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Ageless Love Aging Fleets: A User's View

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Introduction

Today around the world there is great interest in old fleet and in ageing aircraft.

The reason for this is due mainly to budget constraints but also to other reasons as safety, and environmental laws. Interesting is to note that today one of the more sparkling area in aerospace industry is related to the MRO activities.

But this type of industry requires today and much more in the future the setting of rules and the development of a huge know-how, as well the a/c manufacturer which will introduce as design parameter the "age" and not only the flight cycles or flight hours, as it is today, during the desing phase.



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First question: what kind of
“system” am I talking about?

We may define a system as a
group of many interlocking
parts operating together with a
common goal...



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Not strictly a technological system ...
but a “broad-defined” system composed by

- Weapon system
- Support factors
- Operative and geopolitical factors
- Environment

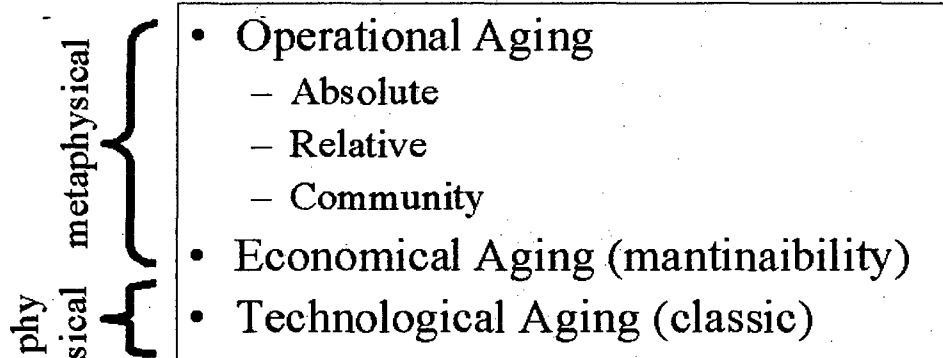
...and this definition leads me to a second
question



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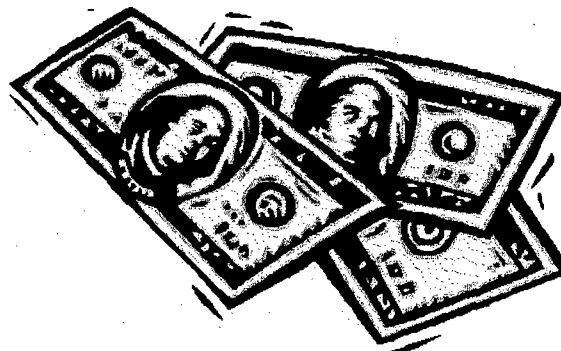
Second question: what is “aging”?

Not a single aging phenomena...
but a “three-leg table” composed by



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But for a Logistician what Aging does mean?



MONEY, AS ALWAYS!

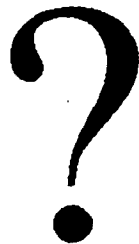


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Third question: Where is the money ?

These charts are the theory about ILS...

But where are the costs of
aging

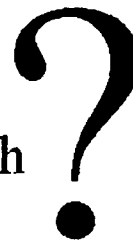


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TIMES ARE CHANGING

- At the beginning, systems were developed aiming only at performance.
- Then, the Integrated Logistic Support approach was adopted, taking care of the Life-Cycle Cost of the system.
- Now it's time to adopt the ILS+Aging Awareness approach

(physical and metaphysical)





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The resulting ageing of the system can be modelled by the combination of many positive and negative first order feedback loops which occur in the subparts of the system when time elapses.

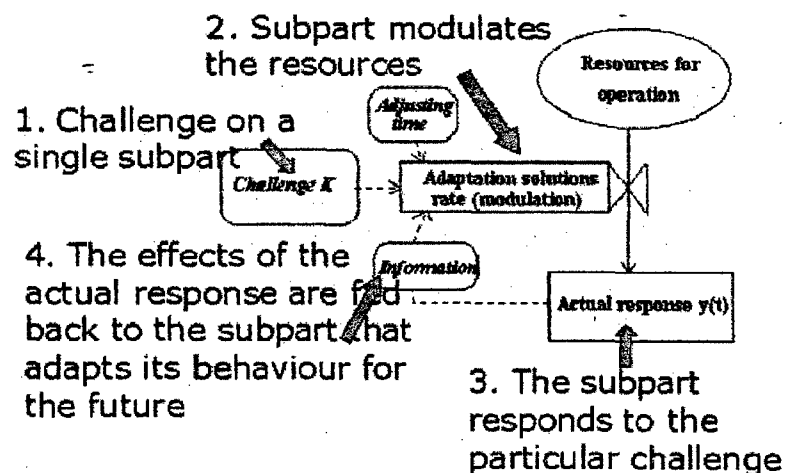
Note that ageing is taken in the sense of an evolution or progress in time, without giving any qualitative value to these words: it is just the displacement of the system along the positive time axis in a quadri-dimensional space-time.



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Negative feedback loop

The operating of the system results in internal challenges on the subparts which may jeopardize the system's integrity. The subparts have to adapt to the challenges in due time in order to allow further operation of the system as a whole.

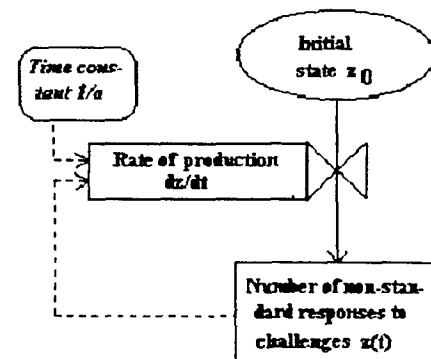




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Positive feedback loop

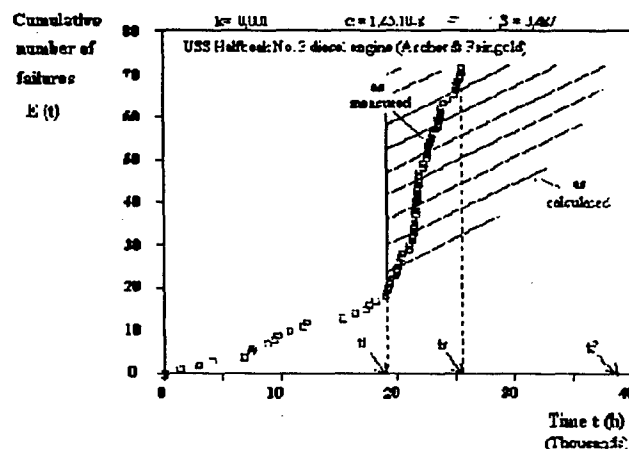
During operation, the challenges appear again and again, sometimes on a steady base sometimes not. It may happen that the adaptations in the subparts be sometimes non-standard even if satisfactory for the further operation of the system. The word "non-standard" means "different from what could be expected from the past behaviour". This may result in changes of information for neighbouring subparts about what their challenges are. Their responses could then also become non-standard. There will be a snowball effect: non-standard responses will induce differing assessments of the challenges which in turn will induce other non-standard responses.



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The Ageing Zone

After t_1 , the system will follow a path between sudden collapse and the continuation of the curve described by the equation $y(t)$ (or its normalized form). This zone is the shaded in one (the Ageing Zone).

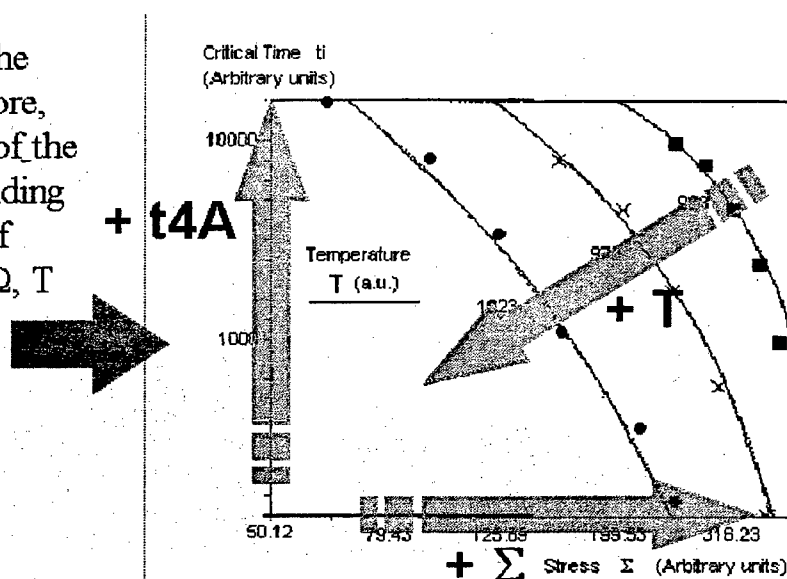




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The "Time Ageing Limit"

So it is possible to predict the "Time Ageing Limit" t_i . More, using the normalized form of the equation $y(t)$ (β -only depending form), we can trace a sort of trade off chart between Σ , Ω , T and t_i , like this example



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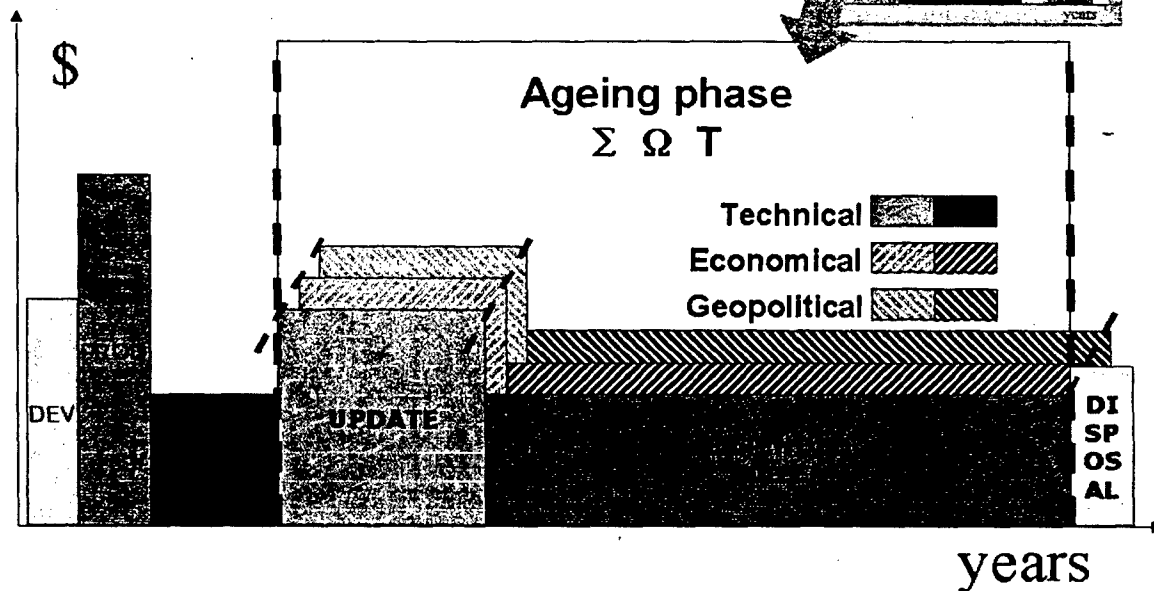
-- Σ , Ω , and T are broad-meaning terms.

We can use them in all kind of phenomena: technical, medical, economical, geopolitical, logistical, etc.



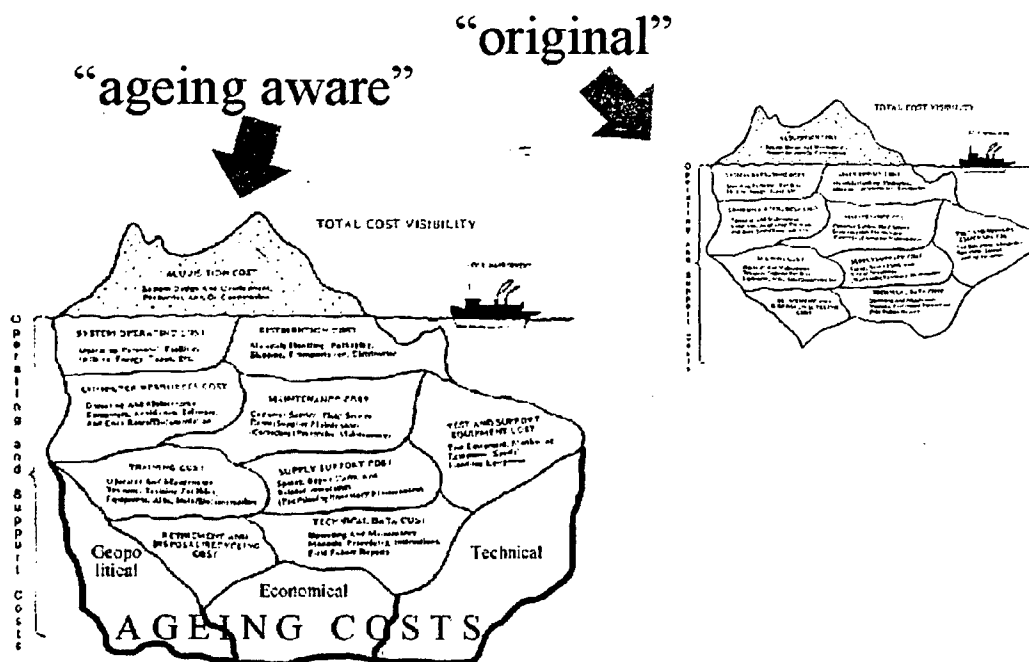
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"Ageing aware" Cost Components in an Aeronautical Programme



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The "Ageing aware" Iceberg of Costs





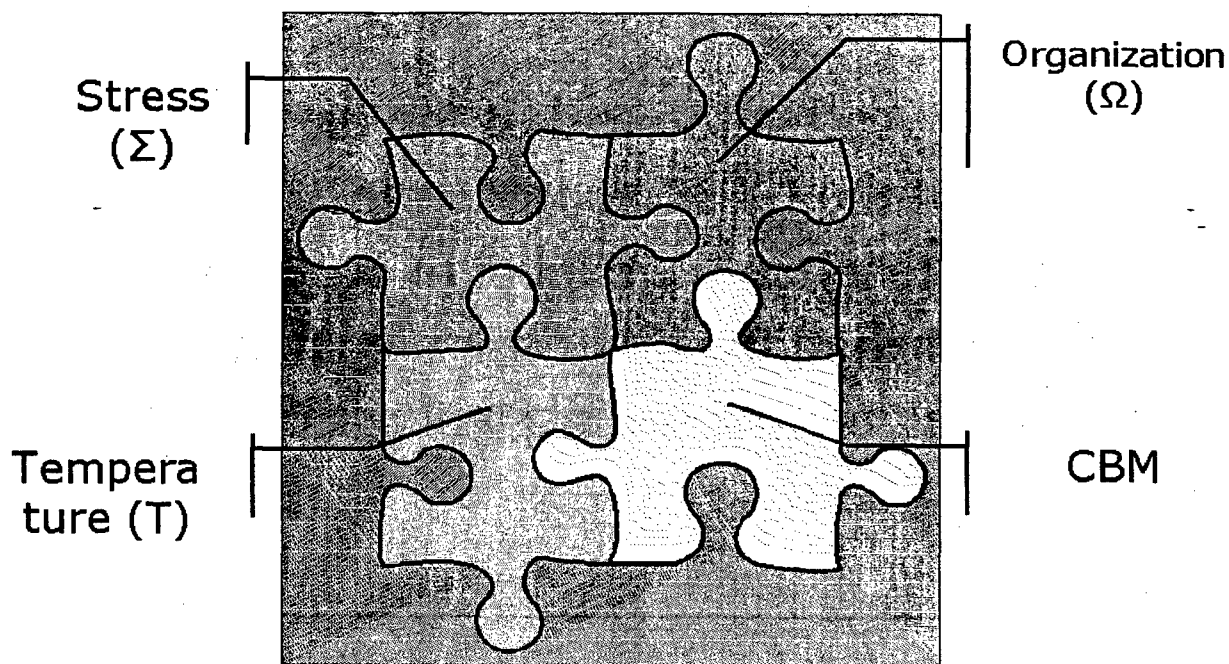
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To control Σ , Ω and T across technical, geopolitical and economical factors, requires the use of IT. Dropping politics and economics stuff, for the technical ones what is a key to cope with ageing? ...CBM !



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The Aging Puzzle





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For Western Countries it is mandatory to keep a stable geopolitical situation in the World (T). And it is mandatory to keep military organizations lean and well oiled (Ω).



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And at the end of the day the use of the CBM approach to maintenance we expect to cut LCC better than the other maintenance strategies monitoring technical ageing of the fleet.



Conclusions

Based upon these considerations, mathematics, coupled with CBM, can help us in this “chaotic” situation.

It is necessary for aerogeriatrics, as we are, to start following a “local” approach, but in accordance with our slogan:

...Act locally, but think globally.