CHAPTER

XII

Production Operation of ECM Tools

Electrochemical machining can produce consistently high standards of accuracy and surface quality, with almost 100% utilization of a machining facility. It can, on the other hand, be erratic and unreliable if placed in the wrong manufacturing environment or in the hands of untrained personnel. The way to succeed is to ensure that the operating personnel are knowledgeable of the process (they do not require special skills or aptitudes), the process parameters are closely controlled, and machines and tooling are regularly maintained. The production supervision must have adequate knowledge of the process so that faults can be detected and rectified in the proper manner, for the smooth operation of an ECM facility. Operators should also have a good working knowledge and be trained to respond immediately to any process variation or malfunction, and identify and correct the true cause. So often a parameter is altered, a change is made in the procedure, or adjustments to the tooling or machine are made to *compensate* for a fault rather than correct it. Several adjustments are sometimes made before it becomes apparent that the operation is out of control. The classic example, which has occurred frequently in the past and will, no doubt, be repeated often in the future, is as follows. An operator finds that his machine persistently stops in the middle of an ECM operation and discovers that the spark detection equipment causes the switching off of the machine. Having desensitized this equipment or disconnected it entirely, he obliviously then continues to operate the machine.

12.1 PROCESS CONTROL

The controlling parameters in the electrochemical machining process are as follows:

- Electrolyte—pressure, temperature, composition, and conductivity.
- Tool feed rate.
- Machining voltage.

The machining gap is dependent on all these. They must, therefore, all be kept within close limits to control both the component contour and the depth of machining.

The control of electrolyte temperature deserves special mention, since its importance is often overlooked. It has a small effect on conductivity and also on anode potentials, both of which are factors in determining the machining gap size. Thermal expansion of the tooling is, however, far more significant. If close dimensions are to be held on repetitive operations, the variation of tool and fixture thermal expansion can be a problem, unless close control in maintained on the electrolyte temperature. Control to $\pm 1°$ C is normally adequate. In the same context the "warm up" time for tooling may prove critical in holding close tolerances. Electrolyte should be circulated through the tooling for a few minutes after any undue delay.

As a general guide all the process parameters should be held to within $\pm 2\%$ of their set values.

12.2 MAINTENANCE

Regular preventive maintenance, of both tooling and machine, is even more important in ECM than in other processes. This is because, in addition to the normal wear and tear, the chemical and electrolytic corrosive effects also cause depreciation of the equipment. The wet corrosive environment, for example, causes deterioration of electrical joints and loosens bolts. All tooling should, therefore, be periodically stripped down and rebuilt. Both mechanical and electrical joints should be treated with grease, to slow the rate of corrosion, and substandard parts should be remachined or replaced. The maintenance is best done immediately after tooling is taken from the machine, so that it can be stored in a clean condition. At least weekly maintenance is required for tooling in constant use. A store of spare parts, such as, spare electrodes, sacrificial pieces, and electrical contact pads will prevent delays. Repair facilities should include copper electroplating and tool insulating.

Machines require daily cleaning; inspection and cleaning of filters after 30 hours of operation is essential. The filters must be 100% effective for the process to operate and should be treated with appropriate respect. Periodic inspection of the electrolyte circuitry for scale deposits, along with cleaning as necessary, is advisable. Normal servicing applies to the other features of the machine and its auxiliaries.

The importance of close process control has already been stressed. It is for that reason that all controlling instrumentation needs regular checking and calibration. This also has the added advantage that tooling may be run on different machines with equal effectiveness.

12.3 REDUCING-DOWN TIME

Electrochemical machining is a high production rate process, but it requires costly equipment. Both these factors make it imperative to gear supporting activities so that they are commensurate with the pace of the ECM operations, and to design tooling to limit set-up times and take full advantage of amperage capacity.

The following are some of the ways to obtain high volume output from an ECM machine and to reduce labor costs.

- Design of tooling to make full use of the available machining amperage often requires running several parts simultaneously in a single machine. Consider loading the parts in a single shuttle that may be loaded outside the machine while other parts are being processed. This reduces the total operation time.
- Load work, with similar operation times, on adjacent machines to permit operation of more than one machine by a single operator, and so reduce labor costs.
- Run machines for two 8-hour shifts per day on work that requires frequent tool changes. It is worth having the extra shift available to cope with contingencies. Three shifts per day should be used where machines are totally engaged on single operations.
- Tooling set-up times can be reduced by good tool design, and by avoiding the use of shims and so on, to compensate for small errors. The dimensional errors in the tooling should be eliminated immediately to ensure future efficiency and accuracy in locating the tooling in the machine.
- Wherever possible, large batches of components should be planned

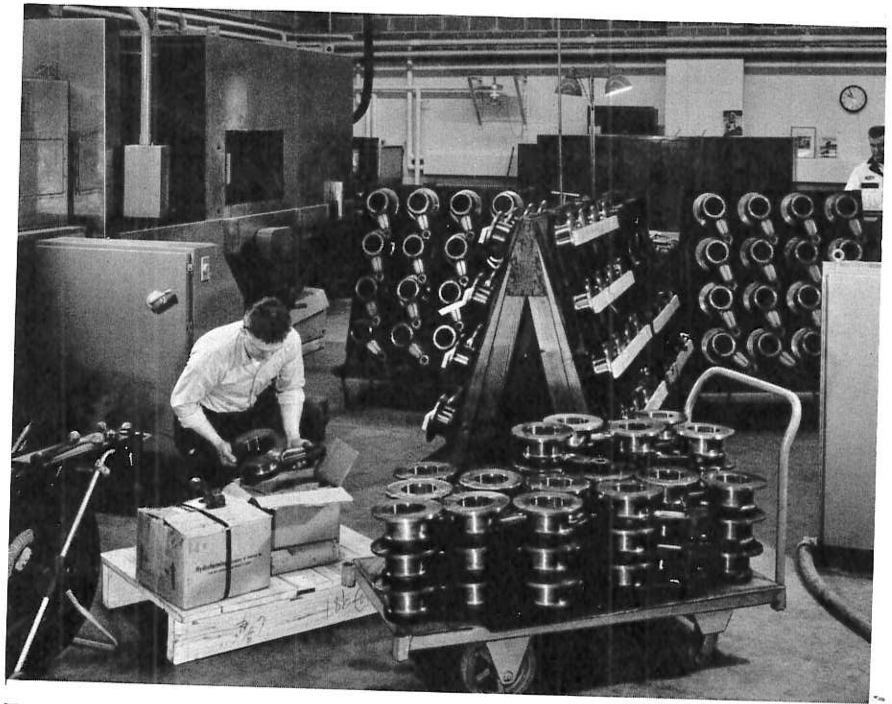

Figure 12.1 Typical view of ECM production shop. Oval lightening pockets, two per part, were machined into all of the parts shown. One pocket in each part is partially located under a flange, making it difficult to machine with conventional contouring machinery. (Courtesy of the Anocut Engineering Company.)

for an EC machine, so that the high productive rate of machining is not compromised by frequent tool set-up delays.
- Methods for inspection of machined components should be suitable to meet the high production rate. Obtaining inspection clearance for the first component machined in a batch should not constitute a disproportionate delay. Subsequently machined components need only be checked at one or two select points, since this is sufficient to ensure the process is functioning correctly. Sampling inspection techniques are suitable when one operation is run continually.
- It is worth repeating that one must closely control the process and routinely maintain both machine and tooling.

A typical view of an ECM production shop is shown in Figure 12.1.