The focus of this research is to investigate methods for material substitution for the purpose of re-engineering legacy systems that involves incomplete information about form, fit and function of replacement parts. The primary motive is to extract as much useful information about a failed legacy part as possible and use fuzzy logic rules for further logical processing. Machine elements can fail by any number of failure modes but the most probable failure modes based on the service condition are considered critical failure modes. Three parameters are of key interest in identifying the critical failure mode of the part. Critical failure modes are then directly mapped to material properties. Target material property values are calculated from material property values obtained from the originally used material and from the design goals. The material database is searched for new candidate materials that satisfy the goals and constraints in manufacturing and costs. Uncertainty in the extracted data is modeled using fuzzy logic. Fuzzy member functions model the imprecise nature of data in each parameter and rule sets characterize the imprecise dependencies between the parameters and makes decisions based on the incompleteness. A final confidence level for each material in a pool of candidate material is a direct indication of uncertainty. All the candidates satisfy the goals and constraints to varying degree and the final selection is left to the designer’s discretion. The process is automated by a software that inputs incomplete data, uses fuzzy logic to extract more information and queries the material database with a constrained search for finding candidate materials.