the German "Ship of the Future" program, which had IBS, easy engine room layouts and automated safety equipment with only 14 crew. Or the Japanese "Pioneer series" with only 11 crew. A very cautious approach is required. These are five issues that need to be considered.

Firstly are we now at a **CRITICAL MASS** in terms of crew size? Perhaps Yes. Earlier reductions were effective as technology changed slowly and crews were larger, but today a detailed functional task analysis will reveal a shortage of at least 2 in the crew size. Why did such experiments not become common practice? Current manning levels (21 on an average on most ships) seem to be optimum, operationally and commercially? The adverse effects of current reduced manning are evident.

a) Insufficient people: to handle emergencies, for jobs requiring strength and to share workload of the impaired crew.
b) Desire in senior officers to quit the industry; professional pride on decline.
c) Stress, fatigue, Reduced socializing- all being safety issues as well.
d) Chronic Fatigue of the bridge crew who are also the cargo crew in port. Breach of rest hours results in over reliance on the pilot.
e) Less or No shore leave produces a stress reaction that makes ships personnel unreliable.
f) No time for on board training: resulting in declining practical professional competence, particularly gaps between operations & use of technology.
g) Problems of drug and alcohol abuse not only to de-stress, but to keep awake, overcome fatigue or loneliness.

The second concern is the need for **ACCURATE STATISTICS**. Is there any statistics available to demonstrate the success of these experiments? Were the impacts of reduced manning levels on safety or human behavior studied? And this industry is known to be lagging behind when it comes to statistics or research particularly on the human factors. The aircraft industry and its regulators spend generously on R &D. Studies conducted by a few flags prove that 'fault line' of fatigue has deepened, itching to cause another 'tsunami' in shipping.

Third concern is the current average age of the world fleet, which is about 15 years. It has been statistically proved that this is also the age for maximum losses and causalities. We also remember how unreliable UMS is on a ship 10 years of age or over. Hence to suggest manning reductions for the entire world fleet is illogical. Also consider that when big & good companies pass on their ships to small businesses under FOC, the provision of manning reductions will only be **MISUSED**.

Fourthly, Has the introduction of machinery and automation reduced the losses in the shipping industry? Figures from underwriters' show that number of incidents resulting in partial losses has increased over the last 5 years.

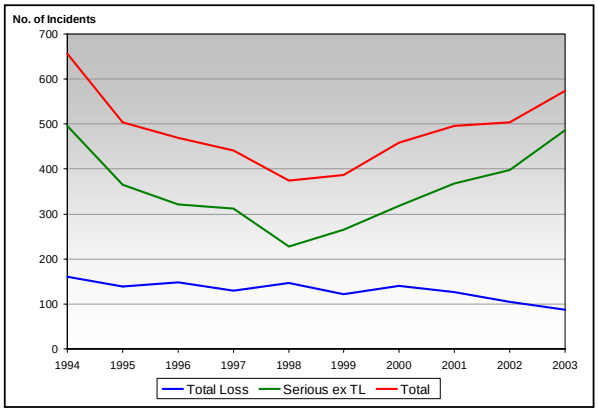

Figure –3: Number of Incidents causing losses yearly

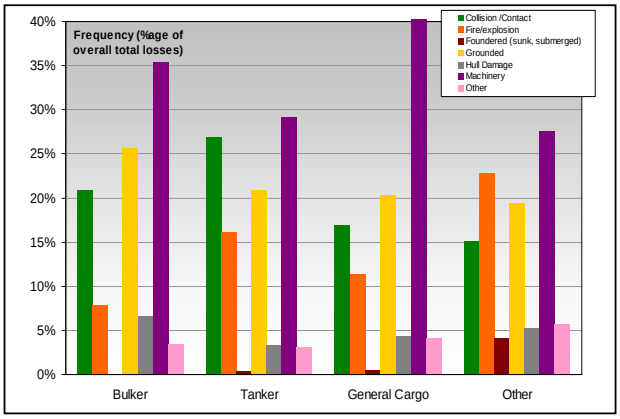

Figure – 4: Frequency of Causes of Incidents causing losses and ship type.

Source: LMIU for Joint Hull Committee. (Mr. Simon Beale presentation in Ocean Hull committee workshop September 2004)

If you have a look at the causes of underwriters' losses, machinery failures are the greatest **CAUSE OF LOSSES** for all types of ships. Those who suggest more machines for better profitability need to think again. In fact exposure to losses is increasing with technology. For those believing in the superiority of machines, the saying goes 'It is only when they go wrong that machines remind you, how (disastrously) powerful they are.'

The fifth issue is the anticipated disadvantages of **EXCESSIVE AUTOMATION**.

a) It accompanies information overload that a watch keeper may not be able to cope up with. e.g. IBS with engine & cargo controls may be distracting when a critical manoeuvre is going on. (Implying losing on safety)
b) Installing automation does not reduce the crew's workload, because – it doesn't work as reliably as advertised, automation does break and you are forced to resort to manual methods. (Implying losing on human issues)

c) Installing automation and its continued maintenance requires high cost and thus does not solve the competitive cost problems, which form the basis of crew reductions. (Implying losing commercially)
d) Over reliance on automation results in the loss of necessary specialized skills and seamanship aspects being ignored. Is the industry prepared to lose certain skills like steering by hand? (Implying losing the future)

If crew reductions accompany automation the industry will lose on all fronts.

The maritime industry and the civil aviation industry.

Discussions of vessel automation and smaller crews often focus on parallels between ships and commercial airliners, which are also increasingly automated and have also reduced their crews in recent years.

A comparison of the two industries illustrates:

• Navigation of airliners is directed by a mandatory traffic control system, where the craft is handed over from one control station to the other. Ships entirely depend on the skills of their crew, as no such system is possible due to the duration of voyages.

• Aircrafts have higher Maintenance standards, strictly enforced, done by ground staff (and not flying staff); quite unlike the maritime world where quadruple duties of watch keeping, security, maintenance and cargo are thrust on the sailing staff.

• Hours of work aboard aircraft are strictly limited by regulations. Aircraft do not fly if the available crews have not had the specified rest. Aboard merchant ships, current-manning statutes set no upper limit on the hours a crewmember may work. The 'no rest, no fly' principle is not applicable.

Requirements of efficient transport

The importance of the human factor in the governance of any industry should be obvious to all. Lets see why.

What is crucial to efficient transport? Particularly marine transport, whose physical environment is the hazardous, ever changing, unpredictable, unforgiving sea. What we need is:

1) ***To recognize & act on a problem:*** It is a known fact that humans can distil complex information to the bare essentials very quickly and react appropriately.
2) ***Goal Setting:*** Humans have better strategic & planning abilities**.** Machines definitely cannot think, adapt, react, decide or be flexible. If ships were to operate on decisions made by machines then it would disastrous.
3) ***Goal Switching as per circumstances:*** Machines are even weaker compared to man when it comes to the ***forces of nature*** as they work on pre-fed information and only in predictable circumstances.
4) ***Reliability:*** While both can ***fail***, it is proved, machines tend to fail at the least convenient moment, whereas human performance tends to degrade somewhat more gracefully.

So we are talking about 1) inductive reasoning 2) resolving conflicts between various data/inputs 3) Risk assessment 4) system stability. The human element is there to provide a degree of rationale that cannot be attained by a machine directly.

Operating a ship is not a mechanized task but requires practice of good seamanship making Seafarers specialists in their trade. Expecting machines to practice seamanship is beyond comprehension. People remain a basic component with all their strengths and weaknesses. Our task is to sort out the issues - to build on the strengths and correct the weaknesses.

Manning as a cost effective option:
When mariners relinquish seafaring lives or manning reductions drive away efficient and experienced officers, the knowledge base of the industry is undermined, operational risk increases, profits plummet. Instead of diverting costs from man to machinery if we improve our ability to retain personnel - they will give us prolonged service, resulting in reduced recruiting & basic training costs. Some may argue that seafarers will any way leave at some stage or the other. Optimising means utilising their experience in the diverse sectors of this industry ashore. How to improve ability to retain personnel? Have more people on board, involve them in decision making, budgeting and costing. Remote control of shore management on every issue must go. Psychologists say people feel most satisfied when they take decisions. But for this the seafarers require better maritime education.

The Human machine: The most valuable machine is held in the cranium. It can innovate, change losses into profits, it can fix all problems. Exercise of responsibility, authority and participation in the process is optimising.

Analysing optimisation:
So how do we do the analysis of optimising manning & machinery? Ergonomics is the analytical tool that gives us a clue of how to optimise these. It is the science that studies the relationship of humans to their working environment and seeks to improve working conditions and increase efficiency.
In order to understand ergonomics, let us now do an analysis of the ‘Torrey Canyon’ incident described earlier.

Proper matching: We first saw built in USA, later expanded in Japan. Users and designers when of different cultures may vary in their interpretations or understanding of the machines. **Optimising means finding a proper matching between the worker, equipment, or the environment**. For example, What if you turned the wheel of a new car to the right and the car went to the left and crashed. This scenario is often called 'human error' as the driver did not know how to work

in the system. But, what we actually have is a mismatch or poor fit between the environment (car), the task (turning right), and the human perception.

By improving the fit between humans and systems, we can improve performance, safety & comfort. The first approach to optimise is to design and engineer systems to **match human** capabilities, human perception and human limitation.

Sub-optimal controls: The cause of the accident was- the autopilot lever being on disengage perhaps due to an inadvertent knock by the helmsman. This means the ship had sub optimal controls. Optimisation means that the displays and controls must be carefully designed to eliminate machinery-assisted errors and be user friendly. The user must **communicate with the systems** and that is what optimising is all about.

Some suggestions for optimising machines are:

a) Standardize automated shipboard equipments. Essential controls should be in same location. Non-standardization has effect on learning, operating reliability, and cost.
b) Ship designers & equipment manufacturers need to make good workstations; giving due importance to visual display and physical environment.
c) Provide exhaustive information of the machineries, its limitations, alternatives in failures, exact procedure of maintenance including time required for opening every bolt, to facilitate better task planning.

Machinery Limitations: the ship had a single propeller, large stopping distance etc. In other words, it was almost un-manoeuvrable-a problem in coastal waters. Optimising means taking a complete view of circumstances or a systems view of things. Thus the second approach to optimise is to **help humans to adapt** to the system and its limitations.

Job Aids: Sperry autopilot- that made clicking sounds- best way to indicate turning. Every worker seeks to simplify his working life or job by such job aids. **Optimising means simplifying the job by the aid of reliable machinery.** Humans should be trained to check the reliability of the aids and not be overcome by them.

Design Procedures: The ship was owned by Union Oil, Liberia registered, Italian crew etc. **Optimisation is concerned with issues of responsibility and authority, and the design of procedures.**

A triggering factor was the single method of plotting position. Why alternative methods or 3 bearings were not used, though available? Because it requires greater effort. It is human tendency to conserve mental effort. What we need is to design work on ergonomic principles i.e. have efficient procedures that don't need short cuts.

Proper execution of procedures: Unknown destinations & poor deadlines lead to time pressures which always leads to probability of errors and bad decisions. Invariably the safe alternative in a decision is discarded, because it needs more time. Optimising requires **transparency and adequate time frames**.

The Junior Officer made a navigational mistake, which took a while to become evident. Optimising requires **experience** by doing the real job and not just competence acquired in the classroom. This requires **onboard training** to be ensured by the company, requiring more people on board to train. It may also require repeated exposure to difficult situations on the **simulator** ashore.

Sub optimal decision-making: Captain was certainly tired due to only 2.5 hours of sleep. Fatigue is increases the probability of errors as you become slow to realise what's happening. No wonder he took the fateful decision that triggered the incident - deciding to go in between the gap.

When steering does not respond he decides to have the fuses checked and later the pumps. Sub optimal decisions can be avoided if people are trained for emergency situations and machinery failures. Logical responses need to be listed.

Capt rings ER, gets galley. An example of "Haste makes waste'. We all do this when we are close to panic, which is why training should be repeated frequently, to try to make sure people would do the right thing.

Design Learning: Lastly we saw there were no plans to combat this; an important part of ergonomics is learning from the past, and making sure the lessons are made available to designers and engineers, so that mistakes are not repeated. This requires designing knowledge acquisition systems and information dissemination.

We require machines too!

Life without machines is impossible to conceive. We need to optimise the use of people and machines together. The distinct advantages in having the optimal mix of humans and machines is that, working together reduces the probability of common mode failure. How ever the inevitable increase in automation should be limited to non-expert tasks.

Some suggestions include:

-Bring machines & automation where the work is labour intensive- e.g. self lubricating machines, for opening nuts & bolts, fully automated winches, automated gangways & hatch covers, hatch cleaning.
-Bring machines to warn about human failures.
-Machines to monitor security system (access control)
- Automatic chart updating
- More Internal communications equipment to raise reinforcements quickly.

It is all about training:

Lack of attention to the human system interface, and training in their use, is the root cause of many accidents today. The key to improvement is in "fit for purpose" designing, proper selection of people fit for a job and adequate training. Training equips them with the right knowledge and skills. It modifies the person to fit technology. Undoubtedly training programs need to be dynamic to generate specialized skills to deal with more of sophisticated technology. With or without manning reduction, we are talking about a transformation process for the crew.

What has become more established over recent years is the concept of Continuous Professional Development (CPD). Humans are not born with the skills needed to progress through life, but rather that we are learning all the time.

Training should help people to develop their expertise throughout their career till they become experts in their field and pass on that knowledge and expertise to others.

In order to optimise manpower:

a) Train the seafarers, principles of good management and decision-making.
b) Make them understand the complexities of trade, commercial knowledge to maximize owner's interest.
c) Training to appreciating design limitations
d) Repeated training in emergency response and continued learning from past events.
e) Train them to train people on board.
f) Expose the Junior staff to real life situations before stepping on board
g) Keep them abreast of the latest developments
h) Let focus of training shift from cramming as is done for competency exams, to lot more research and project work.
i) Train them to relax; de stress and keep a positive outlook- thus improve their capacity to work- perhaps yoga training.
j) Improve the power of expression, as the Speech and written skills of many of our seafarers is still poor.
k) We need training that helps the searing population develop, to find jobs ashore.
l) We need training for shore personnel- the management companies- port personnel- to appreciate ship personnel's job and develop greater sensitivity towards matters in common interest of human race- like pollution or human rights.
m) We need training to change mindsets and attitudes. To develop professionalism.
n) Training to eradicate the fear of being victimized, reporting the wrong for better performance and interaction.

o) Any machinery that is introduced must be first introduced to the training institutes. Manufacturers must collaborate with training institutions; provide simulators, models of new equipments. This will remove the fear of failures and any under utilisation of machineries.

By the focus on the human element we are reiterating the Indian philosophy that believes in harnessing the power of the mind and spirit. Proper education gives us the wisdom that gracefully rearranges tangles of commercial life. Optimising manning means making humans consistently deliver wise leadership, take decisions without prejudice, with loyalty, maintain authority, encouraging the best in people and achieving success without sacrificing happiness.

Finally optimisation is all about training in the right areas in the right way. The following quotation by William James very aptly connects humans, optimisation and training.

‘The greatest discovery of my generation is that human beings can alter their lives by altering their attitudes of the mind.’’