THE SPRING RESEARCH AND MANUFACTURERS' ASSOCIATION

SURVEY OF MEASURING EQUIPMENT SUITABLE FOR STATISTICAL PROCESS CONTROL

Report No 387

by

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SUMMARY

Statistical process control (SPC) methods are being demanded more frequently by purchasers of springs, and the extent of this requirement has been surveyed. In the light of these demands, a further survey was conducted into the equipment which is currently available that is designed to help springmakers implement SPC.

Details of manufacturers who supply equipment suitable for the spring industry have been tabulated under the headings; Dimensional Measuring Equipment, Data Logging and Processing Equipment, Load Testers and Profile Projectors.

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1. INTRODUCTION

With customers continually demanding higher quality products, manufacturers are being obliged to introduce formal statistical process control methods. Due to the apparent speed that manufacturers are introducing SPC, this project was initiated to investigate SPC in detail. A survey has been carried out on a sample of member companies to gauge the speed at which SPC was being introduced into the spring industry and the problems being encountered. The survey was then extended to look at equipment which is currently available which would aid spring members with the implementation of SPC.

2. GENERAL DESCRIPTION OF SPC

The implementation of SPC requires considerable organisation with a methodical approach to quality control. The use of fully calibrated measuring equipment in conjunction with documented procedures for the measurement of the various parameters must be used at all times. If this is not done only partial benefit will be obtained from the considerable time and money that will have been invested.

Before an item can be made under SPC a capability study must be undertaken on the production machine or process. This study ensures that the production machine and/or process is capable of producing items to the specified tolerance. A process or machine is usually said to be capable when the standard deviation (σ) of a sample of at least 50 consecutive measurements is less than a quarter of the allowed tolerance for the product.

i.e. $+/- 4\sigma <$ +/- tolerance

The exact criteria for capability is not fixed and may vary from the $+/- 4\sigma$ quoted depending on customer requirements.

Should a machine not prove capable the introduction of a 100% measurement system to measure and grade the output from that machine can often produce a capable process. A coiling machine fitted with a lion or micro gauge is a good example of such a system.

Should the machine still not be capable, production cannot be started until the cause (wear, bad raw material, poor control etc.) has been eliminated. If after all corrective proceedures have been tried the process is still not capable consultation with the customer must be sought so that a more realistic tolerance can be placed on the product.

Once the process has been proven capable, production can be started. Throughout the production run consecutive samples must be measured and the values used to plot control charts. The sample size should be a minimum of five, and the period between taking the samples must be established by consultation with the customer and related to normal and practical sampling procedures. The resulting measurements are then plotted on a control chart with the range (max. reading - min. reading of the sample) and the sample average being calculated and checked against tolerance control lines on the control chart.

Two systems for calculating the tolerance control lines are used. The tolerance based system uses a fixed percentage of the tolerance band to define the control lines (e.g. 50% for the average control lines and 65% for the range control lines). The performance based system uses all the previous dimensional measurements and various statistical factors to calculate the position of the control lines on the charts. The latter system is more sensitive to abnormal changes in the measured dimensions, but it does however require more work in calculating the control lines. For a more detailed analysis and description of SPC see SRAMA Report No. 395.

It can be seen that using SPC requires considerable paperwork involving calculation and plotting of the results. Certain aspects of the work can be speeded up by using sample sizes such as 5 or 10 which simplifies the arithmetic. In addition if the tolerance bands are divided into 10 equal divisions a standard printed sheet can be used with the tolerance and control lines (tolerance based system only) already drawn at

standard interval spacings respectively.

The benefits of SPC can be considerable because it will immediately indicate whether the proposed series of manufacturing processes are capable of producing the parts to specification, and if not, will highlight which particular process in the manufacturing scheme is at fault. Even when a process is running well the charts will indicate when routine resetting is required as well as monitoring for abnormal problems such as a change in raw material properties.

SPC does not require specialised measuring equipment, however due to the relatively large volume of measurements being made it is advisable to make the process of measurement as quick and simple as possible. The use of electronic measuring tools is extremely worthwhile as they are quick to use, usually have both metric and imperial units and are less prone to operator errors. Many also have the ability to interface to external data-logging and processing equipment which can be used to produce all the statistical information as required along with hard copies of charts and analysis sheets via a printer.

3. SURVEY OF SPRINGMAKERS

A survey was carried out on a sample of springmakers' quality departments to ascertain the problems being encountered with SPC and to what extent customers were demanding SPC. The questions asked were as follows:-

Q1. Does your company manufacture springs or pressings to SPC?

Q2. Have you had to carry out machine capability studies?

Q3. What type of springs have you had to apply SPC to (i.e. compression,

tension, torsion springs or pressings)?

Q4. What parameters have you had to apply SPC to?

Q5. Do you have on-line meausurement equipment?

Q6. Do you have electronic measuring equipment?

Q7. Do you use patrolling inspectors?

Q8. What sampling procedures do you use?

Q9. How do you produce the control charts?

Q10. What are the main industrial groups requesting SPC?

Q11. Any comments?

The replies to the questions can be summarised as follows:-

A1. Most of the companies had produced springs to SPC. However with one or two exceptions these jobs were only a very small part of their total production.

A2 Only some 25% of the springmakers had carried out capability studies - some being for their own interest and some to meet with customer requirements.

A3 The most common spring type for which SPC was requested was the compression spring followed by tension and torsion equally.

A4 Load requirements are the main parameter being controlled by SPC with the occasional critical dimension also being specified. With torsion springs leg angles and shape in addition to torques are controlled. Pressings only require critical dimensions to be controlled.

A5 Apart from the lion or microgauge measurement devices only two companies had other automatic on-line testing equipment. These were both load testing machines.

A6 The use of electronic measuring equipment is becoming a little more common particularly with spring load testers. Some companies are replacing vernier and micrometers with their electronic counterparts. Three companies were installing computerised SPC systems which allowed direct interfacing of measuring equipment. Though in general these systems require the springs to be taken back to the QA room for measurement.

A7 All the companies surveyed used patrolling inspectors, however the companies which are starting to use SPC are now using the setters to a greater extent for recording the critical dimension on to control charts.

A8 At present most companies use the BS 6001 sampling procedures which are not directly applicable to SPC. Where SPC is to be used an agreed sampling procedure based on BS 5700 must be devised by customer and manufacturer.

A9 With the exception of one company all surveyed companies produced control charts by hand.

A10 The major industrial group requesting SPC is the automotive industry with Ford being the main force behind it. However the electrical/electronic industry is also starting to request SPC due to their use of large scale automation which requires tight tolerance components. It is generally expected that most industrial groups will request SPC in the future.

A11 The comments expressed by the surveyed companies could be split into the following areas.

11.1 The cost of introducing SPC can be high in terms of new equipment, staff and education of personnel. Customers are not willing to help financially and only rarely help with the practical problems involved with SPC implementation.

11.2 Customers are requesting SPC on unrealistic tolerances and/or conflicting tolerances which cannot be met. These tolerances presumably being ignored in the past but must now be documented.

11.3 The variation in wire is the major cause of problems with dimensional control.

11.4 Of those companies that had instigated SPC all of them thought it was very useful, particularly in pinpointing the causes where production problems have occurred. In general it was felt that it made the job of producing in tolerance springs easier although it did increase the paperwork.

The springmakers involved in the survey were requestioned after a period of six months to ascertain how quickly SPC was being introduced. The main change was that companies who had been in the preliminary stages of introduction were now running jobs under SPC. Most companies reported an increase in customer enquiries asking for SPC. Two companies had installed computerised SPC equipment with others looking at what was available with a view to installation at a later date. The general conclusion of the survey was that it was now inevitable that most customers would be requesting SPC in the future.

4. SPC ORIENTATED MEASURING EQUIPMENT

4.1 General Description of Data Logging and Processing Devices

As previously stated special measuring equipment is not required for SPC. However the use of electronic measuring equipment adapted for SPC can have very real advantages in terms of both speed and accuracy of use.

The modification of equipment for SPC requires an electrical output from the measuring device to be fed into a computer for storage and processing. Most electronic measuring equipment can be supplied with this output (usually RS 232 compatible) when purchased. However the use of the RS 232 standard for interfacing means that the data logging equipment must have certain programmable options such as baud rate (data transfer rate), which way round the information is passed (highest or lowest digit first), units, sign and data validity checks. The way all or part of the measurement information is transfered from the measurement device is not

standard and will vary between equipment manufacturers. The simplest solution to this problem is to purchase the equipment from a single manufacturer. This unfortunately is not always possible with the wide range of equipment needed. However some manufacturers will help interface non-original equipment to their own SPC systems.

There are three basic types of logging/processing equipment available for SPC.

1. A hand held logging device which simply stores the measurement values. Because it does not have read-outs or processing capabilities the unit must be taken to the main computer for down loading so that the data can be processed. The advantages of such a device are the low cost and the fact that it can be used on the shop floor. Its disadvantage is that the unit must be taken to a computer before the user can read the information. Only one parameter at a time, can usually be measured with these devices.

2. The second type of unit is a modified version of (1) with varying amounts of data processing power incorporated. These units are again usually hand held with a keyboard to allow input of control information and a LCD screen or a tally roll printer for output.

   On command, information such as average, mean, standard deviation can be calculated along with control chart print outs. These units are either specially constructed or they use the various portable computers commercially available. Both types can be used on the shop floor although the latter will often not be quite as rugged. The

advantage these units have over the type (1) is that the operator can process the results on the shop floor and does not need to return to the main computer except at the end of a run if a central data bank type of system is in use. These devices usually allow more than one parameter at a time to be measured.

3. The type '3' unit often incorporates a standard micro-computer fitted with RSC 232 ports into which the measuring equipment is connected. The main difference between these units and type (2) is that much larger quantities of data can be stored and processed. Superior quality printers also allow the production of test certificates, control charts and measurement information for records and for the customer as well as for production control. Because of their superior processing capabilities they can be used to monitor several parameters and several jobs simultaneously. In general this type of machine is not suitable for use on the shop floor due to their size and sensitivity to dirt and abuse.

4.2 Measuring Tools

The range of electronic measuring equipment available at present is not very comprehensive, with many manufacturers marketing the same equipment under their own name. If equipment is being purchased with the possibility of it being used in the future for SPC it must have an RS 232C interface, or the ability to be modified to incorporate one at a later date. It may also be found that when the RS 232C interface is being used a separate power supply may be required because of the increased power consumption.

Due to the open design of electronic vernier calipers particularly the optical grating type they can be susceptible to oil and dirt and thus need to be used carefully.

Load testing equipment tends to have various electronic outputs which often do not meet recognised standards. This means that either a special interface has to be built into the existing outputs or the computer/ software package as supplied by the load tester manufacturer has to be used.

One of the main advantages of electronic measuring equipment is in their range of switchable functions. These usually include switchable units, floating zero, setable tolerance bands and display freeze (memory). These features do not make the equipment any more accurate but due to their ease of use they help minimise operator error.

Electronic equipment available at present includes micrometers, vernier calipers, height gauges, profile projectors and load testing equipment.

4.3 Survey of Manufacturers Producing Equipment Suitable for the Spring Industry

The following sections outline in product types, manufacturers who produce equipment that is directly applicable to S.P.C. A more detailed product breakdown is available in the tables at the end of the report.

4.3.1 Work Shop Measuring Equipment

British Indicators Limited

Address: Acrewood Way,
Hatfield Road,
St. Albans,
Herts AL40JX

British Indicators produce a range of electronic dial gauges which via an RS 232C interface can be linked to a computer. Their own system uses a small New Brain computer and outputs via a VDU or a tally roll printer. Standard ROM based software allows the production of statistical information.

Mauser GmbH (Also marketed as Roch SA)

Address (Agents): Metalogy International,
8 Cold Bath Road,
Harrogate HG2 ONA

Mauser GmbH and Roch S.A. again produce a standard range of measuring equipment which via an interface unit connects to a portable Epson computer for processing. A small data logging device is also available for use on the shop floor. Several measuring units can be connected to the last computer via interfaces and used simultaneously for multi parameter measurement.

Mitutoyo (UK) Ltd

Address: Kings Way,
Walworth Industrial Estate,
Andover,
Hampshire SP10 5LQ

This company produces the widest range of electronic equipment available at the time of writing. The product range covers all normal workshop measuring equipment (except spring load testers) with a range of processing equipment to cover most requirements. It should be noted that not all their electronic equipment can be connected to computers. In general all of their equipment is specially designed for SPC rather than being modified from existing ranges.

Moore and Wright Microsystems Limited

Address: 100 Fitzwalter Road,
Sheffield S2 2SP

This company was one of the instigators of electronic measuring equipment and market a standard range of tools which can be connected to their CADAR computer system. However much of the equipment supplied is not of their manufacture and is adapted for use with their Apple II computer based processing unit. A Networking system is available along with constant updates of software as they became available. New measuring equipment is being added to the range continually. The processing software is of high quality.

Tesa Metrology Ltd

Address: P.O. Box 418,
Halesfield 8,
Telford,
Shropshire TF7 4QN

The Tesa electronic equipment for SPC covers the standard workshop range except that a digital micrometer is not available. The equipment is connected via a separate interface to a small Epson portable computer. The American parent company - Brown & Sharpe also manufacture dedicated SPC processing units but at present these are not available in the U.K. The processing software is a little basic at present and needs improvement before it is of real use in SPC.

T.P.C Technology Corporation

Address: 345 Criss Circle
Elk Grove Village
Illinois 60007

This American company manufactures data logging and display equipment which can be interfaced to most RS 232 and BCD equipment. Keyboard entry is also possible for non-electronic measuring equipment. Information can be viewed from its own small display, by connecting to a video monitor or by connecting to an A4 printer. The result can also be down loaded onto a host computer for central processing. Full SPC software is available for IBM compatible computers.

Sellars Data Systems Limited

Address: Edge lane
Droylsden
Manchester M35 6BU

This company produces a hand held data logging/processing unit which connects via interfacing cables to most of the electronic measuring equipment available. It is capable of logging approximately 6000 readings which can be sub-divided into a variety of multi-parameter and multi job arrays. The information can then be processed and the results displayed either on the inbuilt screen or down loaded onto an A-4 printer for full display. The results can also be down loaded to a computer for central logging if required via its RS 232C port.

4.3.2 Spring Load Testing Equipment

Chatillon Corporation

Address (Agents): Mecmesin Ltd.,
Newton House,
Cross Road,
Todworth,
Surrey KT20 58R

Chatillion produce a range of spring testers which due to their American origin support SPC. This is accomplished by connecting the load testers to Hewlett Packard or IBM compatable computers via the load testers RS 232C port. Several testers can log their information into a single computer via a specially developed network system. Full softwre packages are available to produce the SPC information required. Mecmesin also supply a range of spring testers of their own manufacture and produce an SPC package for many of the machines.

Howden-Ellis-Kirkaldy Ltd.

Address: Sommers Road Industrial Estate,
New Bilton,
Rugby CV22 7DG

This company produces a sophisticated fully computerised spring load testing machine which incorporates their own statistical package for producing SPC information. Several machines may be linked to a network to allow central processing of information.

Link Engineering Co. Ltd.

Address: 13853 Elmira Avenue
Detroit
Mitchigan 48227

Link have produced a large range of electronic spring testing machines for many years and have a standard SPC package for interfacing to their machines. IBM or Hewlett Packard computers are used in conjunction with a range of interfaces to allow input directly from the load tester or other electronic gauges.

Probat Werke GmbH

Address (Agents): Dartec Ltd.,
Mill Race Lane,
Stourbridge,
West Midlands,
DY8 1HU

Probat have produced electronic spring load testing machines for many years and all have electronic outputs from the displays. However these outputs do need modifying to enable computer interfacing.

Probat supply their Progress Q package which is either Commodore or Hewlett Packard based and allows statistical processing to be carried out. Their range covers compression, tension and torsion spring testers of all sizes.

Reicheter GmbH

Address (Agents): Metcma Ltd.,
Cannon Newton House,
70 Evesham Walk,
Redditch B97 4HA

Reicheter like Probat have also manufactured electronic load testing equipment for a considerable number of years and can supply computer interfacing as required. A Hewlett Packard microcomputer is generally used for processing of the data. Their range covers testers for all sizes of compression, tension and torsion springs.

Salter Springs & Pressings

Address: Spring Road
Smethwick
Warley
West Midlands B66 1PF

Salter Springs & Pressings produce three standard spring load testers which cover the range from 10N to 40000N. All of the machines have R.S. 232 outputs and can be linked to the Moore & Wright Cadar system as standard or to one of the other universal SPC systems.

Simplex Rapid

Address (Agents): S.A.H. Machine Tools Ltd.,
90 High Street,
Gaton Bray,
Nr. Dunstable,
Bedfordshire OU6 2DP

Simplex Rapid market under their own name a range of electronic testers of Japanese origin. They all have non standard electronic outputs and thus require interfacing equipment before connection to computers is possible.

4.3.3 Optical Profile Projectors

J. E. Baty Co. Ltd.

Address: Victoria Road,
Burgess Hill,
West Sussex RH15 9LB

Baty make a comprehensive range of projectors, however due to the light source and lens position only a few of them are suitable for spring and pressing measurement.

Mitutoyo (UK) Ltd

Address: Kingsway,
Walworth Industrial Estate,
Andover,
Hampshire SP10 5LQ

Mitutoya make a limited range of projectors which must be fitted with their digimatic micrometer leads when used with their own SPC equipment.

Nikon (UK) Ltd

Address: PO Box 36,
New Star Road,
Thurmaston Lane,
Leicester LE4 7JQ

Nikon produce a comprehensive range of projectors most of which are suitable for spring measurement. Electronic readouts are only available on X-Y axis and must be linked to a host computer and software if SPC processing is required.

Pexit Precision Ltd

Address: Wilbraham Road,
Fulbourne
Cambridge CB1 5ET

Pexit make a large range of projectors and due to the modular nature of these units they can meet almost any requirement. Most of the units have large screens and digital readouts as standard. RS232 outputs are standard to allow the connection of computers.

5. CONCLUSIONS

1. From the information gained from the survey it is apparent that S.P.C. is here to stay and will be used increasingly in the control of product quality. It is thus vital that all spring makers familiarise themselves with the procedures of SPC and with the equipment required to carry out the work.

2. SPC orientated equipment is still in its infancy. However more and more specialist equipment is now appearing that will help reduce the time and work involved in implementing the SPC procedures. By contacting the companies listed in this report springmakers should be able to locate suitable equipment for this purpose.

Dimensional Measuring Equipment

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Company	Verniers (size mm)	Micrometer (size mm)	Height Gauge (size mm)	Dial Gauge (size mm)	Bore Gauge (size mm)	Electronic output	Comments
British Indicator Ltd	-	-	-	0-3 0-25	-	RS232C	Only manufacture dial gauges at present. Has output and print mode as standard. Dial can rotate full 360°.
Mauser GmbH	0-150 up to 0-1000	0-25 25-50 50-75 75-100	0-300 0-600 0-1000	0-10	-	RS232C	Output must be requested at time of purchase. A good standard range
Mitutoyo	0-150 0-200 0-300	0-25 25-50 50-75 75-100	0-300 0-600 0-1000	0-12.7 0-10 0-30 0-50	-	Serial BCD	A very good range specially developed for SPC. Output must be requested at time of purchase. Micrometers have some stats processing as standard. Note that not all their equipment can be used for SPC.
Moore & Wright	0-150 0-300 0-500	0-25 0-50 0-100 150-300	0-300 0-450 0-600	0-25	1 up to 210 in increments	RS232C	Equipment from various manufacturers. Outputs must be requested at time of purchase. Micrometer can give stats processing as standard.
Tesa	0-150	-	0-300 0-600	-	15 up to 120 in increments	RS232C	Verniers of optical type and can be prone to oil. Outputs must be requested at time of purchase.

Data Logging & Processing Equipment

Company	Product Code	Type	Max No. Readings	Multi-Parameter	Portable	Output Device	Output Information	Comments
British Indicator Ltd	Model AD + STAT-AN	Small Newbrain computer	Depends on software. Has large capacity.	Yes up to 64	No	Tallyroll printer and VDU	Basic SPC tolerance based charts	Device mainly for BI dial gauges. Good multi-parameter feature. Software a little limited.
Mauser GmbH (Roch SA)	Digiroch 2 M.A.O	Epson Hx20 portable computer	6000	Yes up to 10	Yes	LCD screen + tally roll printer	Very basic no control charts	Need considerable improvement to software before it can be used for SPC.
	825 MAO	Datalogger	1500	Yes up to 10	Yes	None	needs Digiroch 2	Small portable logger for shop floor. Needs host computer for processing.
Mecmesin	Elco SPC	Portable Sharp computer + printer	3000	No	Yes	tallyroll printer	full SPC	Gauges do not interface to this unit. Information must be entered by hand.
	SPC	micro-based H.P.86 and IBM compatibles	Almost unlimited	Yes	No	VDU and A-4 printer	full SPC	For use with the range of test equipment. Can be adapted for other equipment. Very good software.
Mitutoyo	DP1	Small SPC calculator and battery	100	No	Yes	tallyroll printer	Basic calculations	Simple device that calculates the information required for plotting control charts.

Continued ..../

Data Logging & Processing Equipment continued

Company	Product Code	Type	Max. No. Readings	Multi-Parameter	Portable	Output Device	Output Information	Comments
Mitutoyo	DP2	SPC calculator and plotter battery	1000	No	Yes	tallyroll + plotter	Basic calculation with slightly more detail	More sophisticated version of DP1. Does not plot charts. Calculates capability factors.
	DP3	SPC calculator and plotter battery	1000 can be split into sub groups	Yes 2 dim x 8 parts	Yes	Tallyroll plotter	full SPC	As DP2 but with full SPC. Plots tolerance based control charts and capability factors.
	DP20	Portable computer Battery/mains	High capacity	Yes 8 dim x 3 parts	Yes	Tallyroll plotter	full SPC	Full SPC output for performance and tolerance based control charts. A-4 printer link. Real time clock and keyboard entry if required.
	Host computers H.P.85, H.P.86, H.P.150 IBMPC CBM64 Apple 2E Apple 2L	Desk top micro computers that require use of multi plexers and special interfaces. Mains	8000	Yes up to 10 parts	No	High resolution screen + A4 printer plotter	full SPC	Sophisticated system able to handle large amounts of information. Remote data loggers can be used away from the computer. Good software.
Moore & Wright	Cadar	Desk top Apple 2E micro computer mains	Very high capacity	Yes 16-32 depending on software and hardware	No	VDU + printer	full SPC	Very good software: with continuous updating of programs. Not portable but networking is available.

Continued ...../

Data Logging & Processing Equipment continued

Company	Product Code	Type	Max. No. Readings	Multi-Parameter	Portable	Output Device	Output Information	Comments
Sellars Data	Dataputer 2000	Portable data logger Battery/ mains	6000	Yes up to 99	Yes	LCD screen A-4 printer	full SPC	Small and very comprehensive device: will interface to most electronic equipment. Good software. Needs printer.
Tesa	Epson Hx 20 + AP1 + AP2 programs	Portable computer Battery/mains	1200	Yes up to 6	Yes	LCD screen and tally roll printer	Basic calculations	Very basic output. Software needs improving before it can be used for SPC.

Company	Product Code	Type	Max. Capacity (N)	Printer	Comments
Chatillon	DST40RS	compression and tension	180 360	Yes Yes	Computer compatible with RS designation. Good facilities with interface being programmable to allow connection to a wide range of computers: standard software is available.
Howden Ellis Kirkaldy	EK200	compression and tension	2000 40000	Yes Yes	Very sophisticated computer controlled testing: Allows full SPC processing using on board computer and printer. Has disk storage for information and several machines can be networked to a main computer for central processing.
Link Corpn.	GL0	compression and tension	20	No	All of these machines can be connected to Link's own IBM based SPC package. They all require the use of a modular interface which can also be used for electronic calipers etc. Printers can be supplied as an option on the standard m/c.
	EL1	"	40,80	No	
	EL3	"	100,200, 400,1200	No	
	EL4	"	100,200, 400,1200	No	
	EL5	"	2,000 3,000	No	
	EL6	"	4,000 6,000	No	
	TP	"	1000, 2000, 4,000 8,000	No	
	EL483	Torsion	12N.m, 120N.m	No	

Continued ...../

Spring Load Testers continued

Company	Product Code	Type	Max. Capacity (N)	Printer	Comments
Probat	SF 201	compression and tension	200	No	Comprehensive range of testers all having electrical outputs. These however are not computer compatible and need special interfacing. This can be supplied on request. Probat produce a range of software under the Progress Q name for commodore on Hewlett Packard computers.
	SF 202	"	2000	No	
	SF100EL	"	100	No	
	SF100EL	"	1000	No	
	SF21/2EL	"	5000	No	
	SF26/2EL	"	20000	No	
	TO 14EL	Torsion	5000 N.mm	No	
	TO12SEL	"	500kN.mm	No	
Reicheter	NRE-D2	compression and tension	100	No	Comprehensive range of testers all having non electrical outputs. Interfacing equipment will be required to connect these to computers. Reicheter can supply this along with Commodore and Hewlett Packard computers and software.
	NRE-D3	"	100	No	
	EE1	"	2000	No	
	EE4	compression	20kN	No	
	EEH2	"	200kN	No	
	ET1D-20	Torsion	20N.mm	No	
	ET1D-1000	"	1000N.mm	No	
	ET2	"	2000N.mm	No	
	ET3	"	100kN.mm	No	
Salters	Salter 200	compression and tension	10 100 200	Yes	A wide range of capacity with RS 232 ports available. Interfacing to Cadar system already available. Printer available as an option.
	Salter 4000	compression and tension	4000	Yes	
	Salter 40000	compression and tension	40000	Yes	

Spring Load Testers continued

Company	Product Code	Type	Max capacity (N)	Printer	Comments
Simplex Rapid	RM /5	Compression tension	50	No	Electronic outputs for printer. Interfacing equipment required before computer connection possible.
	RM /10	"	100	No	
	RM /25	"	250	No	

Profile Projectors

Company	Product Code	table travel (mm)	Screen Size (mm)	Electronic X - Y readout	Electronic Angle Measurement	Comments
Baty	SM20	50x50 or 150x50	500	Yes	Yes	Lens under table - not ideal for coil springs but good for pressings RS232 output as standard on digital readouts, edge detectors available.
	SM122	50x50 or 150x50	305	Yes	Yes	Lens above table - has small screen but RS232 standard and digital readouts.
Mitutoyo	PJC 250C	50x50	250	Yes	No	Outputs only available when digimatic micrometer heads are used. Only suitable for very small items. Range of lenses available.
	PJ 300	50x50 100x50 150x50	300	Yes	No	Outputs only available when digimatic heads are used. Edge sensor available. Zoom lens available.
	P V 600	100x50	600	Yes	No	Lens fitted under table. Not really suitable for coil springs. Digimatic head required for output.
Nikon	V 12	50x50 or 100x50	305	Yes	No	Lens above table small screen. RS232 available on X-Y co-ordinates. Edge detector available. Printer can also be supplied.
	V16E	50x50 or 100x50 or 175x75 or 225 x 75	406	Yes	No	Lens above table. Good size screen with a wide range of tables available. RS232 as standard on X-Y co-ordinates. Printer available.

Continued ..../

Profile Projectors (continued....)

Company	Product Code	table travel (mm)	Screen Size (mm)	Electronic X - Y readout	Electronic Angle Measurement	Comments
Nikon	V 20-A	175x75	500	Yes	No	Large screen and table. RS232 as standard on X-Y co-ordinates. Printer available.
	V24B	225x100	600	Yes	No	Very large unit and table. RS232 as standard on X-Y co-ordinates. Printer and edge detector available.
Pexit	20 LD	125x50	605	Yes	Yes	Vertical lens under table - not ideal for coil springs. Good facilities with RS232 output available.
	Cambridge system	to suit	750-2000	Yes	Yes	This range of machines is made to order and specification. Very competitively priced with very large screens available.