The Intelligent Machine Tool

Throughout the four industrial revolutions, machines have gradually migrated from rough, clunky, mechanical devices that provided power and force for the convenience of man, to precise, computerized numerically controlled and robust systems capable of completing their mission unattended. With the onset of the fourth industrial revolution, an accelerated rate of change became possible. Manufacturing is one of the main drivers of this change, and an essential element shaping the future is the machine tool. Almost everything we use in our everyday life is touched by machining and machine tools – appliances, transportation, electronics, energy infrastructure, and even food. Building on the current trends of technology developments and smart manufacturing, the machine tools are expected to undergo revolutionary transformations. Enters the Intelligent Machine Tool (IMT) – a connected, automated, and digitalized system capable to ingest a 3D-model and generate the finished part with high precision and consistency, maximum yield and minimal human intervention. The Intelligent Machine Tool will be able incorporate additive systems for hybrid processes that either repair a part or build it from scratch.

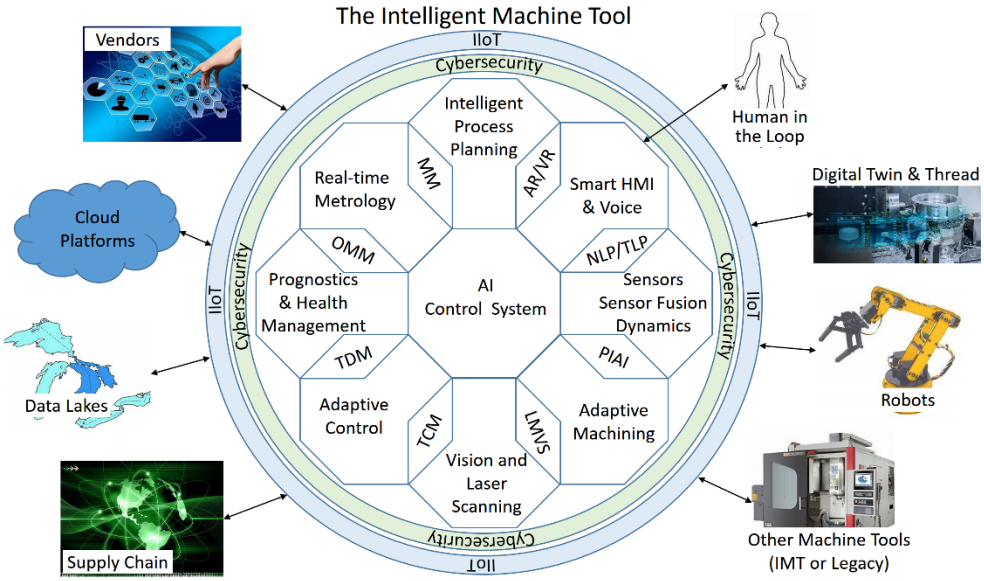

Figure 1. The Intelligent Machine Tool (IMT) concept diagram

The IMT integrates physics-informed artificial intelligence (AI), human machine interface capable of voice communication, prognostics and health management (PHM), communication and coordination with other machines and even factories around the world, and other emerging technologies. This machine is able to adaptively correct its motions and machining parameters as a function of the changing shape of the workpiece, local deformation, system dynamics and health. It cannot be made to chatter. It cannot produce defective parts. It is also very easy to use. Our presentation will provide an overview of the IMT concept with its associated technology areas, and will illustrate how the path to this transformation is possible through a collaborative effort of the academia, industry and governmental organizations. As will be seen, the future machine tool will be familiar in appearance, but unprecedented with respect to capabilities.