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Three Balloons™ for Future Product Design

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Abstract

Industrial product design cycle need to be accelerated to meet the growing customer needs, emerging technology, new materials. Products especially in aerospace and defence need large product design cycles leading to heavy cost, time, and high technical expertise. With the advent of new manufacturing process like 3d printing enables engineers to conceptualize the designs that were otherwise impossible. Use of high performance computing, big data, artificial intelligence algorithm is being explored for its application in accelerating product design cycle. Current study is focussed on developing a futuristic framework for product design cycle. In current project artificial intelligence algorithms like fuzzy logic, neural networks, genetic algorithms are used for accelerating the product design cycle. Blending big data technology into product design help in making design lessons from earlier version reach to future versions. The virtual design framework makes the loads from operating environment are applied on applied onto proposed product for quick product localization. With rapid progress in space travel there is need to accelerate the A and D product design with emerging technology. Current paper summarizes the case studies in accelerating the A and D case studies.

Keywords: Artificial Intelligence, Futuristic Design, Product Design, Smart Technology

1. Introduction

Future engineering products like Aircraft, Automobile, Ship, and Spacecraft are needs to be designed with emerging materials, emerging manufacturing technologies to meet ever increasing customer needs. Variety in engineering product has become an important requirement which needs to be met by integrating numerous ideas to meet customer needs. The cost of product design and development has become important conservation to innovate in high cost engineering products like aircraft and spacecraft. One of the hindrance to innovation in high cost engineering products is huge cost and time to design and develop a new product with new innovative features. Future of engineering design must use the emerging technologies at each stage of product design cycle as shown in the Figure1.

Aerospace and Defence Industry needs to significantly focus on Cycle Time Reduction (CTR) in design & development. Due to shrinking margin in aviation industry the cycle time reduction techniques must be developed by using various emerging techniques. In Civil Aerospace various classes of aircrafts needs to be development in smaller cycle time of design and development. Smart technologies can be one of the tools to accelerate product design.

Existing Product with current day technology forms the basis for new product proposed to be developed. Problems in current product needs to be identify before going for a new product definition. The needs and aspirations of customers with

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futuristic view needs to be developed incorporated into new product definition. Emerging materials, manufacturing methods, Emerging design needs must be considered for new product definition.

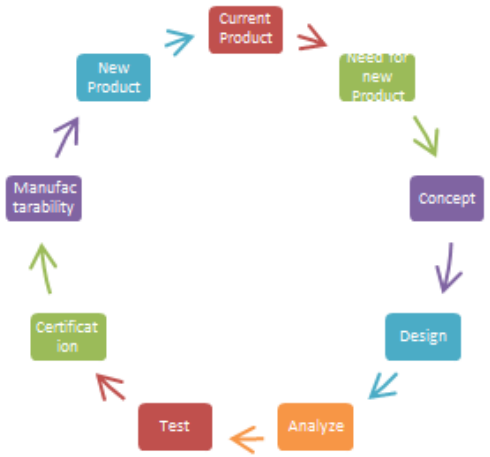


Figure 1. Product Design Cycle.

Problems in Current product design cycle

- High Cost
- Huge Time
- Lots of expert dependency
- Difficult to implement many new ideas.
- Unable to meet unique user needs like handi-capped
- Unable to meet to geopecific design needs
- Statradizaiton as problem
- Inability to apply emerging materials
- Larger efforts for product testing.

2. Three Balloon™

The future of engineering product can be visualized three balloons co-existing in harmony under operating conditions. The equilibrium among these 3 entities ensures an ideal design for any product. Three balloons is an integrated approach for futuristic engineering product design.

2.1 User Balloon

Each engineering product has to meet the needs and requirements of a User. So the safety and security of the user forms the core of the product design requirements. In recent times due to accidental conditions the user needs and comforts must be considered for product design. Future user would like to be more joyful about operating a product that means the know-how about engineering product has to be minimal for a user. Future of engineering product must provide a best in class user experience. Especially in Aerospace and defence human error has been one of the concerns for many accidents this needs to be addressed with user as a balloon, whose integrate and safety is an element of design for future. Users have varied physical and intellectual abilities which must be considered to ensure that the User balloon is integral and safe. So the first layer of design is user balloon.

2.2 Product Balloon

Product balloon forms the envelope onto the uderballoon, this represent the choice of materials, manufacturing methods. The product balloon's strength will ensure the safety of user balloon. Design of product balloon must meet the criteria set based on the experience.

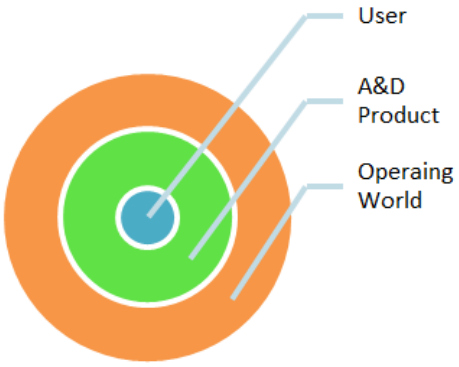


Figure 2. Three Balloons approach.

2.3 Operating World Balloon

Operating environment has been a challenge to comprehend and simulate for a realistic product design. The load environment is major factor that is being influenced by the operating world balloon.

3. Confluence of Technologies

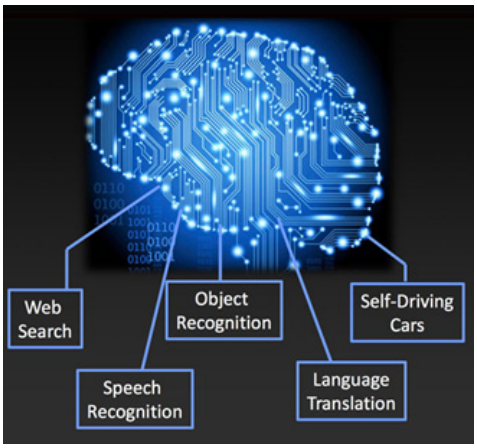
Three balloons is confluence of emerging technologies integrated to represent three balloons of engineering product design. The computational Operation Regulation

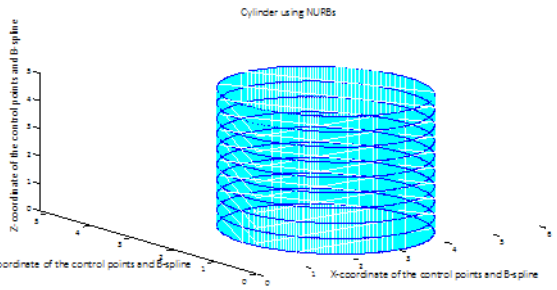
- Artificial Intelligence
- Big data
- Cloud
- IOT
- High performance computing
- Multiscale modelling
- Artificial intelligence
- 3d printing
- Virtual testing
- Sensors Technology
- Mobility
- Material genomics
- Energy Storage
- Energy

4. User Balloon

User being the centre of any product the intelligence computational framework which can give best in class user experience will help the user to operate the product with ease. Due to advancement in cloud & mobility, Analytic users are being continually monitored and understood. The user for future will not be a standard user as we are using right now. The user will be unique as per his choice product, so that this unique user is designed and imbedded into three balloon approach suing SMAC S tools.

- Mobile apps as a tool to map user choice and skills
- Neural network learning algorithm is used for predicting the phenomenon at user interface like driving pattern, braking pattern etc.
- Algorithms that can mimic human brain
- The algorithms will try to predict the human behaviour under normal & operating conditions so that the user is represented as it is in simulated 3d balloons.
- For an autonomous vehicle the computational suer must have ability of language translation, object recognition, speech recognition so that the user balloon exactly represents the true world. The real time internet of things makes it possible the user to make quick decisions.





5. Product Balloon

Product Balloon resembles the material form of the product being designs. This balloon has integrated with material genome so that the product balloon

will be a replica of product needs and characteristic. Material like composites and their failure behaviours numerically built into product balloon.

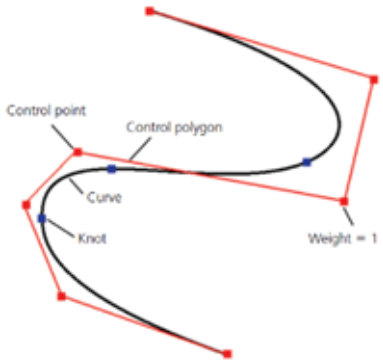
- Materials genome will provide a material layer so that all the characterises of form of product are integrated.
- The algorithms that can learn form historical material failures will be used to continually learn the product balloon.

5.1 3d Printing

3d printing has been emerging to help people to design things with many mathematical variations so that the ideal products can be designed and prototyped. 3d print allows

5.2 Smart Stress Analysis

An algorithm to represent the geometry as it is much needed for the accurate prediction of stresses and strains in component.

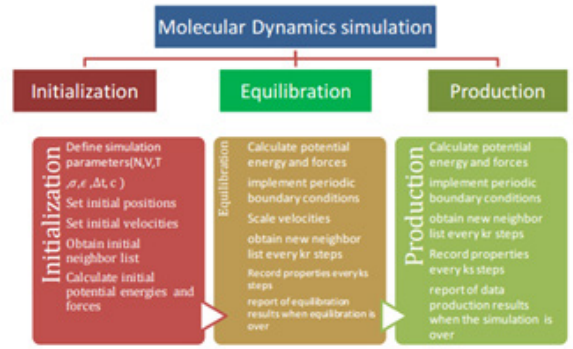


6. Operating World Balloon

Comprehending the operating world into a simulation which can resemble as close to reality as possible. Especially operating world has uncertainty in terms of loads and chemistry which can influence the product performance. So the in technologies which can help to comprehended the operating world into an intelligence balloon. In a typical aircraft design thousands of Load cases needs to be considered while design. Load case reduction techniques like surrogate modelling will help to minimize the loads.

6.1 Nano Technology

Nano Technology has been one of the emerging technology to understand the molecular behaviour of all the matter, interaction of operating environment easily liquid, gas, solid form. Gurupra



6.2 Smart Load Prediction

Loads form the fundamental design criteria for any engineering product. To predict the loads from real life operating world sensors technology can be used, further surrogate modelling technique can be used for load reduction techniques.

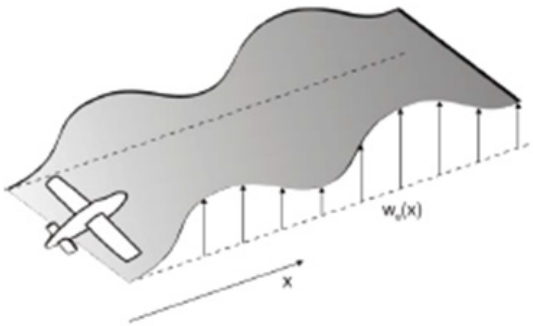
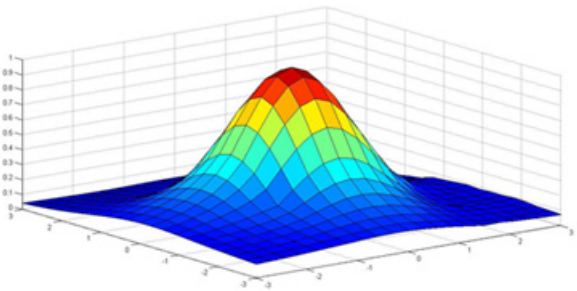


Figure 3. Design Load cases for Aircraft.

Table 2. Performance of MOIL

Number of points	Parameters
50	flight points(altitude and speed)
100	mass cases (loaded weight and weight distribution)
10	control surface configuration
50	manoeuvres and gusts (gradient length)
4	control laws
10,000,000	**TOTAL NUMBER OF CASES REQUIRED**

$$Total\ analysis\ \text{cost} \approx \frac{N_{case} \times N_{sim} \times C_{sim}}{N_{span}}$$



6.3 Smart Chemistry Load Prediction

Most of the component failure in engineering are due to environmental chemistry, a smart chemistry prediction app can simply the process and the figure shows a surrogate modelling technique for load case reduction using computational methods.

7. Conclusion

The needs for better products and desire for product variety is intense increasing. A computational framework for accelerated product development of engineering products is need of the hour. Present paper aims at an intelligence three balloon platform for engineering product design, so that latest computational, sensors, artificial intelligence are applied for engineering product design at accelerated rate leading to significant cost.

8. References

1. Katukam SR, Metev SM, Veiko VP. Laser Assisted Microtechnology. 2nd ed. Berlin, Germany: Springer-Verlag; 1998.
2. Shah M, Katukam R, Prasad G, Katukam R. Nano technology, molecular dynamics. IDCEME'15; 2015 Aug 21-22; Hyderabad.
3. Reddy A, Katukam R, Kiran L, Katukam MHR. IJLTET. 2015; 5(2).