Justification

Powder processing is a means to form complex shapes from metals, ceramics, plastics, cermets, and composites. When a plastic molding machine is used to form the shape it is a potent, productive technology known as powder injection molding (PIM) – the core topic of this course. The PIM approach changes the design rules, allowing more complex components with more features at a lower cost when applied at high production volumes (say up to five million parts per day). Once tooling is created, the technology replicates the tool shape. Thus, expense is in the set-up and tool creation, after that PIM as a replication technology repeatedly forms components such as medical implants, cellular telephone hinges, watch cases, automotive fuel injectors, metal cutting tools, firearm bodies, dental braces, teacups, and jet engine linkages.

This course details the PIM process, and variants, to understand how to take advantage of powder technologies. It is a mixture of engineering, manufacturing, design, economics, market, and application details; best termed techno-marketing. Topics range from basic ideas such as atomic motion in sintering, to identification of target components based on features and complexity. Designers combine the cost-effective shaping attributes of plastic injection molding with the performance and engineering properties associated with durable engineering materials.

Topic Listing By Category

INTRODUCTION
Background, This Course, Powder Metallurgy, Ceramics, Powder Processing, Applications, Process Essentials, Unique Aspects, Historical Evolution, Key Terms, Contrast with Other Technologies, History, Importance of San Diego

PROCESSING

SCIENTIFIC
Rheology, Viscous Flow, Newtonian Model, Bingham Model, Solids Loading, Einstein Relation, Sintering Theory, Atomic Motion, Boltzmann Distribution, Arrhenius Temperature Dependence, Densification, Microstructure, Grain Growth

MATERIALS

DESIGN
ME 596, Spring 2016

Design Cycles, Recognizing Good Candidates, Statistic Analysis, Qualitative Criteria, Quantitative Criteria, Geometric Details, Features, Design Support Software, Example Shapes, Sizes, Complexity Criteria

MANUFACTURING

COSTS
Unit Process Steps, Project Costs, Tooling, Equipment Costs, Component Costing, Competitive Forces, Design Effects on Processing, Optimization, Operation Parameters, Batch Size Effects, Component Costing, Per Piece Costing, Cost Sensitivity

APPLICATIONS

MARKETS
Industry Structure, Historical Shifts, Production Levels, Sales Breakdown, Competitive Technologies, Financial Performance, Geography, Materials, Emerging Opportunities, Industry Changes, Future Trends, Opportunities, Titanium, Life Critical

Grading

Three projects will be assigned during the course. These will be team-based oral reports class graded efforts, presented in class at announced dates, approximately after 4, 8 and, 12 weeks of class. They will be accompanied by submission of PowerPoint presentations and open question and answer periods. The projects will involve the following:

1 – process innovation
2 – analysis of new materials and properties
3 – conceptualization of a new PIM application

There will be several random quizzes given in class. There will be no makeup quizzes.

Grading is based on the following.

40 % quizzes (two low scores not counted)
60 % in class project reports (three at 20% each)

Grade Assignment – 90 to 100% = A; 80 to 89% = B, 70 to 79% = C, 60 to 69% = D, below = F

Book

A PDF copy of Metal Injection Molding: A Comprehensive MIM Design Guide (Metal Powder Industries Federation, Princeton, NJ) will be made available to the students of the class with the request that it not be distributed to those outside class to protect my copyright.

Opportunity

There is a PIM conference in Irvine 7-9 March, and if anyone wants to attend one day we can probably arrange free admission, but travel is on you own (car pool or train). There will be table top exhibits and tour of Arburg molding machine facility. See www.mpif.org for program details and let me know if you want to be registered.