國立臺灣科技大學

八十九學年度碩士班招生考試試題

系所組別： 機械工程系在職專班

科　目： 機械工程實務

一、 簡答題：請由下列問題中任選五題作答，每題十分，超出五題部分不計分（50%）

1. 簡述同步工程(concurrent engineering)的概念並列舉數種應用的手法。
2. 何謂 ISO9001？
3. 簡述光蝕刻(lithography)的基本步驟。
4. 簡述任兩種材料強化的機制(strengthening mechanisms)。
5. 試以流體力學的觀點說明高爾夫球面上的小凹洞(dimples)設計對飛行距離的影響。
6. 何謂 proportional-plus-integral-plus-derivative (PID) control？
7. 簡述快速原形成形技術 (Rapid Prototyping technology) 的基本原理。
8. 國內汽油可分高級汽油、92、95、98，試問若採用了不正確的油品，對引擎會有什麼影響？

二、 請<u>依據下頁所附關於 Design for Environment 的短文內容</u>，以中文（依短文內容摘要中譯）回答下列問題

1. 簡述綠色設計考量的兩個主要目標。 (10%)
2. 請說明 Xerox Corp. 在綠色設計的作法與成效。 (13%)
3. 請說明電腦輔助設計工具 Restar 的用途與作法。 (13%)
4. 解釋 Design for Recycling 的意義及其應用實例。 (14%)

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Green Design

According to the OTA report, green design concerns two general goals: waste prevention and better materials management. This means avoiding the generation of waste and coordinating the design of products with remanufacturing operations or waste-management programs so that a product's components or materials may be recovered and reused in the highest value-added application at the end of the product's service life.

One aspect of waste prevention involves specifying a smaller quantity of a material in a product, a step that has a multiplier effect on both the industrial and post-consumer waste streams. This also applies to packaging, said Whirlpool's Willis. When packaging engineers at Whirlpool's German affiliate reduced the number of constituent materials in their appliance packaging from 20 to 4, disposal costs dropped more than 50 percent, materials costs were reduced, and performance improved.

Similarly, increasing a product's lifetime can result in direct waste reduction, said the OTA report. Product life extension can be achieved through the use of more durable materials or modular designs that facilitate the repair or upgrading of product components. DFE programs will allow companies to offer cost-effective takebacks of their products for recycling, as consumer demand for this service rises, it said.

Xerox Corp. (Stamford, Conn.) is a leader in the field of product remanufacturing. The company restores and remanufactures many used parts from its copiers, including electric motors, power supplies, photo-receptors, and aluminum drums, according to Jack Azar, manager of environmental design/resource conservation and operations at Xerox. The company now recycles about a million parts a year as both replacement components and in new equipment, resulting in annual savings of about $200 million, he said. To facilitate the refurbishing and recycling of various components and product subsystems, Xerox engineers are working to standardize their designs so that a larger number of parts can be used in a variety of different products. Azar said that the company has set up its remanufacturing lines in parallel with its new product lines to achieve the same level of quality. It has also involved its suppliers more directly in the design process, so that opportunities to use recycled components and materials, especially plastics, will not be overlooked.

Design for Materials Management and Disassembly

Until recently, product designers rarely thought about how their products would be managed as waste after their useful life is over, and waste management providers tended to accept the composition of waste streams as a given, the OTA report said. If product design and waste management were coupled more closely, the cost of materials to industry could be reduced and environmental concerns addressed. Of course, since it is difficult for product designers to predict the nature of the waste streams that will be available in the future, it will take a substantial amount of effort to coordinate the two.

A major issue in materials managment is design for disassembly (DFD). DFD can go a long way toward establishing both closed-loop production reclamation systems in which components and materials are reused in the same products and open-loop systems in which materials are recycled several times for use in different products.

A noteworthy example of research to improve the DFD function is occurring at Carnegie-Mellon University's Center for Integrated Manufacturing Decision Systems (Pittsburgh). Assistant research professor D. Navin-Chandra and his colleagues have developed a software design tool for CAD environments called Restar that analyzes dissassembly tasks. "As the tool works through a disassembly procedure for a product," Chandra explained, "it keeps track of the time, cost and effort of

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each step, the value of recovered components and materials, and the associated savings in energy and carbon dioxide emissions. The idea is to show the designer how much of the product is worth dismantling and reusing. It also shows how changes in the design (changing a weld into a snap-fit joint, for example) could improve the results."

Research on Restar was funded primarily by Ford Motor Co. (Dearborn, Mich.), which provided cars that were disassembled by technicians to gather data for the recovery analysis. The project is continuing with support from Xerox and GE Plastics (Pittsfield, Mass.). Chandra noted that Xerox is currently analyzing the remanufacturability of old and new copier designs with the Restar system. Another software tool covering materials selection is also under development, he said, though the necessary data on environmental impact of various materials choices is still being developed.

Design for Recycling

Just as important as designing for materials recovery is designing for the use of recovered materials. Developing designs that facilitate the disassembly and separation of product components is not enough; for true DFE, companies must incorporate recycled materials and components into their products. While the primary barriers to recycling are economic, the limited availability of high-quality recovered materials can complicate efforts to incorporate them into designs.

This issue is highlighted by a project developed by Digital Equipment Corp. (Maynard, Mass.) and GE Plastics to recycle plastic housings and keyboards from used Digital computers. Concerned about the disposal of its products in ever-shrinking landfills, Digital established a process to recycle plastic computer parts. "Our original goal was to reuse the plastics in new computer housings, but technical difficulties concerning polymer contamination and obtaining Underwriter's Laboratories' approval made us look at other uses," said Charlie Adair, business manager at Digital's Property Disposition Center.

"After researching the issue, we helped identify a third party—Nailite Corp. (Miami)—which could recycle and reuse the polymer in a roofing application that does not require virgin polymer," said Doug Nutter, general manager for resource recovery at GE Plastics. Digital engineers developed a proprietary automated separation process based on specific gravity and the appropriate solvents by which the housing material of GE's Noryl blend of polyphenylene oxide and polystyrene is almost entirely cleaned of contaminants. The recycled polymer is then blended by Nailite technicians into a resin that is 52 percent clean Noryl flake and 48 percent virgin polymer, which is molded into Class A roofing shingles. The roofing panels are being installed on McDonald's restaurants and other places. Digital has agreed to supply 50,000 pounds per year of the recycled Noryl.

According to Nutter, GE Plastics is initiating a similar pilot project with Ford to validate the commercial viability of recycling Xenoy polycarbonate and polybutylthiolate-blend car bumpers. Meanwhile, Digital has pursued a recycling scheme with Corning Glass Works (Corning, N.Y.) to reuse the leaded glass in the cathode ray tubes of its computer displays.