AN APPROACH TO EDUCATION AND TRAINING OF SEAFARERS IN LOW CARBON – ENERGY EFFICIENCY OPERATIONS

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ABSTRACT

The 'Low Carbon–Energy Efficiency' subject has never been as important as now with increasing worldwide concern about climate change and the pending enforcement of International maritime carbon policies and regulations. Implementation of operational measures alone offers a significant potential for reducing Shipping Carbon Emissions. Currently there is no formalized Education and Training of maritime personnel in the area of Ship Energy Efficiency with focus on reducing Ship Carbon Emissions. This paper considers this existing gap within the current Maritime Education and Training system and it addresses the potential benefits of providing a specific 'Low Carbon–Energy Efficiency' Maritime Education and Training course on a large scale. Various approaches to course delivery are examined and a course framework is presented based on the most effective methods for knowledge transfer: for increased cadets' awareness, knowledge, skills and motivation towards the Low Carbon' subject. The appropriate course content is discussed including consideration of the material required for theory based learning, exercises, case-studies, simulator training and E-learning, and the subsequent assessment of each.

Keywords: Low Carbon, Energy Efficiency, Education, Training, Seafarers

NOMENCLATURE

CBT	Competency Based Training
CO_2	Carbon Dioxide
EEDI	Energy Efficiency Design Index
EEOI	Energy Efficiency Operational Indicator
GHG	Green House Gasses
MET	Maritime Education and Training
METS	Maritime Emissions Trading Scheme
ICF	International Compensation Fund
IMO	International Maritime Organisation
SEEMP	Ship Energy Efficiency Management Plan
STCW	Standard of Training, Certification and Watchkeeping for Seafarers

1. INTRODUCTION

Over a decade ago concern about global warming and a detrimental increase in climate change became an increasing worldwide concern. Global warming is associated with green-house-gas emissions (GHG) of which carbon emissions (most significantly carbon dioxide, CO_2) are considered the most detrimental to our atmosphere. Globally, we need to develop and implement both mitigation and adaption techniques to reduce the effects of climate change as far as possible.

'Shipping is estimated to have emitted 1,046 million tons of CO2 in 2007, which corresponds to 3.3% of the global emissions during 2007.'
(Buhang et al, 2009)

Shipping is under pressure at a global scale to reduce the proportion of carbon emissions it emits into the atmosphere. It was agreed internationally that responsibility should be given to the International Maritime Organisation, IMO, to design and implement the necessary policies and regulations within the maritime industry.

The IMO have published a report (Buhang et al, 2009) that discusses the development of regulation tools such as the Energy Efficiency Design Index (EEDI), and the Energy Efficiency Operational Indicator (EEOI), which both measures carbon emissions against the ships design and operation profile retrospectively. Calculation of both at present is voluntary but baselines are being developed along with financial incentives (such as: Maritime Emissions Trading Scheme, METS and International Compensation Fund, ICF). Enforcement of the new Ship Energy Efficiency Management Plan (SEEMP) is also pending.

The EEDI can be affected by making Technological changes. Technical methods for reducing shipping carbon emissions include vessel design, in terms of: (Buhang et al, 2009)

- Design Concept
- Hull and Superstructure
- Power and Propulsion systems
- Low-Carbon Fuels
- Renewable Energy

These technological methods could be implemented as retrofits or onto/into new builds. The EEOI can be affected by making operational changes. Operational methods for reducing shipping carbon emissions include: (Buhang et al, 2009)

- Fleet Management
- Voyage Optimization
- Improved Operation
- Maintenance optimization
- Energy Management

These operational methods can be implemented on all ships (new builds and existing ships), with a relatively small investment cost, a short payback period and a large benefit: thus providing an effective short-term and sustainable solution to start acting upon shipping carbon emissions.

The implementation of the regulatory, technological and operational carbon reduction methods discussed will directly affect the crews onboard ships as well as other shipping personnel. The human aspect associated with these changes requires that the necessary education and training along with supporting material and tools is provided for crew.

This paper firstly considers and discusses the 'Low Carbon – Energy Efficiency' Maritime Education and Training (MET) required for all shipping personnel influential to the ships operation, then focuses on the education required for seafarers.

This paper starts by identifying the 'Low Carbon – Energy Efficiency' gap within MET. The target group are then identified followed by their current levels of 'Low Carbon – Energy Efficiency' awareness, knowledge, skills and motivation, and the existing MET materials and resources available. Course aims and objectives are subsequently proposed and methods for education and assessment are discussed before the 'Low Carbon – Energy Efficiency' Framework is presented. The potential benefits of implementation of the framework are then discussed.

2. IDENTIFYING THE CURRENT GAP AND NEED FOR EDUCATION AND TRAINING

Before commencing this research it was first necessary to establish the current availability of 'Low Carbon-Energy Efficiency' MET. A survey was carried out at maritime education and training institutes in the following countries: UK, Netherlands, Turkey, Greece, Finland, Denmark and Sweden. They were asked if they provide, or know of any formalized or structured 'Low Carbon – Energy Efficiency' MET courses or individual classes. No specific, formalized course is currently available.

External industry contacts and training providers were also asked the same questions and again there is no awareness of any such education and training: however, it was identified that energy efficiency is considered internally within some companies.

A 'Low Carbon – Energy Efficiency' course is in demand from the shipping industry and by MET institutes. Not only will the course help achieve carbon emissions reductions and hence benefit the environment, but it will also encourage cost savings by increasing energy efficient (reducing fuel consumption) and it has the potential to enhance the company's 'GREEN' image; which is already becoming a competitive attribute within the shipping industry.

It can therefore be concluded that worldwide there is no formalized specific 'Low Carbon–Energy Efficiency' MET course provided for seafarers and maritime personnel, and it is in demand.

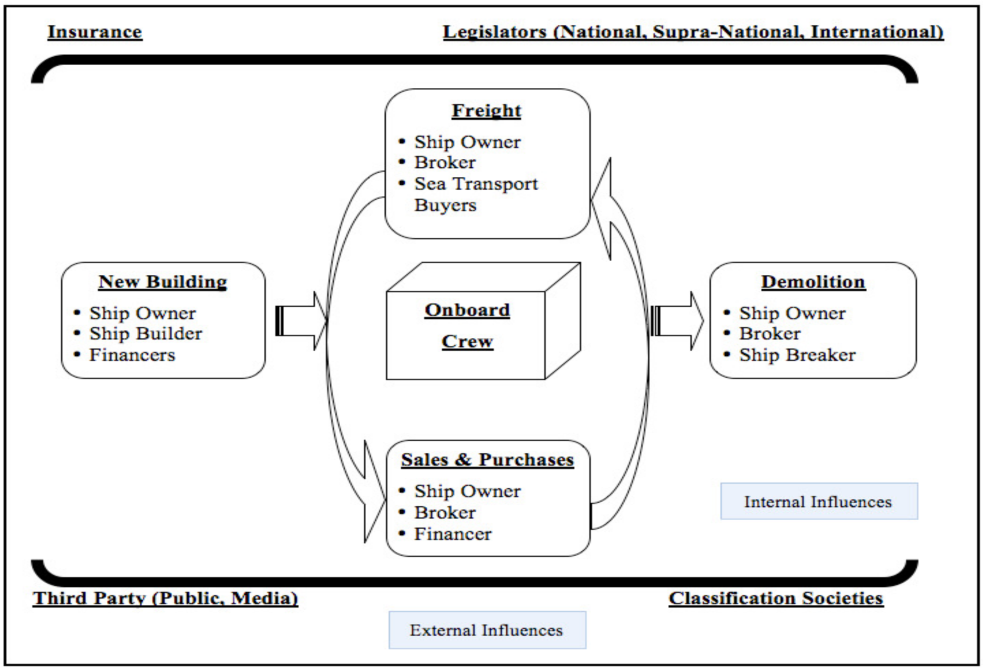

Figure 1: The Stakeholders through a ship's lifecycle, (Österman, 2009)

3. IDENTIFYING THE TARGET GROUP

The shipping industry is very complex in nature and the operation of the ship is not only determined by the crew onboard. Different levels of shipping personnel are responsible for varying decisions ultimately influencing and effecting the operation of the ship.

Figure 1 illustrates the shareholders of maritime human factors. Considering the operation of the ship, the onboard crew and freight personnel all have direct influences over the operation of the vessel. As discussed during Section 1, legislation, regulation and company image (in the eye of the public and Sea Transport buyers), will also influence vessel the operation indirectly. Ultimately education and training could, and should, be provided to all levels of personnel shown in Figure 1, including for New Building and Dismantling. However, focus at present is on seafarers (crew) and the cadets within the maritime education system who will form the next generation of the global crew base.

Crew and cadets have different educational requirements. Depending on the age of the crewmember, they may have undergone different training in comparison to current cadets, possibly due to updates within the existing MET system. Crew and cadets will have varying expertise using various equipment onboard different ship types they have worked on. Crew and cadets may also have differing existing motivational stances: for example, crew who have worked at sea for many years may be less motivated towards changes. Finally the delivery of the education will depend on daily routine: cadets attend collage generally on a daily basis whereas crew will have to take time off work to complete training or learn whilst onboard. As a result the delivery of the education required for crew and cadets must differ. Technical knowledge and skills must be addressed at the correct level so as not to repeat education and hence bore the students, nor confuse and baffle the students and hence lose their interest and motivation to learn. This must be done along with ensuring the necessary personal skills are developed; such as communication, teamwork.

The aim of the proposed MET framework within this paper is to provide the target group with not only ‘Low Carbon – Energy Efficiency’ knowledge and skills, but also the necessary awareness and motivation. This should be introduced at the earliest stage possible in the crewmembers career; within their education. Therefore the ‘Low Carbon – Energy Efficiency’ MET framework will first be developed for cadet within the maritime education system and can then later be expanded to include crew training and retraining and education other levels of shipping personnel.

4. IDENTIFYING EXISTING AWARENESS, KNOWLEDGE, SKILLS AND MOTIVATION AND EXISTING EDUCATION AND TRAINING MATERIALS, RESOURCES AND SCHEDULES

Having specified the target group (cadets in maritime education) the next step was to identify their existing levels of awareness, knowledge, skills and motivation towards ‘Low Carbon - Energy Efficiency’. These four attributes each hold a different and significant relevance in identifying the target group’s ‘Low Carbon - Energy Efficiency’ MET needs.

Awareness: Without awareness of carbon emissions the target group will not be able to draw on their knowledge and skills to help reduce carbon emission. Awareness of the importance of reducing shipping carbon emissions, how reductions can be achieved and awareness of how an individual can help to achieve this, are all important factors in promoting motivation. Additionally, awareness can be considered in terms of focus and emphasis, i.e. a piece of knowledge may already be taught or known but there is not enough focus or emphasis on it to ensure that it comes to the forefront of the target groups mind during every day operation.

Knowledge: Knowledge refers to the knowledge of how carbon emission reductions can be achieved. This will include focus on energy efficiency and how efficiently the ship is operated from a technological and operational viewpoint. Knowledge of individual systems is needed along with a holistic overview. Other influencing factors, such as external incentives, should also be known. This knowledge may already exist within current MET, it may just need to be refined, or ‘new’ knowledge may need to be included.

Skills: Having the knowledge is one thing but being able to apply this knowledge in practice is a critical factor. These skills may already exist within current MET, they may just need to be refined, or new skills may need to be taught.

Motivation: Motivation may come in different forms and focuses but it is a vital part to actively ensure the crew change their inefficient operations onboard (this may involve overcoming years of ingrained habits). Motivation for different levels of personnel will require different motivational focuses. The motivation itself may not come from climate change concern, as it cannot be expected that everyone will feel the same importance or even believe in climate change. Therefore other motivational focuses also need to be brought to the forefront of the designed education and training, such as: general environmental friendliness, cost, shipping company incentives and the pending carbon regulations.

Analysis of target group current awareness, knowledge, skills and motivation can be gathered via interviews and questionnaires. A questionnaire has been designed for cadets and a sufficient sample of results is in the process of being collected. However, via formal interviews and informal discussions with MET student cadets, lecturers (from varying MET Institutes) and with shipping companies, the following conclusions and statements regarding the current ‘Low Carbon – Energy Efficiency’ awareness, knowledge, skills and motivation and how it is perceived and its limitations, are summarized below:

Cadet Interviews

- There is currently no ‘Low Carbon – Energy Efficiency’ education or training provided within maritime education and training institutes. Therefore students have little awareness of the effects shipping carbon emissions have and the importance of reducing them.
- Environmental studies are carried within existing MET and there is an increase in awareness of SOx and NOx; but CO_2 does not yet have the same levels of awareness or focus.
- There is no/very little awareness of up and coming shipping carbon emission.
- Due to the lack of awareness there is no motivation to reduce carbon emissions: there is more motivation to increase energy efficiency for cost saving reasons.
- Rules and procedures dominate in everyday onboard operation and this leads to reduced motivation and discourages making additional energy efficiency improvements.
- Current MET provides energy efficiency knowledge and skills but there is no carbon focus and therefore it is not at the forefront the cadet’s attention. They do not realize how much they already know and therefore do not realize what energy efficiency improvements they could already be making.

Maritime Education and Training Institute 1

- Simulator training is sometimes used to provide indirect awareness about energy efficiency; i.e. techniques such as ‘ try–observe–compare’ for fuel consumption.
- Specific to the Maritime Education Institute, an elective class debates current environmental topics (e.g. CO_2 emissions) to keep up-to-date and promote awareness. However, it is not a compulsory class and does not include specific training on efficient operations and decisions.

Maritime Education and training Institute 2

- Operations are generally carried out with a ‘safe than sorry’ mind set, but how much of this additional safety margin is necessary? The correct safety/energy efficiency balance needs to be identified.
- There is a big difference between how different captains operate vessels in practice and this is very dependent on their motivation towards energy efficient.
- Energy efficiency of individual systems is taught within current MET but no holistic overview of how efficiently all the systems work once integrated onboard a ship nor what ‘Low Carbon – Energy Efficiency’ improvements could be made, is given.
- Simulator training is only used to assess the overall running of the vessel and it concentrates on what goes wrong rather than how to make improvements. It is not a technical assessment, more competency based.
- Currently simulator training looks at departure, arrival and emergency situations – but it could be valuable to carryout out energy efficiency training combined with a communication and teamwork full mission exercises.
- Classroom based simulation programs may be the best place to start introducing ‘Low Carbon – Energy Efficiency’ focus, before or instead of bridge and engine room simulators.

Industry Contact 1

- An energy management course is provided for one specific ship type and one company only.
- Positive results have been observed providing evidence that MET course can produce practical results.
- Workshops are scheduled into the course syllabus to gather feedback on real time issues observed by the crew.
- Such a course now requires delivery on a larger scale for significant carbon emission reductions

Industry Contact 2

- In opinion, Crew need to be educated in the following areas:
  - What instruments can be found onboard to aid operations, measurements readings, …
  - What material (e.g. written document) can be found about the instrument onboard
  - Where to find the material onboard
  - How to use the instruments
  - How to take measurements properly
  - How to validate the results
  - How to report the results
  - How to interpret the results and hence make adjustments
  - How EASY this can all be
  - What savings it can be made
- Current crew practices are demonstrating reduced:
  - Hands on work skills
  - Problem solving skills
  - Problem solving confidence
- There is the potential that too much programmed maintenance and operations have resulted in the crew not getting the chance to use their initiative as they are too busy following

mandated procedures. This promotes reluctance for problem solving and trial and error; which is vital for the generation of new 'Low Carbon – Energy Efficiency' knowledge.

- Energy efficiency of a vessel is an increasing area of concern. Monitoring of this performance is becoming more popular and more established.
- Benchmarking methods are being developed, experimented with and utilized.
- Performance support ashore is provided.
- When required, 'How to' documents can be sent to the onboard crew to help them make specific operational changes and carry out tasks.
- 'Low Carbon – Energy Efficiency' company incentive and competition between sister vessels is being introduced to encourage results.
- Regulatory proposed benchmarking tools (EEDI and EEOI) are being calculated and a SEEMP has been developed.

Industry Contact 3

- Technical and operational methods to increase energy efficiency are being experimented with using informed trial and error. Comparisons are drawn between sister ships.
- Knowledge, motivation and perception, (e.g. 'the feel of the vessel') are all based on experience and confidence. They are important attributes that influence and effect daily decisions, even when decision support tools are provide.

Research Institutes

- Developments of a Model Course on Ship Energy Efficiency Course at the World Maritime University have been discussed (MEPC 61/16/3)
- The World Maritime University propose a week course: this will not be feasible and sufficient for transfer of knowledge and skills as proposed within this paper.

The above identified limitations of 'Low Carbon-Energy Efficiency' MET discussed within this section will be considered when defining course objectives, developing the framework and preparing the material proposed within the following sections of this paper.

5. IDENTIFYING 'LOW CARBON – ENERGY EFFICIENCY' COURSE AIMS AND OBJECTIVE

This section concentrates on the development of a curriculum and ensuring that there are clear MET objectives defined to assist in deciding the appropriate methods for education, training and assessment. There are several learning theories that can be considered and adopted including Behaviorism, Cognitivism, Constructivism, Informal and post-modern theories and Connectivism. However, existing theories and structures used within current Maritime Education and training (MET) will firstly be considered to ensure the feasibility of merging the proposed 'Low Carbon – Energy Efficiency' course into existing MET, and potentially into MET standards and regulation.

Over the past years there has been attention given to MET, with particular focus on Safety. The IMO have adopted the *Standard of Training, Certification and Watchkeeping for Seafarers* (STCW) code into a convention where part A of the code is mandatory whilst part B (which focuses on how to implement part A) remains voluntary, although recommended. Further revisions to the code have just been agreed upon within the Manila amendments, adopted on the 25th June 2010 (for enforcement in 2012). These amendments include: (IMO, 2010)

' New requirements for marine environment awareness training and training in leadership and teamwork'

It is important to follow existing MET methods but it is also imperative to realize the strong points and faults within the current system, and hence try to improve upon it.

Current MET is based on Competency-Based Training (CBT). This is an approach where the education is designed specifically to what the student is expected to do in the work place after education. Certification is issued once the student has shown
that they are competent in carrying out the specified task(s). As imagined this type of learning lends itself very well to the maritime industry where cadets are being trained to complete a specific job at sea. In general, MET consists of classroom theory learning, practical exercises, simulator training and onboard experience. In practice, if CBT educational objectives are achieved, the global crew base should be very competent and skilled. However, investigation has proved that there are some fundamental issues that prevent this from realistically being achieved.

A study carried out by (Emad et al, 2008) discusses and concludes that the current methods used for CBT assessment may be to blame for leading the educational objectives astray, putting more focus on passing exams than gaining the knowledge and skills applicable for every day onboard operations: 'course attendees' primary concern is passing the exams rather than acquisition of job-related competencies'. This pressure to pass along with the exam style may therefore result in the student's simply learning facts (a low level cognitive skill) rather than learning how to analyze, evaluate and apply the knowledge. Fact remembering may also be encountered if the same exam questions and styles appear year after year. This type of learning can reduce motivation and confidence particularly if the course material is not kept up-to-date and students are aware that the knowledge being gained will be of no practical use: ‘mariners trained in this system generally are not convinced that the education they receive is of much benefit to them.’ The lecturer wants his/her students to succeed, and to do this they must sufficiently prepare their class for the exam. This is often at the request of the class and therefore the sight of the real objective (to prepare for the working world) is often neglected. Therefore the lectures also feel as though ‘examinations constitute an obstacle.’ However, the above does not mean to say that assessment is not necessary; on the contrary, it is essential. What it does mean is that design improvements into the ‘Low Carbon – Energy Efficiency’ MET course and education and assessment objectives should be made.

There are three types of learning objectives that need to be considered:

Cognitive Objectives: what thinking process will the target group undertake?
Active Objectives: what feeling and attitudes will the target group undergo?
Psychomotor Objective: what physical actions and activities will the target group have to carry out.

There are several different levels at which these objectives can be attained and the following table gives examples:

Table 1: Examples of learning objective attainment levels.

Cognitive Objectives	
Lower – Level	Remembering factual information
Higher - Level	Evaluating, Analyzing
	Creative Recognition, Problem solving
Active Objectives	
Lower - Level	Paying attention
	Attach value to learning
Higher - Level	Change in life-style and outlook
Psychomotor Objective	
Lower - Level	Use a screw driver
	Take a part apart
Higher - Level	Fix and fine tune a part

In general it is necessary that the lower level skills are attained before the higher levels. Existing levels need to be clearly identified so as not to repeat skills and waste time (potentially reducing attention and motivation due to the mendacity of the work). However, it may be the case that low level skills need to be addressed within the education to ensure that the desired higher-level skills are achievable (if a student cannot understand or does not follow the lower levels and is expected to complete the higher levels, then it is likely they will lose interest and motivation without even trying)

From the Section 4 it has already been identified that there is a lack of problem solving skills and initiative within current crew and therefore this type breakdown of objectives can be used to ensure that the education starts at the correct cognitive, active and psychomotor level (all are needed) to build up and promote the higher level skills like problem solving.

New knowledge and skills will continually be identified over the years to come and therefore it is necessary to identify an educational framework that will allow for and incorporate this. The framework must not only allow for the incorporation of new material, but a main objective must be to prepare the target group with the awareness and motivation for change- whatever it may be in the future. The rate of development of technology is increasing and therefore the target group should be prepared for this and develop an open-minded but technically critical attitude towards it. Stories of people being set in there ways are common, but how about ingraining open mindedness into the new MET mindset?

Drawing together the limitations discussed in Section 4, existing MET problems discussed within this section and the general aims of providing a ‘Low Carbon – Energy Efficiency’ course, the following educational and assessment objectives can be defined:

1. The provided education and assessment should be feasible for merging with existing MET and of the correct standard for possible incorporation into MET regulation.
2. The education should ensure that all the appropriate lower level skills have been attained sufficiently before higher level skills are taught.
3. The focus of the education should be on attaining higher level ‘Low Carbon – Energy Efficiency’ cognitive, active and psychomotor objectives (i.e. develop creative recognition, problem solving, a ‘Low Carbon – Energy Efficiency’ outlook and a high level of practical skills)
4. Assessment should be specifically designed to assess objectives 2 and 3 and it should not take focus.
5. The course should promote ‘Low Carbon – Energy Efficiency’ attitudes such as: motivation, confidence, teamwork, communication, …
6. A holistic overview of the ‘Low Carbon – Energy Efficiency’ operation of the vessel

should be achieved by students as well as for individual systems.

7. The course should provide a method for gathering and distributing – i.e. transferring the ‘Low Carbon – Energy Efficiency’ knowledge between the target group, education institutes and industry.
8. The trainers (lecturers) should be trained and competent in the required knowledge and skills. They should also have the required awareness and motivation, and be able to convey this to their students.
9. A sufficiently large knowledge, scenario, question and exercise bank should be developed.
10. The course should be sustainable and the course material updated in real time.

Particularly with objective 10 in mind the design on the ‘Low Carbon – Energy Efficiency’ framework will be developed in line with the follow the following design spiral (Figure 2).

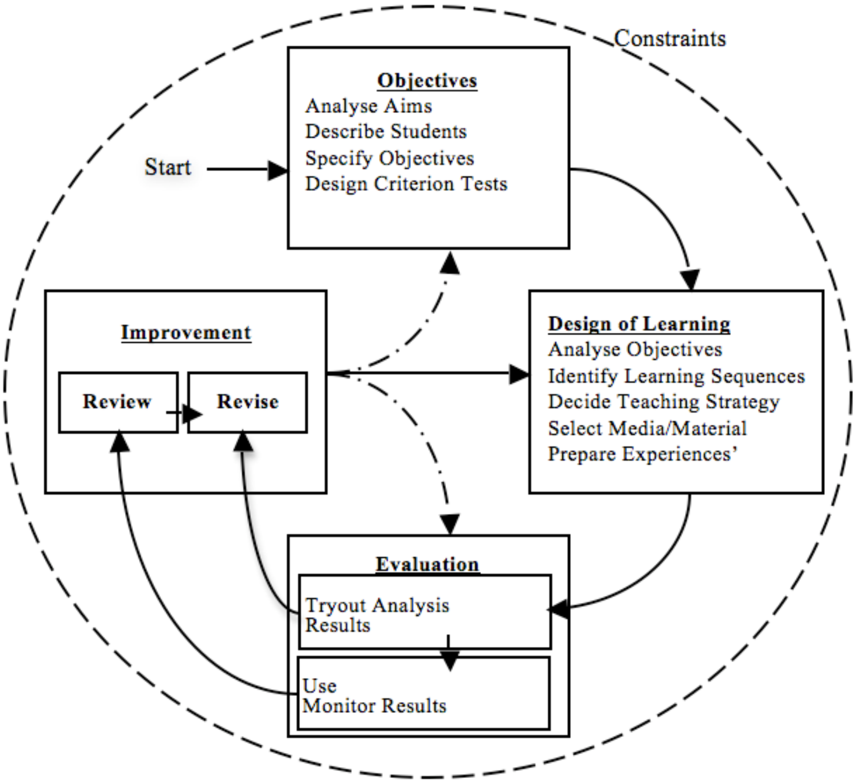

Figure 2: Educational Technology in Curriculum Development (Rowntree, 1974)

6. METHODS FOR EDUCATION, TRAINING AND ASSESSMENT

This section discusses the various platforms that can be used for education and training, the varying didactic approaches available and assessment methods.

6.1 PLATFORMS

There are several different platforms that can be used to deliver education and each of these can be discussed for usefulness within this application

- Classroom based learning

This includes teaching within a classroom and/or college based environment, generally led by a lecture but can include directed group and discussion work.

- Workshops

This includes teaching and practicing the practical skills and techniques taught in theory. It could include time within an engineering workshop or in computer labs running simulation tool, etc.

- Onboard learning

This is already a necessary part to a cadets education where they spend periods of time onboard gaining experience and completing task specified in their onboard training manuals as and when they occur in the real situation.

- E-learning

Refers to learning via a technological platform (e.g. computer). The platform may or may not be connected to the Internet (it can include DVD’s and CD-ROM’s). The learning usually follows a curriculum and each section includes the necessary information and exercises. E-assessment can be used for each section or for groups of sections.

- Simulator training

This includes carrying out exercises within a bridge and/or engine room simulator. Full missions can be simulated where the bridge and engine room communicate and operate within the same exercises. Lecturers can observe and monitor performance from an adjoining room and/or from within the simulator itself.

- Other delivery platforms

Other platforms could be used such as hand held devices like ipads, phones, … These platforms are being increasingly used within the industry to provide decision support, data logging measurements.

A variety of the above platforms will be used to provide flexibility and variety to the education provided. Each platform also lends its self better to providing differing knowledge, skills and motivation. Each of the platforms above can be used for directed and or self-learning:

- Directed Learning

This includes learning led by a lecturer or following specific set out sections of a course syllabus e.g. classroom based learning and E-learning.

- Self learning

This includes undirected learning that that the student carries out to further their education. This could be done

6.2 DIDACTIC APPROACHES AND MATERIAL OPTIONS

For each delivery platforms mentioned different approaches to presenting the information can be used. Therefore, for each platforms a combination of the following presentation approaches can be selected for effective achievement of increased student awareness, knowledge, skills and motivation.

- Theory Material

Theory material can consist of class/lecture notes, lecture slides, books and other sources of information. This is a good method for teaching facts and ensuring knowledge. However, particularly if the assessment method encourages this focus, pure theory can lead to students simply remembering facts (lower level cognitive skills) and not learning how to analyze, evaluate, apply and problem solve, with the knowledge they gain.

- Exercises

Exercises can be long, short, numerical and calculation based, written answers, scenario based questions, … . They can be used to add more context and relate theory knowledge to practical applications (scenarios, calculations) and practice this.

- Case Studies

Case studies are an extension to exercises but give further context to the real application. They encourage the higher-level cognitive skills (e.g. analytical skills).

- Practical Work

Practical work offers the chance for Cadets to develop their technical skills within a workshop or onboard. Simulator exercises can also be considered as practical work as the cadets get the chance to practice their knowledge and skills in a life like environment.

- Discussions

Group discussions allow the cadets to debate and question knowledge, form personal opinions and viewpoints (active objectives) and further develop personal skills like communication and teamwork. Discussions can also include briefings which are very beneficial before and after practical work is carried out.

- Project Work

Projects encourage all levels of skill to be drawn upon. The cadets should identify the project requirements, identify their knowledge, apply their knowledge, utilize their technical skills and then analyze and evaluate the outcome. Group projects can also promote teamwork and communication skills.

An important consideration for each of these approaches is to ensure that the material is developed as close to a real case as possible (e.g. exercises and case studies). This will ensure that the cadets understand and take away how the knowledge can be used within a real scenario. This will increase their educational motivation.

6.3 ASSESSMENT

The assessment technique selected will be very much dependent on the subject topic area, the delivery platform and the didactic approach selected. Any of the following, or a combination of the following, methods could be selected:

- Multiple choice (exam/test)
- Short written answers (exam/test)
- Long written answers – essays (exam/test)
- Written coursework Evaluation
- Project Report Evaluation
- Oral Interviews
- Observations
- Check list of achieved skills

A combination of varying methods should be selected to ensure that all the learning objectives have been achieved (Section 5). The method for assessment must be aimed at the correct skill level dependent on the knowledge being tested. It should be non-intrusive to the course curriculum (not become a focus) and should therefore complement the education provided, which is based on up-to-date knowledge and material.

7. IDENTIFYING THE 'LOW CARBON – ENERGY EFFICIENCY' COURSE SUBJECT AREAS

The type of 'Low Carbon – Energy Efficiency' topic areas and material required to fill the Knowledge Bank (presented in Figure 3: The Proposed Framework) can be identified. This will include gathered knowledge, information and material from various research projects and existing MET as well as experience, observations and knowledge generated by industry (shipping companies). In general it is the larger shipping companies that have the expenses and recourses to implement trial energy saving methods, assess them, and hence generate knowledge. Delivery of this proposed course will therefore ensure that this generated knowledge is distributed to all crew and can therefore be effectively utilized by all shipping companies.

Section 1 has already broken down the education requirements into three areas: regulatory, technological and operational methods. These can be further broken down to give examples of the type of modules (subject areas) that will be covered in the proposed course. Table 2 illustrates these examples but is by no means exhaustive.

Table 2: Example course topic areas.

Topic Area's	Intended Impacts
General Topics	
Climate Change Shipping Contribution to Change Potential Effects of Climate Change Ways to Mitigate Climate Change Ways to Adapt to Climate Change Regulatory Incentive New or Up and Coming Regulations The Implications How to Comply	Increased **Awareness** **Motivation**
Marine Engineering Topics	
Propulsion System Main Engine Steam Turbines Genset System Boiler System Waste Heat recover Exhaust Economizer System	Increased **Awareness** **Knowledge** **Skills** **Motivation**
Hydrodynamics Topics	
Hull Propeller Polishing Appendages	Increased **Awareness** **Knowledge** **Skills** **Motivation**
Voyage Planning Topics	
Speed Optimization RPM Acceleration/Deceleration Weather Routing Wind, waves, current, fog, … Ballast Optimization Loading Optimization Trim Optimization	Increased **Awareness** **Knowledge** **Skills** **Motivation**
Other Topics	
Fuel Selection Type Grade/quality Hull Coating Selection Coating/Paint Selection Maintenance Degradation monitoring and detection Contract Speed	Increased **Awareness** **Knowledge**

8. THE PROPOSED FRAMEWORK

This section discusses the proposed framework that can be found in Figure 3. It discusses the framework in line with the expected development of the course.
The types of topic areas have been presented above and the knowledge, information and data will come from research projects, existing MET and the industry as discussed. This knowledge, information and data will come together and will be stored within a Knowledge back (see Figure 3). Within this Knowledge Bank a data bank will need to be formed along with a Question Bank based on the 'as close to a real case' Scenario Bank.

There are two types of course designs that need to be considered:

- The construction of an entire course made up of modules for each topic area (Table 2). A modular approach provides flexibility and hence the best combination of learning for the cadets. The modules taken by each cadet will depend on their intended job roll (officer, marine engineer, deck crew) and their educational needs. Some modules will provide general information and therefore will form part of all cadet courses, and some modules will be more specific to the cadet's discipline. This approach allows for easy adaption of the modules for varying target groups which will be very beneficial when designing the MET for varying levels of shipping personnel (crew, onshore personnel, management, ship owner, …)

- However, as discussed there is currently energy efficiency already taught in existing MET, it just has no focus on 'Low Carbon – Energy Efficiency'. Therefore a second design type of educational course will focus on enhancing the existing MET; syllabus and material. This design may concentrate more on training the trainers so that they can provide the additional focus and motivation to the cadets and supplying the trainers with the new and correct materials (additional theory material, exercises, case studies, …). Where necessary, complete modules (as discussed in design method 1) can be incorporated into the existing syllabus.

A combination of the different delivery methods should be used to provide variety to learning and hence enhance the overall quality and experience of the student's experience (e.g. lectures could set E-based learning secessions and working onboard is an existing mandated part of cadet education). A certain degree of self-directed learning should also be carried out and encouraged.

The different types of delivery platforms have already been discussed along with the material approaches; each will lend itself better to different topic areas, varying levels of previous knowledge and the recourses available. A combination of all should be utilized for attainment of the different and correct level of learning objective skills (Table 1). The relationships shown in Figure 3: The Proposed Framework are not exhaustive but indicate the combinations to necessary to achieve the objectives set out in Section 5.

One key delivery platform to point out is the potential benefits that could be achieved by using simulator training. Exercises could be carried out in the bridge or engine room simulators or, most beneficially, a full mission (where bridge and engine room operated and communicate within the same exercise). The significant added benefit that the cadets would receive would be a holistic understanding of the performance of the vessel. It will provide the opportunity for them to focus on 'Low Carbon – Energy Efficiency', try out energy efficiency improvements and experience the effects and savings. This will significantly increase their awareness, motivation and confidence to continue this these operations within their continuing career. Current simulator training focuses on safety and not at a technical level and therefore this is currently not carried out. This energy efficiency simulator exercise could be coupled with practicing and assessing other skills such as communication and teamwork. Not only are these skills essential for energy efficiency, they will also benefit safety and enhance quality of the existing MET system. Simulators are also becoming more common and therefore this could be a valuable utilization of recourses.

The assessment methods have also already been discussed and can be selected dependent on their applicability to the combination of directive method selected, delivery platform, and material approach.

From completing the proposed education (and not just the assessment) and then continuing within their career, the cadets/crew will gain experience, observations and opinions and will hence generate new 'Low Carbon – Energy Efficiency knowledge. If crew awareness and motivation has been developed as proposed within the MET course objectives then crew should be able to identify improvements that they make onboard, what operations give savings and what does not and by how much. This can then be discussed during re-training (which will be developed into the course life-cycle) and hence fed back into the Knowledge Bank. This systematic method for updating the course will be presented in future work and will ensure the course is kept up-to-date and meets the challenges of the ever-evolving technologies, operations and regulations.

9. EXPECTED IMPACTS AND BENEFITS FROM PROVIDING EDUCATION AND TRAINING

By developing the proposed 'Low Carbon – Energy Efficiency' course, a formalized set of 'Low Carbon - Energy Efficiency' material will be introduced into the existing MET system for the first time. If problems within the existing MET are addressed, as proposed in this paper, then the design and introduction of this Low Carbon – Energy Efficiency' MET could enhance the quality existing MET in general (not necessarily just CO_2 related).

The proposed MET course will provide a platform to educate all cadets and crew in the up and coming regulations as well as teach skills of how to be energy efficient. Therefore when the regulations become mandatory progress will have already been made to achieve compliance and the cadets and crew will know what actions to take and understand why; hence ensuring the correct application of skills.

By delivery of the proposed MET course (particularly simulator training), awareness and understanding of how the individual operations and decisions of one member (deck crew, master, engineer) affect the ship from an overall perspective will be gained. Communication and teamwork will be promoted between crew/cadets to achieve efficient operation of the ship as one entity. (E.g. improved understanding and communication between the Bridge and Engine room crew). Cadets will have increased confidence in their actions and this will help ensure that efficient operations are carried out and are correctly applied, wherever applicable

Moving away to wider impact, individuals' awareness and knowledge of the importance to reduce carbon emissions will be increased along with understanding of the simple tasks that can be carried out to reduce carbon emission. This may lead to personal changes in general life style. Benefit to the environment will be observed and there is the shipping industry may gain a competitive 'GREEN' image amongst worldwide industries.

10. FURTHER WORK

Within the next months a sufficient sample of questionnaires will have been received and hence analysis of the target group's (cadets) current awareness, knowledge, skills and motivation can be completed and finalized. Identification and collection of what is currently taught within the MET system and the material used needs to be carried out to identify where increased 'Low Carbon – Energy Efficiency' focus, new knowledge and material or a completely new module(s) are need. The collection of data, information and knowledge to form the 'Low Carbon – Energy Efficiency' Knowledge Bank also needs to continue.

The proposed framework will be developed over time inline Figure 2: Educational Technology in Curriculum Development, (Rowntree, 1974) and will include a systematic methods for up-dating the Knowledge Bank, recourses and material.

11. CONCLUSIONS

In conclusion this paper has identified that there is a need and a demand for a formalized, specific 'Low Carbon – Energy Efficiency' Course. Currently there is not one provided.

Modules of such a course should be delivered to all levels of shipping personnel who's decisions effect the ships operation. For logical reasons the course will first be developed for cadets within maritime education.

Interviews and informal discussions with MET students cadets and lecturers from varying MET Institutes, and with shipping companies, have provided conclusions and statements regarding the current 'Low Carbon – Energy Efficiency' awareness, knowledge, skills and motivation, how it its perceived and the limitations.

A competency based training method has been selected for this course to ensure feasibility within the current MET system and potential adaption into regulatory standards. Delivery platforms and didactic approaches have been discussed and a framework for developing the 'Low Carbon – Energy Efficiency' course has successfully been proposed. The expected benefits from delivering the 'Low Carbon – Energy Efficiency' MET course have also been discussed.

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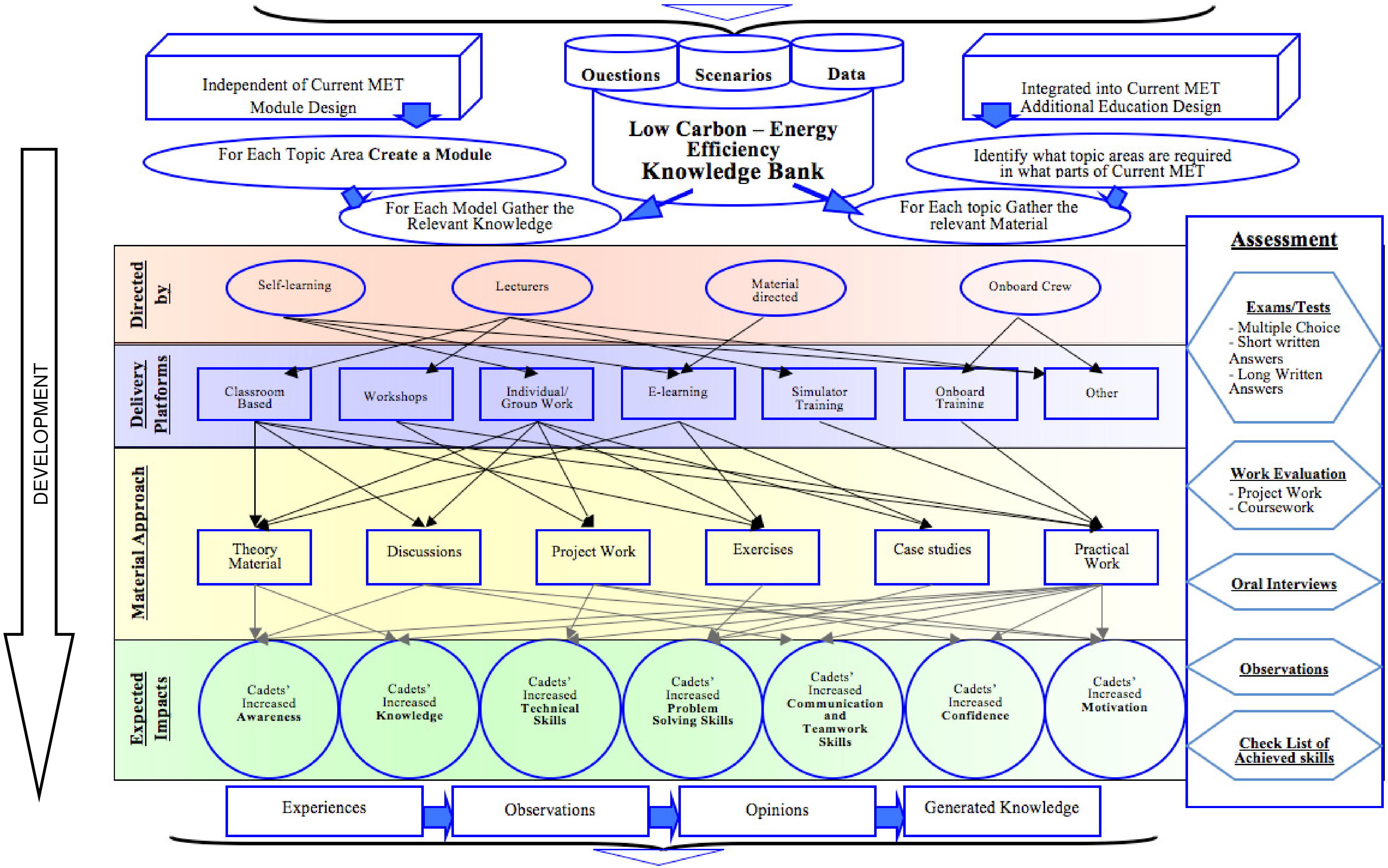

Figure 3: The Proposed Framework