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GENERAL AND SPECIFIC TRENDS IN DESIGN OF FLUID POWER CONTROL SYSTEMS

1. Introduction and General Remarks

It has been proved that most of the product cost (70-80% by some estimates) is committed during conceptual design. Thus good design is at the core of capability to engineer competitive industrial and consumer products. Good engineering design results in lower time to market, better quality, lower cost, lower use of energy and natural resources, and minimization of adverse effects on the environment. It is possible to envisage needs and requirements of the industry in the next 10 to 20 years and to assess changes to the engineering design in general and to the design of fluid power systems (FPS) in particular. It is the subject of this paper.

2. General Trends in the World Industry and the Production of FPS

Some of the major trends in the world industry can be summarized as follows:

- Changes in product
- Changes in product development process
- Changes in marketplace
- Changes in partnering
- Changes in technology
- Changes in society.

These general trends will also affect the development of FPS. There are, however, other reasons the producers of FPS have to take into account to maintain prosperity. The progress in electrical drives, electronics and microprocessors tends to deprive FPS of some important functions. The FPS producers have to resort to researchers to face up to this pressure.

3. Assessment of Industry Needs

The key trends in industry needs are presented below.

- Improve quality of design
- Facilitate team decision making
- Improve design environments
- Create seamless integration between design and analysis
- Understand company's product realization process
- Achieve and reuse design history
- Determine impact of design decisions
- Promote continuous learning
- Create seamless integration between analysis tools
- Enhance creativity and innovation
- Reduce development time by maximizing parallelism
- Improve information infrastructure
- Produce globally optimal designs.

That FPS be competitive to other kinds of power and control systems it is necessary to yet increase the advantages of the oil hydraulic systems (e.g. high power density), to overcome its drawbacks (leakage, noise, environmental hazards, sensitivity to contamination, etc.), and to better integrate with cooperating microelectronic signal circuits. There may also be some novel, yet neglected, areas of contributing to FPS quality.

4. Current Design Practice

There are several drawbacks of the current design practice. Although many companies are studying their product development process in order to identify the factors responsible for lower quality, longer cycle times and higher cost, nevertheless engineers typically lack analytical skills, and consequently resort to ad-hoc methods. This means that design is largely done by trial and error causing delays in time to market. When analytical expertise is available, as in larger or high-tech. companies, modeling, analysis and simulation is typically done in a fragmented manner. If the initial design is poor several design-analysis iterations are necessary before a satisfactory design is found. The ideal goal is to eliminate iteration and have the design meet the specification on the first pass.

With a few exceptions, companies are not documented the history of decisions and lessons learned. The design process and design knowledge are often poorly archived and managed and therefore, in most cases, the acquired knowledge is not easily available for future designs. There is poor communications between design teams working on different parts of the same project. Designers have a poor understanding of many life-cycle issues, such as manufacturability, assembleability, environmental impact, and product liability. Consequently these factors are often not taken into account at an early stage in the design process, resulting in expensive design modifications during manufacturing or use the product.

5. Current Design Research

Current design research directions can be categorized into 12 broad areas, listed below in random order:

- Collaborative design tools and techniques
- Prescriptive models, design methods and normative theories
- System integration infrastructure and tools
- Metrics and benchmarking
- Design automation systems
- Analysis, simulation, and optimization methods and tools
- Design representation
- Sociological aspects of design
- Formal models of design process and design theories
- Teaching innovation
- Design needs assessment
- Design information support systems.

These areas of research are of various development degrees and, perhaps, of different utility for industry. It is interesting to find out which of the above categories researches in FPS belong to and, particularly, what research directions are not cultivated or neglected. There also are some researches specific to FPS discipline that should be supported.

6. Research Issues for FPS Design

In conclusion, research in design for FPS should be identified and coordinated to avoid fragmentation. They should be evaluated against general trends of engineering design as well as against needs of industry. It is recommended that research problems of utmost importance for industry and market competition were given the highest priority. Identifying such problems can be accomplished by setting up a correlation matrix for industry needs versus research problems and available design methods and tools analogous to commonly known QFD (Quality Function Deployment) chart.