

THE GENERAL PURPOSE GREEN CYBER-HARBOUR

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1. With new-advanced carbon-free propulsion systems proliferation, harbours will be at the cornerstone of global logistics, with increasing demanding standards pending on them. And scouting-pioneering the leading-edge cyber-sustainable harbour of the future are the Baltic and the North Sea countries, involving in practical R+D projects their main Ports, Shipping companies, Terminal operators, and Engineering Universities.

As the objectives for these advanced Facilities:

“A flexible-predictive and cost-efficient harbour and their clusters,
with self-sufficient zero emissions energy generation”.

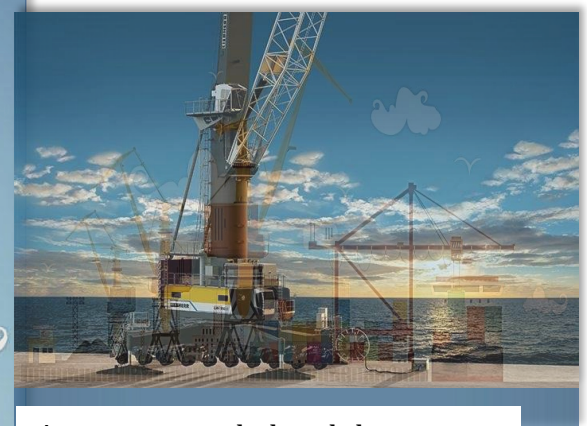
What means:

- Much sorter predictable ship dock time
- Reliable-precise synchronous work
- Full automation and digitalization
- Cost competitive by time competitive,

as a value strategy for the times coming western traffic grow.



Cranes lay-out model

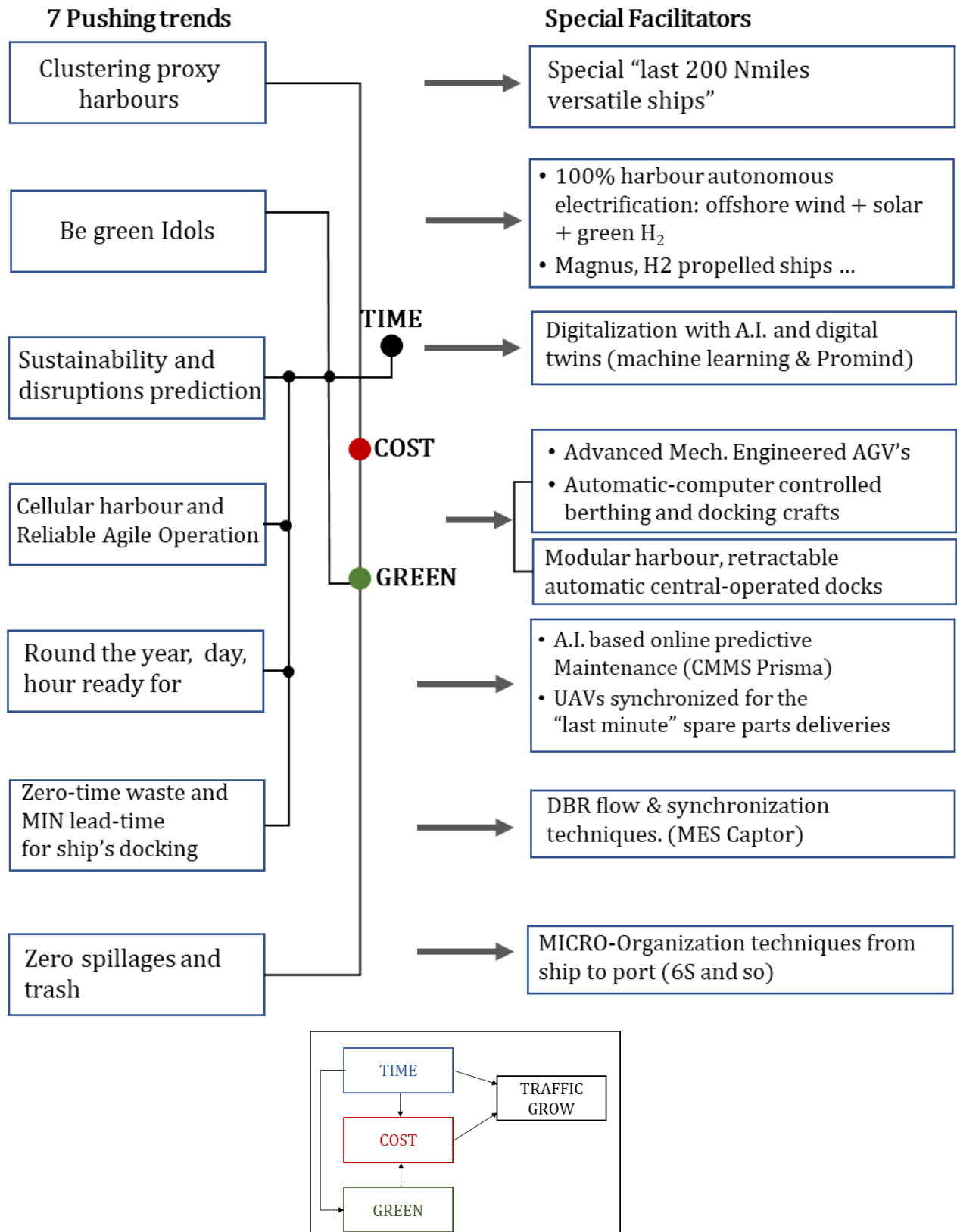


Automatic guided mobile crane

2. Pushing trends and facilitators

Seven main pushing forces must be considered, that relate with special actions that ease them

See 't in the figure:



3. What's waste & synchro in a harbour

Basically waste = time + defects. Time passed without useful valued movements, and defects on handling. Behind this is lack of synchronization between the ship and the port's operations and among these last, and machinery breakdowns. An efficiency figure can be defined as

$$ef = \frac{\text{cargo delivered}}{(\text{std.cargo} \cdot \rho \cdot u \cdot \text{time}) \cdot \text{transcurred time}}$$
, being = 1 when no losses exist. A very good value of ef is about 0,8 ÷ 0,9.

The problem with low values of ef (e.g. < 0,6) is that, though partially nested, small delays end by enlarge ship's harbour waiting time, and always port productivity.



Excellent synchronization and equipment maintenance are the primary for avoiding that:

Synchronization is clearly improved by the following:

- Having a DBR – Real time MES (Movements Execution System) like Captor®, that keeps it through the real-time management and monitoring of critical variable time buffers between the ship and the port end-out.
- Automatic-robotized equipment real-time monitored and ordered to move.
- Sharing, in connection with this MES, a dual digital twin between the ship and the harbour lay-out and flows, performing IoT cargo tracking along with GPS location.
- Cellular designed Terminal, with at least dedicated-exclusive light, handling equipment and local management, including a distributed mini-control tower.

Excellent Maintenance requires predictive techniques as:

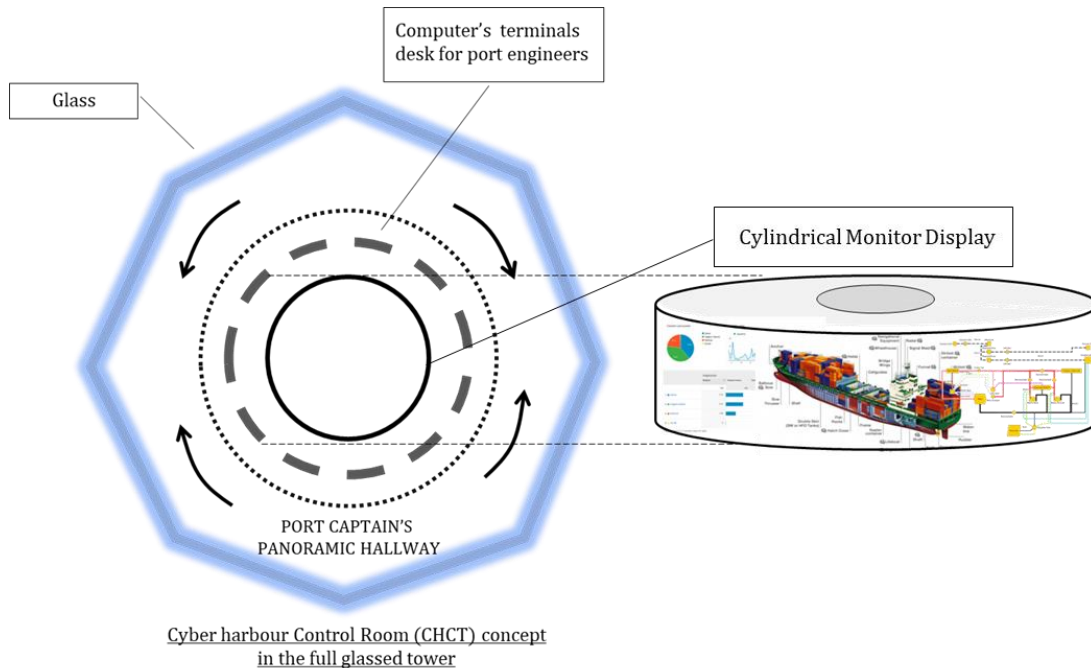
- Real time monitoring of critical equipment reliability parameters, and alarms setting (Prisma®).
- Intelligent prediction of failure (Promind®)

And having a global management harbour control room for flows monitoring with real-time simulation, and maintenance related coordination.

4. The cyber Harbour Control Tower (CHCT)

In a cyber harbour it's the “mother of all logistics”, and is set as an arrange of the Terminals and cells, and the port's head common areas operation. Synchronization management lays here, all monitored and electronically guided for storage, moving, leading operations and maintenance.

Skills required of involved engineers are serious, and far from only ICT's and A.I. knowledge, staying in the functional aspects of the business, flow, equipment, and restrictions.



The information displayed in the central cylinder contents as follows:

- Harbour terminals and Ships interactive-connected Digital Twins.
- DBRs and efficiency indicators monitoring by the MES software
- Vehicles status, current position and velocity, and alarms
- Flows disruption and prediction charts
- Equipment failure prediction and maintenance tasks planning and execution integrated with moving flows (CMMS).



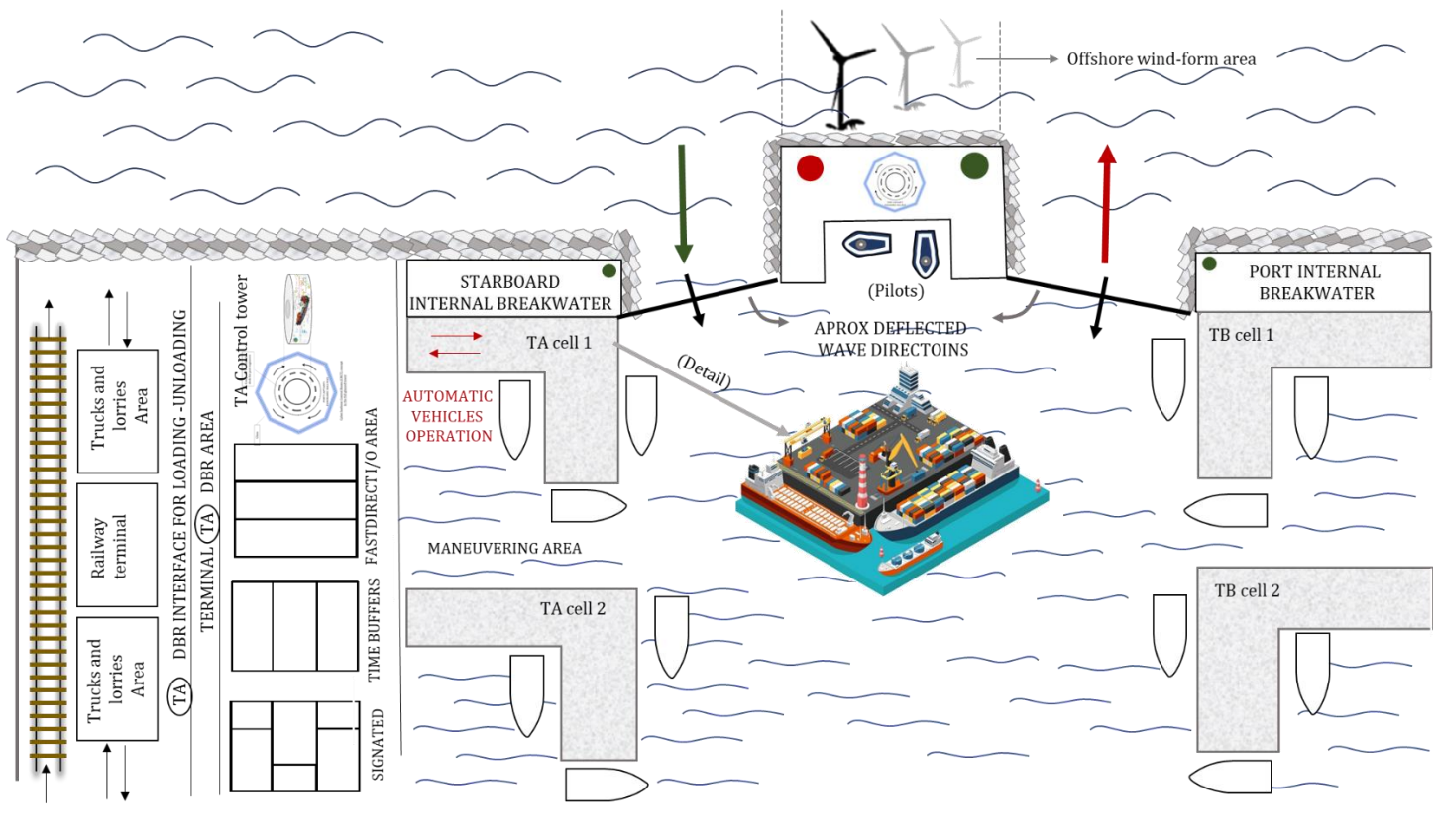
5. Advanced Harbour lay-out draft

Port's lay-out model must matching easy fast berthing and unberthing, minimize ships' interferences and maneuvering, and tight the flow of dedicated dock services.

In addition, with the light loads "last 200 miles" harbours operational clustering, all that leads to a port modular-cellular concept, also including retractable piers along. The following drawing represents the general concept of a Cyber Port that must ease a synergistic work between the harbour print, its automated mechanical systems, and the full-intelligent digitalization



Docking different systems



6. Concluding remarks

Not special difficulties are found when transforming a port into cyber, with the, in general, exception of the civil works for modification.

But most of the times must be good enough just with lay changes along the erected body, including all the new electrification systems and grids, for vehicles operation.

Apart from the civils, the cyber evolution must be taken as a whole, writing a complete integral project that procures the synergistic advantages among reliable agile-flows, intelligent information, and automation, to so getting out:

- Much less ship's berthing time
- Operations efficiency of more than 90%
- Energy consumption reduction per ton load/unloaded of 50%
- And free of carbon footprint

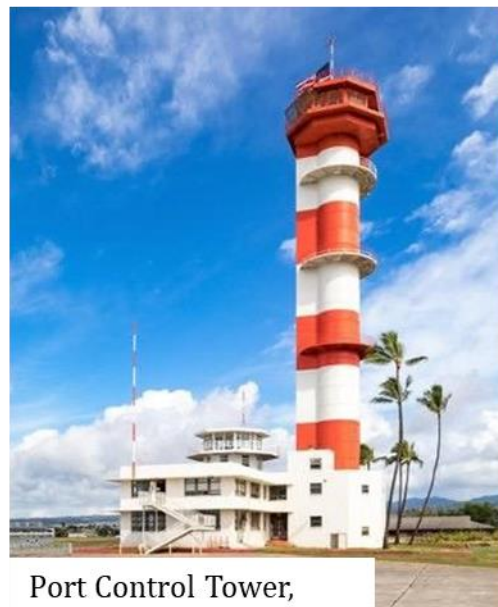
Heavy AGV



UAV for low-medium loads



Rotterdam's harbour green H2 plant



Port Control Tower,
Pearl Harbour, HW-USA