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Competitive sustainable manufacturing: Evolution, paradigms and legal compliance

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The significant global challenges we are faced with today need to be addressed in the versatile context of society, environment, economy and technology. In recent years, the agreement of the need for sustainable evolution has emerged. Along with this knowledge based value-added sustainable manufacturing has been considered as an important enabler. This paper presents the essential steps from economic growth to sustainable development. An essential action by stakeholders at different levels is also considered.

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Electronic measuring setup for gearbox backlash

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In a gearbox manufacturing company, all gearboxes undergo performance tests after complete assembly. A gearbox is tested for performance parameters like speed, torque, temperature, noise, backlash, vibration in running condition. The methods of measuring these parameters often depend upon the accuracy class of the gearbox. Accurate methods and devices have been established in order to measure these parameters as per the required accuracy. But, accurate backlash measurement is never commonly followed in an industry. Conventionally, dial indicators are placed on input shaft and the output shaft. One shaft is rotated in one direction and the pointer set over it starts deflecting. Since backlash is present between the input and the output shaft, the shaft on the other end does not rotate until the movement equivalent to its backlash is given. This difference in movement is determined by the difference indicated by one dial with reference to the other. Backlash is confirmed by repeating the procedure several times in different rotational position of shafts as well as direction of movement. The resulting backlash thus determined is written in terms of mm. The accuracy of this measurement method depends upon the resolution of dial indicator. Moreover, dial indicators being devices to measure linear displacement, they are setup against surfaces such as key or sometimes keyways on the shaft. Mathematically, for rotational displacement m in radian, the linear displacement at r radial distance is l = r . sin(m). Placing the dial indicators in such manner indicates different values at different radial distances. It is rare to find input and output shaft to be of the same radius. Therefore, dial indicators set on the shafts are placed at different radial distances, which deflects differently for same radial displacement. Therefore, calculating backlash by differences in indicator values produces errors. To remove these errors, it is necessary to measure radial displacements at the ends of the shaft and take the difference on these displacements as the backlash in terms of revolutions of input shaft or output shaft. Electronics sensors and devices for the measuring noise, temperature and vibration of gearbox are commonly available and placed to measure the parameters. But backlash measurement devices were not thought of. It was decided to setup an electronic system to accurately measure angular displacement, command forward/reverse movements, as well as calculate rotational difference between two shafts. Backlash thus determined can very well be used to calculate the motion loss of the assembly connected with the gearbox.

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