

High-quality needle-punched felts—a total quality control approach to manufacture

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A project to manufacture needle felts internally incorporated five principles of total quality control.

Two and a half years ago, Rodel Inc. undertook a project to dramatically improve the quality of needle felts used in processing by manufacturing felt internally (1). These felts needed to be of highest quality, as they are used in the manufacture of polishing materials that are subsequently used to make semiconductor materials for the electronics industry. Principles of Total Quality Control (TQC) have been adopted to help meet customers' demands for continuous improvement in quality and continually lower prices. These TQC principles were applied to the purchase, setup, and operation of in-house felt production. This paper will review the principles applied and the results of their application.

TQC principles applied

The TQC ideas adopted and applied to this project include:

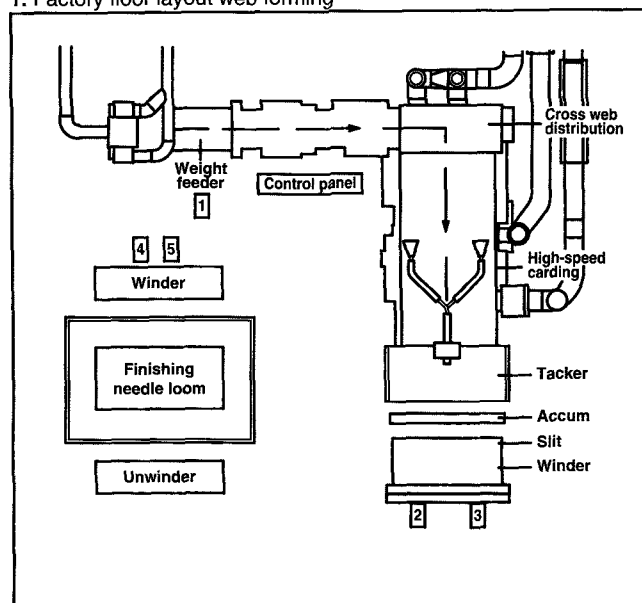
- Equipment engineered for quality
- High-quality raw materials
- Process capability studies
- SPC programs for production
- Operator training and certification.

Equipment engineered for quality

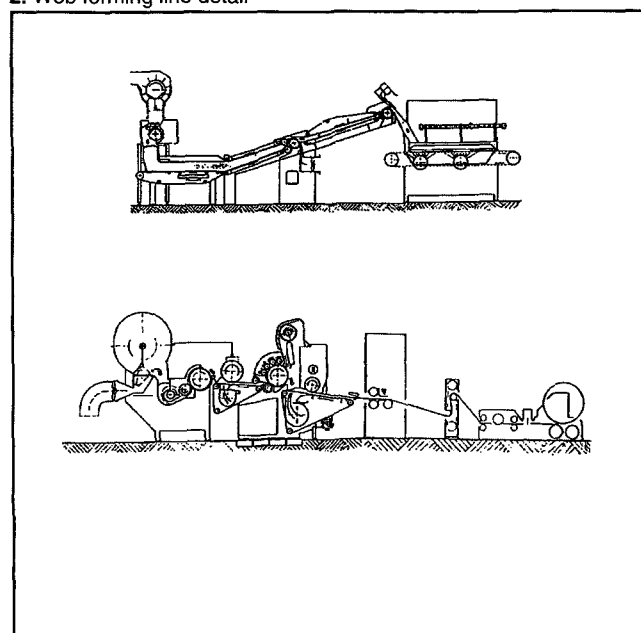
The specifications for the purchase of the manufacturing equipment included a number of built-in quality features. **Figures 1 and 2** provide schematics of the production line. Quality engineering features include:

1. Computer-controlled weight feeder, shown at point 1 in Fig. 1. The system controls the weight of fiber fed to the web forming line. Due to computer control, this section is able to hold weight variations to less than 0.5%, as displayed in Fig. 3. This controller also polices itself, and if out of control conditions exist, it will shut down the line.
2. Regulated motor operating parameters. Each motor in the production line is monitored for "normal" operation. If out of control conditions exist, an alarm is indicated on the annunciator panel, shown in Fig. 4. If not acknowledged, it

1. Factory floor layout web forming

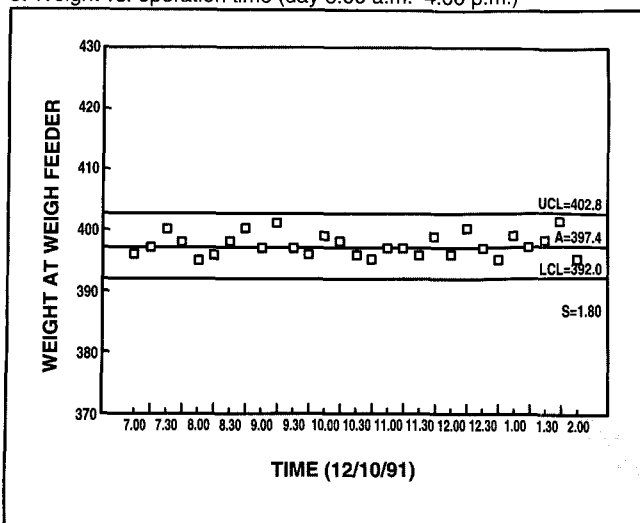


2. Web forming line detail



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3. Weight vs. operation time (day 6:00 a.m.–4:00 p.m.)



I. Machinery trial results

<i>Trial</i>	<i>Web form Process</i>	<i>CV</i>	<i>% Contamination</i>
Purch	CC	4.9%	10.2%
No. 1	CC	3.2%	4.3%
No. 2	CC	2.4%	6.4%
No. 3	AL	2.5%	2.7%

CC = Cardcrosslap
AL = Airlay
CV = Coefficient of variation

will also shut down the operation. A maximum of two minutes is allowed before shutdown, minimizing nonconforming material.

- The machinery manufacture was selected on the basis of rugged design and operational consistency, not price.
- The machinery was completely reviewed by engineering personnel for ease of maintenance and frequency of preventive maintenance (PM). PM programs are carefully maintained (computer tracked) and frequently increased for critical parts of the machinery.

4. Control panel web forming



5. Typical certification for fiber (data omitted)

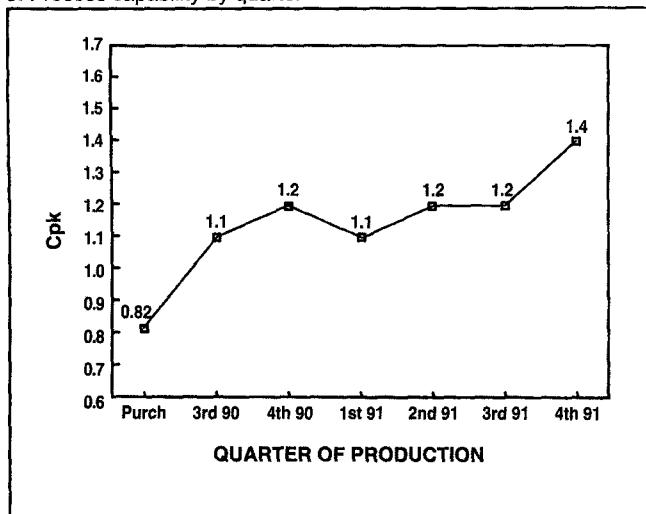
CUSTOMER: RODEL
PLANT: NEWARK
SHIP DATE: 01/07/92
TYPE: LOT: J-4842
ORDER NO: K80904 SHIPMENT: 01

THIS REPORT INCLUDES ONLY SALES WITH ACTUAL TEST RESULTS

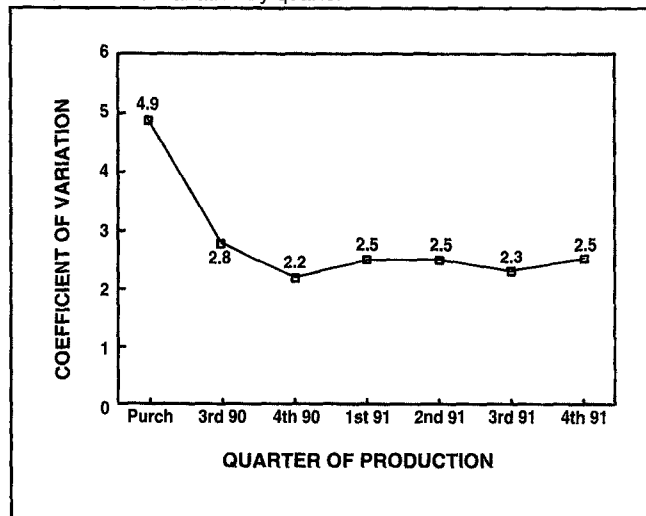
SALE NUMBER	NET WEIGHT	DATE PROCESSED	LENGTH	IR LUBE	CPI/R	ANGLE/R	TEN- ACITY	ELONG	D/F
1572366	761	12/15/91							
1572373	595	12/15/91							
1572374	579	12/15/91							
1572376	579	12/15/91							
1572383	587	12/15/91							

MINIMUM VALUES:
MAXIMUM VALUES:
RANGES:
LOWER LIMITS:
TARGETS:
UPPER LIMITS:

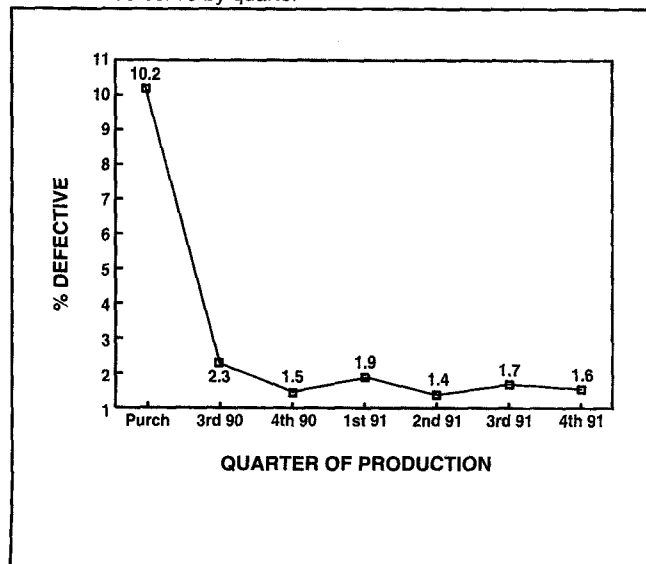
6. Process capability by quarter



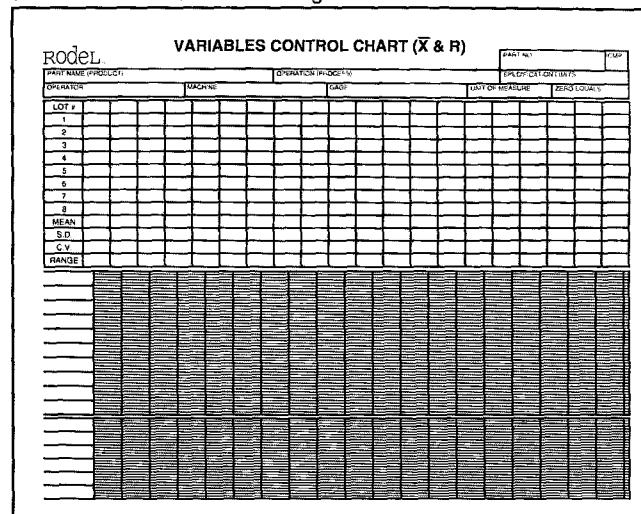
7. Coefficient of variation by quarter



8. Percent defective by quarter



9. X-bar and R chart web forming



High-quality raw materials

Of the many factors that affect the quality of needle felts (2), a key one is the quality of fiber purchased for production. A number of fiber vendors were contacted to supply test fibers for trials on the test equipment. The vendor selected has a reputation for integrity, quality, and stability, in addition to supplying clean and consistent fiber. Price, again, was not a major consideration.

Once selected, the fiber vendor was invited to become a sole source for our company. We require that the vendor offer continuity of supply, provision of quality data from its production process, performance guarantees in our production process, and certification of all material shipped to our company. Figure 5 is an example of the kind of certification required. In return, we supply six-month forecasts, updated quarterly, and a 100% purchase agreement.

Process capability studies

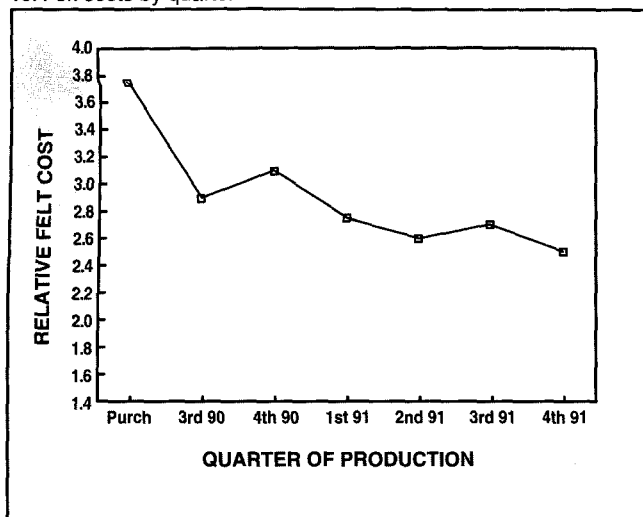
In order to establish operational specifications for the purchased equipment, we ran trials on test lines. The results of these trials were used to establish performance requirements for the equipment and formed the basis of capability studies.

From the results of the trials, it became apparent that new equipment could produce materials with substantially reduced variation in physical properties and contamination. A summary of the machinery trial results is shown in Table I.

Trials were run to evaluate the machinery as well as fiber and needle types. A standard test matrix was used for determining differences from standard materials and processes. These capability studies were used to set up preliminary control limits for the charts used on the production line. Added run experience and added data have led to refined capabilities that are continually updated.

An area requiring special attention was the study of needle use and wear. A consistent product needs special attention in this area due to the constant changes in the process due to needle wear. First a standard process needs to be established specifying run speeds, loom rpm, needle penetrations, etc. Trials need

10. Felt costs by quarter



to be done to pick the best needle designs (there are thousands) and determine needle lifetime. Once this is done, a needle rotation and replacement program needs to be implemented as part of an ongoing PM program (3, 4).

After a year and a half of operation, capabilities are close to those predicted during trials and substantially better than purchased materials. Figures 6–8 illustrate some of the capability data from actual use.

SPC programs for production

After the machinery was in operation and the process was reasonably understood, all manufacturing procedures were written based on modifications to suggested procedures from the machinery manufacturers. These procedures were written by the engineers, operators, and supervisors.

Experience dictated where to monitor the process for best quality, and control charts were established at these points of manufacturing. Currently there are five points charted in the process, as shown in the numbered areas of Fig. 1: weigh belt area (weight 1), after web formation (weight 2) and weight distribution (3), and after final needling (density 4 and defects 5). At each of these points of manufacture, control charts such as the one illustrated in Fig. 9 are kept by the operators and monitored by the engineers and supervisors.

Operator training and certification

The operators for this project received extensive training prior to startup of the equipment. The operators worked as a part of the installation team. This team consisted of technicians from the machinery manufacturer, maintenance, shop people, and engineers from our company and the machinery manufacturer. After completing installation, the operators received extensive training from the technicians during startup and for one month of standard production.

The operators, engineers, and supervisors then wrote all standard operating procedures for the processes. The operators are responsible for all QC and recordkeeping on the materials they produce as well as removing all nonconforming materials. They are also responsible for helping set the run schedule.

Much of the routine PM and all of the cleaning of the equipment is the responsibility of the operators. Clean equipment is essential to keep defects low. All operators have been trained in SPC and receive at least one week's training per year in quality and operations.

Conclusions

Excellent quality results have been achieved by following the principles of TQC. The cost savings have appeared all across the manufacturing areas, as Fig. 10 shows. Customer satisfaction has improved with the availability of higher quality consistent materials. □

Literature cited

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