HSE HORIZON SCANNING INTELLIGENCE GROUP SHORT REPORT

RAPID MANUFACTURING

1. Issue

Status: Active Monitoring

Rapid Manufacturing (RM) has been described as “An Industrial Revolution for the Digital Age”.[1]

2. Background

The approach, which is also referred to as “Direct Digital Manufacturing”, uses additive fabrication processes to construct parts that are used directly as finished products or components. Using a variety of technologies such as Selective Laser Sintering, Stereo-lithography, Fused Deposition Modelling, Direct Metal Sintering/Deposition and 3D printing, items are built up in a layer-wise fashion from Computer Aided Design (CAD) data, without the need for intermediate tooling or casting processes.

Some of the technologies are well established, having been in use for over 20 years for the Rapid Prototyping of new designs. However, a reduction in cost and increase in speed of the equipment combined with the growing range of materials available, are driving a move to use these technologies for the manufacture of functional items and it is estimated that as many as 100,000 RM units could be in operation worldwide by 2010.[2]

Early adopters, who include a number of major multinationals in e.g. the medical, aerospace and automotive sectors are already employing Rapid Manufacturing technology. Raw materials including a variety of resins, filled nylon powders, ceramics, metals and thermoplastics are being used to manufacture such items as personalised dental copings and hearing aid shells through to components for aircraft and radar systems. A key benefit claimed for the RM approach is that it offers the possibility of “mass customisation” as it can be used cost effectively to manufacture individual one-off items or short runs of product, whilst removing some of the design constraints associated with conventional production processes. Greatly reduced raw material wastage compared to existing subtractive (milling) methods is another potential attraction of RM, particularly in the aerospace industry, where expensive metals and alloys are widely used.

For the future, in addition to uptake of RM technology by existing industrial enterprises small, dedicated design and production “bureaus” may appear offering distributed manufacturing facilities and the extension of this approach to high street stores offering RM products is envisaged. In the longer term, the development of equipment and materials enabling the fabrication of products in the home via desktop “fabbers”[3] and ultimately perhaps, Molecular Manufacturing technologies based on

[1] http://www.lboro.ac.uk/departments/mm/research/rapid-manufacturing/rm-book.html
[2] W.Schoenmakers, Keynote Address at TCT2006 Conference
[3] see e.g. http://www.fabathome.org/wiki/index.php?title=Main_Page

the use of nanoscale machines to produce complex articles by the direct manipulation of matter on a molecular scale are foreseen.[4]

3. Implications for Occupational Health & Safety

The equipment used in RM processes tends to comprise self-contained units, which can be on a bench-top scale up to large standalone cabinets. Depending on the particular technology involved, the units might incorporate automated powder coating operations, systems for handling liquid photo-polymers or resins, various types of printhead, high-powered u-v laser or e-beam energy sources and high vacuum chambers or inert atmospheres.

There is no suggestion as yet that any of the RM technologies presents a serious cause for concern and indeed the fact that the equipment tends to be self-contained could offer health & safety benefits e.g. in terms of minimising exposure to the raw materials involved by comparison with more conventional subtractive processes. However, some examples of the areas where the potential implications for workplace health & safety from Rapid Manufacturing may need to be considered are:

- *Processes* – the effectiveness of laser and u-v safety control measures will need to be established.
- *Manufacturing technology* – the effectiveness with which the CE marking system has been applied to the equipment design may need to be assessed. Similarly, quality control/assurance methodology will presumably need to adapt in order to handle single or short run items as opposed to mass-produced goods.
- *Distributed Manufacturing* – could lead to the use of complex and potentially hazardous materials and processes by operators who may be unfamiliar with the health & safety issues and controls required. The ultimate extension of this in the longer term would be to desktop fabrication units, possibly based on Nanotechnology and Molecular Manufacturing being used to produce items in the home.

4. Recommendations

The field of Rapid Manufacturing is still at a relatively early stage of development but given the widespread interest in the technology for a wide range of applications, it appears to have the potential to grow rapidly both within established industries and through the expansion of distributed manufacturing. The possible extent to which the workforce will come into contact with RM technology in the future and the implications for workplace health and safety associated with the raw materials and processes are as yet unclear. Further detailed investigation and tracking of developments in the area may therefore be warranted from the Horizon Scanning team, in conjunction with specialist colleagues within HSE and the wider RM community.

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[4] C.Phoenix, tct Magazine, Vol.14, Issue 4, p. 37-9.