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LOOKING (TRHOUGH THE CLOUDS) AT THE FUTURE OF MOBILE HYDRAULICS

1. Introduction

The first informal discussions in the FPN community about the Forum in Cracow were oriented to see the magic year 2000 as a good opportunity of discussing about the *future* in general, and the future of fluid power in particular.

A systematic approach to the problem is clearly out of discussion, because it would require extensive resources and involve a large number of contributors (companies, public institutions, associations, and so on). Moreover, the chances of success would be constrained by the usual attitude of looking at the future in terms of continuity instead of potential discontinuity (a good example is the total failure of analysts in seeing in advance the increase in oil price during the last part of year 1999).

A much better (and less expensive) approach is that of starting a discussion and an exchange of ideas on the basis of some particular views or opinions, and then trying to move towards more general objectives and strategies of actions. In the area of mobile hydraulics we are lucky enough to say that a useful *event* for the present purposes occurred about ten months ago.

2. The Event

During the 1999 edition of the SAE Off-highway Conference and Exposition, a panel discussion was organized about the trends in *mobile hydraulics* related with the development of agricultural and earthmoving machines. The contributors came from *four* well known companies, i.e. two manufactures of components and two manufacturers of machines, and the time span covered by the discussion was the first decade of the new century.

The general perspective was essentially focused on the *US market*, but it is anyway useful for two reasons. Firstly, the north-American experience anticipates (in many cases) what will occur later in other areas of the world. Secondly, the specific features of the European (or perhaps Japanese) area are more easily seen and appreciated by contrast.

3. Components Manufacturers

The point of view of the manufacturers of fluid power components was offered by Sauer-Sundstrand and Eaton Corporation. In the following, some discussion hints are summarized as they came from the individual companies.

Sauer – During the next decade, R&D efforts will be mostly focused on three major areas, i.e. *cost to performance ratio* (to be reduced), *size* (to be reduced), and *higher level controls*. It is interesting to remark that in this priority list three topics are missing (noise, efficiency, and eco-fluids) which are matters of lively discussions in Europe in the last years. Actually, the reason is that the priority list comes from the criterion of the best possible ROI (return on investment) rather than the intrinsic technical relevance. Some proofs in this respect come from the experience of the last thirty years (from 1970 to 2000), when an improvement of about 15% in cost and size might be estimated (indirect proof of further developments needed), and an improvement of more than 100% in functional flexibility has been due to the integration of electronics (direct proof of still more exciting developments). "Electronics", and its companion "Mechatronics", are trendy terms which lead to other trendy concepts as the *global market*, which implies a number of strategic issues, e.g.: (a) a *worldwide* product design for the *global* customer; (b) a *worldwide* manufacturing strategy; (c) a reduced number of closely integrated *suppliers*. The last point in particular will produce a big change in the relationships with the suppliers, because they will be involved from the beginning in the design process (starting from the specifications stage).

Eaton – As to the *noise* requirements, the unique European environment is confirmed, which means that the decreasing (and compulsory) limits will force significant changes in the emission of engines and consequently the contribution of the hydraulic circuits to the whole system noise will be amplified. A second interesting topic is the improvement of the *power density*. Based on the 1999 market in USA, the typical density of fluid power in aerospace applications was about 10 kW/kg, while fluid power in mobile applications had about 4 kW/kg. Therefore, new margins are to be gained, specially in comparison with the electromechanical motion systems. Considering that the power density involves three terms - pressure, flow (speed) and mass - the following views have been proposed: (1) marginal progress is to be expected from pressure (in particular the fabulous 10000 psi are explicitly excluded), though it is probably true that on the European side more will be gained; (2) relatively more progress can be expected in speed, but dramatic steps are anyway excluded; (3) size and weight are the only degrees of freedom available (though additional details were not given).

Finally, a fallout of the electronic integration was evidenced, i.e. *reliability*, for which an extensive use of principles and procedures from the automotive market are expected.

4. Machine Manufacturers

The point of view of the manufacturers of machines was offered by John Deere and Caterpillar. The hints which follow consider, as obvious, the fluid power problems in the larger perspective of the agricultural and earthmoving products.

Deere – In addition to the general trends of the *virtual* design (e.g. simulation and rapid prototyping), some specific issues have been proposed about pressure, reliability, filtration and costs. As to *pressure*, the increase is expected to be higher if compared with the view of the component manufacturers. As to *reliability*, strictly related with the overall machine safety, a primary OEM requirement is to have fluid power components which are able to identify their internal states and make them available outside, with the additional benefit of implementing higher control strategies. The point about *filtration* states that the next decade will not see a substantial improvement of the filtration systems(i.e. the capacity of removing the contaminants), which means that more efforts should be oriented towards the design of components exhibiting a higher level of (intrinsic) tolerance to contamination. Finally, the specific characteristics of the agricultural market suggest that proper attention should be paid to new generations of *low pressure and low cost* systems to improve the competition in the low technology segments.

Caterpillar – The trends in the next decade have been proposed in terms of tables, which are not reported here for brevity. A number of trends have been confirmed, but few points are to be mentioned because they are new or offer a different view: (a) the evolution towards a *total* control integration based on new procedures of functional synthesis; (b) a significant *increase* in the average pressure of the hydraulic systems up to 400 bar; (c) a substantial increase in the use of *eco-fluids* up to 50% in year 2009 (though the proposed figure seems not totally realistic); (d) a substantial increase in the *useful life* of fluids, with economical and ecological benefits; (e) a slight increase in the operating *temperature*. The prediction about the eco-fluids is a good example of what is stated by the title (looking through the clouds). In fact, the miserable destiny (agony, if not death) of the mineral oils was declared more than one time during the last twenty years, but they are still alive and running.

5. Conclusion

The original panel produced an animate discussion, and the same will hopefully do the Forum, trying to see the consequences of the trends proposed by the big ones, and considering that they are in the position of not only seeing the future but of influencing the future.

Maciej ZGORZELSKI

THE LEAN THINKING PARADIGM AND WHAT IT MEANS FOR ENGINEERING EDUCATION

The beginnings:

- Dr. W. Edwards Deming in Japan after World War Two
- Taiichi Ohno at Toyota after World War Two

A very brief history of industry: craft production around 1900

- One of a kind products
- Flexible, simple tools
- Quality through tinkering
- Build to order
- Costs did not decline significantly with volume

A very brief history of industry: flow (Ford Motor Co around 1915)

- Flow production
- Dedicated tools
- Long product life
- Unlimited demand
- Zero product variety

This was the "special case" of learn thinking

A very brief history of industry: mass production (GM around 1930)

When Ford's special conditions did not exist, it was possible to run volume manufacturing with large buffers, long throughput times, and by working to forecast. This exacerbated quality problems and created the world of General Motors and mass production

A very brief history of industry: lean production (Toyota around 1965)

- Flow production
- Flexible tools
- Short product lives