We present a stochastic dynamic programming model for the optimal operation of a flexible machine tool, to find a sequence of cutting speeds for the successive tools used in a cutting operation, in order to minimize expected makespan. We assume the tool life is random and the expected tool life decreases with cutting speed, and each tool requires a setup time when manually installed. Using a numerical method for computations, we compare the optimal dynamic policies with well-known static policies and we examine their impact on tool magazine capacity allocation among several part types and on expected makespan. Our results explain why dynamic adjustment of cutting speed is better with random tool life.