"Thermosets 2000"
Conference

Sponsored By The
THERMOSET DIVISION
And The
CHICAGO SECTION
Of
THE SOCIETY OF PLASTIC ENGINEERS

March 22-24, 2000
Chicago O'Hare Marriott
8535 West Higgins Rd.
Chicago, Illinois

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Topical Conference (RETEC), Sponsored by the

Thermoset Division and the ***Chicago Section***

Society of Plastics Engineers

March 22-24, 2000

Chicago O'Hare Marriott

Wednesday, March 22nd

3:30 - 6:00 PM	Thermoset Division Board Meeting
6:00 - 9:00 PM	REGISTRATION
6:30 - 9:00 PM	Display Table Exhibition

Thursday, March 23rd

8:00 - Noon	REGISTRATION
8:50 - 9:00 AM	Welcome
9:00 - 9:30 AM	**Keynote Address** - LARRY NUNNERY BMC Inc., St Charles, Illinois *New Directions for Thermoset Polyester For the New Millennium*

MORNING SESSION

MODERATOR:	Chip Retert, Plastic Engineering Company
9:30 - 10:00 AM	*Machine Performance Cloning - The Impact on Molded Thermosets* By: TARAS KONOWAL Apex Plastics Technology
10:00 - 10:30 AM	*In-Mold Cure Monitoring of Thermoset Molding Compounds* By: DAVID SHEPARD Holometix Micromet
10:30 - 11:00 AM	BREAK and EXHIBIT VIEWING
11:00 - 11:30 AM	*Process Optimization for Automotive Phenolic Applications* By: TOM BRYLINSKI Occidental Chemical Corporation
11:30 - 12:00 PM	*Computer Technology for Injection Molders in the 21st Century* By: STEPHEN SINDERSON Woodland Plastics Corporation
12:00 - 12:30 PM	CASH BAR & EXHIBIT VIEWING
12:30 - 2:00 PM	LUNCH

AFTERNOON SESSION

MODERATOR:	Mark Pelnar, Davies Molding Company
2:00 - 2:30 PM	*Uses of Cryogenic Processing in the Thermoset Molding Industry* By: RICK DICKMAN Controlled Thermal Processing Inc.
2:30 - 3:00 PM	*Using Modern Machine Technology to Increase Profitability* By: PETER LIPP Krauss Maffei Corporation
3:00 - 3:30 PM	BREAK and EXHIBIT VIEWING
3:30 - 4:00 PM	*New Product Development* By: GEORGE BOLTON Kurz-Kasch Inc
4:00 - 4:15 PM	Thermoset Div. General Business Meeting
4:15 - 4:45 PM	*Rheological Study of the Phenolic Cure* By: TED MORRISON Plastic Engineering Company
4:45 - 5:15 PM	*BMC for the New Millennium* By: LEN NUNNERY BMC Inc.
5:15 PM	Hospitality Suites Open

Friday, March 24rd

8:00 - 10:00 AM	REGISTRATION
MODERATOR:	Tom Wilczewski, Plastic Engineering Co.
8:30 - 9:00 AM	*Injection vs. Compression Molding An Overview of IMM Technologies* By: TOM BETTS Battenfeld of America Inc.
9:00 - 9:30 AM	*Heat Resistance Part II* By: DONALD BAUMAN Plaslok Corporation
9:30 - 10:00 AM	*Overview of Materials in Thermoset Compression Molding* By: FRANK KALUZA J.M. Huber Corporation
10:00 - 10:30 AM	BREAK and EXHIBIT VIEWING
10:30 - 11:00 AM	*RF Preheaters for the Future* By: NED SNOW Nemeth Engineering
11:00 - 11:30 AM	*Past and Future Trends in Thermoset Injection Molding* By: JOHN TIMMERMAN Engel
11:30 - 12:00 PM	*Yes, Thermosets Can Be Recycled* By: RANDY LEWIS P.R. Lewis Consulting Inc. and HADLEY KLINE Cuyahoga Plastics
12:00 - 12:30 PM	*Future of Thermosets in the New Millennium* By: DAN BUCKLEY Lawton Machine Corporation
12:30 PM	INFORMAL BUFFET LUNCH

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Of
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An SPE Conference is a forum for discussion of contributions to the scientific and engineering knowledge of plastics. Conference pre-prints aid communications between speakers and audience, encouraging meaningful discussion. They are not a substitute for publication.

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Chicago O'Hare Marriott
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Check the membership grade for which you are applying. ❑ Student ❑ Member

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Check your preferred mailing address. ❑ Company ❑ Home

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Country: ______________ Zip: ______________

Phone: ______________________

Fax: ______________________

E-mail: ______________________

Primary end product manufactured or service performed at your company?

____

What is your primary job function (check one only)?

- ❑ (01) General & Corporate Management
- ❑ (02) Design & Design Engineer
- ❑ (03) R&D
- ❑ (04) Production Manufacturing
- ❑ (05) Quality Control
- ❑ (06) Purchasing
- ❑ (07) Sales/Marketing
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- ❑ (12) Technical Sales/Support
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Country: ______________ Zip: ______________

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(Month) (Day) (Year)

Gender: ❑ Female ❑ Male

STATEMENT OF FEES (U.S. Funds ONLY)

The SPE year extends from 7/1 to 6/30. Dues are not pro-rated.

MEMBER $94.00 ($84 + $10 initiation fee)
STUDENT MEMBER $21.00 (no initiation fee)
REINSTATED MEMBER $84.00 (no initiation fee)
Dues include a 1-year subscription to *PLASTICS ENGINEERING*

❑ Payment enclosed: ❑ Check ❑ Money Order ❑ Travelers Checks

❑ Charge my: ❑ American Express ❑ MasterCard ❑ VISA

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Signature ______________________

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I certify that the statements made in this application are correct. I agree to be governed by the Constitution and Bylaws of the Society and to promote the objectives of the Society.

____
Signature in ink Date

Sponsor: Name ______________________ (optional) ID

FOR OFFICE USE ONLY	
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Section	Source: P

"THERMOSETS 2000"
March 22-24, 2000

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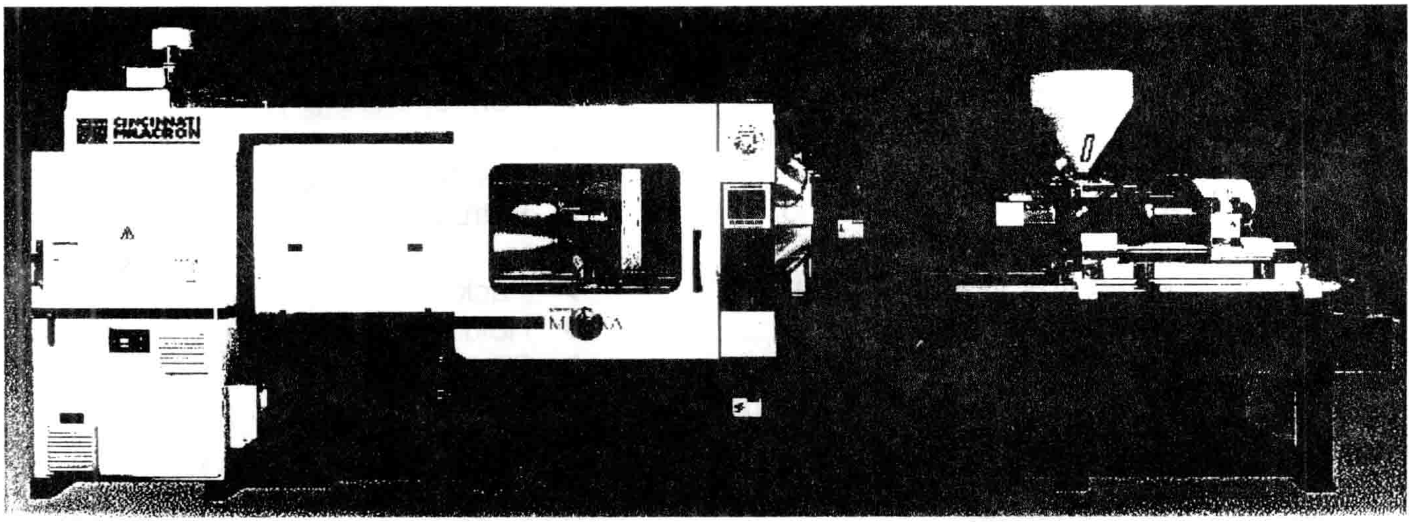
MACHINE PERFORMANCE CLONING-THE IMPACT ON MOLDED THERMOSETS



TARAS KONOWAL
APEX PLASTIC TECHNOLOGIES

RETEC "THERMOSETS 2000"

The Webster Dictionary defines *"to clone"* as: "One that appears to be a copy of an original form."

The basic goal in molding thermoset materials is to optimize the process to increase quality and efficiency while lowering production costs. A simple formula that is a daily struggle!

Discussions about moving a mold from machine to machine have been going on for eternity. Moving the mold is not the problem. Optimizing the process, in a timely manner is the challenge. Is there a real need to be able to do this? Is it done often enough to warrant any attention? What would the advantages be to having this capability?

Versatility in scheduling.
Consistent results.
Reduced QC inspections.
Reduced set-up time.
Reduced scrap.
More time for Preventive Maintenance.

Often enough it is difficult to analyze the cause of a defect on molded parts. Finding a suitable remedy can be a very time consuming process. Also add-in potential inconsistencies in the molding machine, and efficiency levels become extremely low.

In order to clone molding machines it is important to know what are the causes of inconsistencies. Also, what performance characteristics are important to mold a high quality thermoset part.

What then is important in an injection molding machine that influences performance?

ACCURACY

Accuracy can be defined as the maximum amount by which the result differs from the true value.

The accuracy of a machine is based on the three measured parameters:

Pressures
- Pack
- Hold
- Back Pressure
- Mold Protection
- Tonnage

Speeds
- Injection
- Extruder

Times
- Pack
- Hold
- Screw Recovery
- Clamp
- Eject

PRESSURES

Pressures on the injection side of the process are related to moving the material from the injection unit into the mold. The backpressure affects the material flow between the screw and the barrel. It also assures that the material is filling the area in front of the screw consistently. The injection pressure is the amount of pressure needed to start the material flowing and keep the fill rate into the mold consistent. The holding pressure is the final stage of preparing the material for crosslinking and curing. The hold pressure is used to control the material shrinkage and stress. Pressures associated with the clamp can cause premature mold wear and damage. The clamp pressure also has a direct impact on how the tool lets air escape and releases the material gases.

Molding problems associated with pressure inconsistencies are:

Pack/Hold Pressure

Unfilled Parts
Sink Marks
Cracks Near Sharp Edges, and Cores
Cracks due to Shrinkage
Dull Spots
Glass Fiber Streaks
Flow Lines
Flash Inconsistency

Back Pressure

Porosity
Blisters
Sink Marks
Glass Fiber Streaks
Color Steaks
Flow Lines
Flash

Mold Protection

Damaged Mold Lands
Damaged Vents

Clamp Pressure

Venting Inconsistency
Injection/Compression problems
Sinks
Flash Inconsistency
Dull Surfaces

SPEEDS

The speed of injection has direct impact on the crosslinking, curing and surface appearance of the parts. The speed of material preparation can impact the part strength and cycle times. The problems that will occur with speed inconsistencies are:

Injection Speed

Premature Cross Linking
Unfilled Parts
Surface Blemishes
Blistering
Cracks
Sink Marks
Burn Marks
White Streaks

Extruder Speed

Overheating Material/Curing
Unfilled Parts
Surface Blemishes
Sink Marks
Glass Degradation

TIMES

The timers are the controlling factors on the pressures and speeds of the molding process. If the times are inconsistent the parts will have defects. The defects that can occur with timer inconsistencies are:

Pack/Hold Pressure Time

Parts not filled out completely
Sink marks after ejection
Blistering
Crack near gates, sharp edges or restricted areas.
Cracks due to shrinkage
Sink marks near gates or thick walls
Dull Spots
Glass Fiber Streaks over entire part
Flow Lines
Inconsistent flash

Recovery Time

Parts not completely filled out

Sink Marks
White Marks
Burn Marks
Moisture Streaks

Clamp Time (Including Venting and Injection/Compression

Parts not completely filled out.
Sink Marks.
Blistering
Burn Marks
Flash Inconsistency

Ejection Time

Ejector Marks
Gate Cutter Inconsistencies

REPEATABILITY

Repeatability is the degree of agreement between repeated results. The parameters that are measured for repeatability are the following:

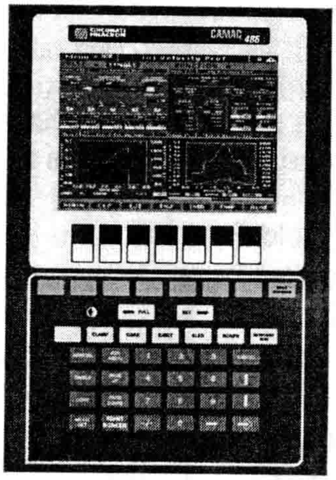
Times
- Cycle
- Mold Close
- Mold Open
- Fill
- Recovery

Pressures
- Fill
- Pack
- Hold
- Back Pressure

Many molding machines have difficulty with repeatability from *cycle to cycle*. What happens, then when the mold is moved to a *different* machine?

The goal, therefore is to insure that the machine performance characteristics are accurate and repeatable.

HOW DO YOU ACHIEVE ACCURACY & REPEATABILITY?



The main factor in injection molding machines that influences the accuracy and repeatability of the press is the resolution and response time. How fast the machine can respond to the inputs and feedback will determine the level of accuracy and the repeatability of the machine functions. The responses of the machine are based on the resolution and scan time of the control.

RESOLUTION

The resolution of the control depends on the microprocessor speed and the type of feedback devices that are used.

5-YEAR-OLD TECHNOLOGY

386 Control

Analog Stroke Devices
- 12.00 inch stroke

12 BITS = 4,095 INCREMENTS
Therefore,
1 BIT = 0.00073 INCH

- 3000 PSI Inj Pressure

12 BITS = 4,095 INCREMENTS
Therefore,
1 BIT = 0.733 PSI

2 YEAR OLD TECHNOLOGY

486 Control

Analog Stroke Devices

- 12.00 inch stroke

14 BITS = 16,384 INCREMENTS

Therefore,

1 BIT = 0.0029 INCH

- 3000 PSI Inj Pressure

14 BITS = 16,384 INCREMENTS

Therefore,

1 BIT = 0.200 PSI

YEAR 2000 TECHNOLOGY

Pentium II Processor

Digital Stroke Devices

- 12 inch stroke

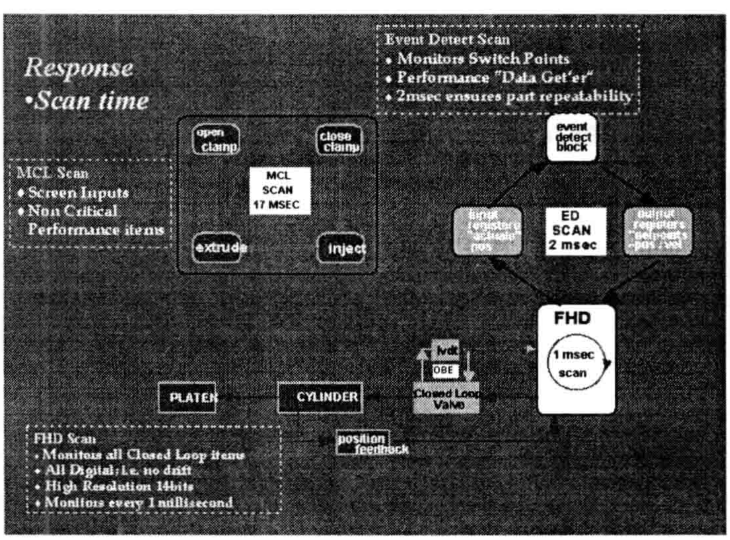
Resolution = 0.0014 INCH

- 3000 PSI Inj Pressure

Resolution = 0.150 PSI

SCAN TIME

The other aspect of a machine's response is the scan time. Most modern machines use multiple microprocessors working simultaneously. The scan time can be defined as the time it takes for the microprocessor to go through one complete cycle of looking at inputs and delivering outputs.



Different machine functions are driven by different speed microprocessors. As an example, a processor that has a scan rate of 17 milliseconds handles the clamp open and close, injection and extruder run. Another processor with a scan rate of 2 milliseconds handles switch points and critical events. A third processor controls all of the closed loop functions making corrections around deviation from setpoint and actual.

Third Party consultants such as Hunkar Laboratories have developed criteria for machine performance. They have a quality classification system that defines what tolerances should be expected from a machine. Machines are segregated from excellent-Class 1 to barely running-Class 9.

ACCEPTABLE TOLERANCES FOR QUALITY CLASS CLASSIFICATION

PARAMETER		CLASS1	CLASS2	CLASS3	CLASS4	CLASS5	CLASS6	CLASS7	CLASS8	CLASS9
CYCLE TIME	SEC	.20	.24	.29	.35	.41	.50	.60	.72	.86
HOLD TIME	SEC	.02	.02	.03	.03	.04	.05	.06	.07	.09
INJECT TIME	SEC	.04	.05	.06	.07	.08	.10	.12	.14	.17
CLAMP CLOSED	SEC	.10	.12	.14	.17	.21	.25	.30	.36	.43
CLAMP OPEN	SEC	.10	.12	.14	.17	.21	.25	.30	.36	.43
PLASTICATE	SEC	.15	.18	.22	.26	.31	.37	.45	.54	.64
CAVITY PRESS	PSI	15.00	18.00	21.60	25.92	31.10	37.32	44.79	53.75	64.50
PK INJ PRESS	PSI	20.00	24.00	28.80	34.56	41.47	49.77	59.72	71.66	86.00
HOLD PRESS	PSI	4.00	4.80	5.76	6.91	8.29	9.95	11.94	14.33	17.20
BACK PRESS	PSI	5.00	6.00	7.20	8.64	10.37	12.44	14.93	17.92	21.50
RAM STROKE	IN	.05	.06	.07	.09	.10	.12	.15	.18	.21
MOLD A TEMP	F	3.00	3.60	4.32	5.18	6.22	7.46	8.96	10.75	12.90
MOLD B TEMP	F	3.00	3.60	4.32	5.18	6.22	7.46	8.96	10.75	12.90
OIL TEMP	F	3.00	3.60	4.32	5.18	6.22	7.46	8.96	10.75	12.90
DEW POINT	V	.01	.01	.01	.02	.02	.02	.03	.04	.04
TEMP 1	F	2.00	2.40	2.88	3.46	4.15	4.98	5.97	7.17	8.60
TEMP 2	F	2.00	2.40	2.88	3.46	4.15	4.98	5.97	7.17	8.60
TEMP 3	F	2.00	2.40	2.88	3.46	4.15	4.98	5.97	7.17	8.60
TEMP 4	F	2.00	2.40	2.88	3.46	4.15	4.98	5.97	7.17	8.60

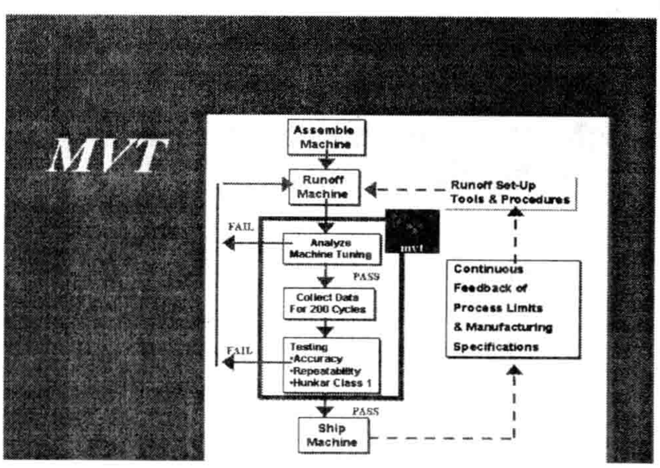
The molding machine performance levels are tested for how tight the machine holds tolerance levels. The tighter the tolerances are held the lower the class ranking.

WHAT ARE MACHINE MANUFACTURERS DOING TO CLOSE THE LOOP ON PERFORMANCE?

True 100% cloning may never be reached due to the variability of hydraulic drive systems. Nevertheless, manufacturers on a daily basis are turning out the next closest clone.

In 1994, the Product Validation Department at Cincinnati Milacron created a software program that eliminates human judgement from the initial machine setup and runoff. Machines that are of a given size are "near clones". This Machine Validation Tool, "MVT" calculates and inputs initial hydraulic tuning values. These values have been developed based on an extensive database of test that have been determined to deliver the optimum level of performance for a given machine model.

In the past, the results of the initial setup and runoff of a machine were determined by the individual doing the work. This is why the market currently has thousands of older machines each with their own unique and sometimes quirky personalities.



The MVT system is based on performing three types of tests on the machine parameters and tuning values.

Test 1: Accuracy

Compares average to the specified range.

Test 2: Repeatability

Compares standard deviation to a Cpk constant generated by the Product Validation Department.

Test 3: Hunkar Class One Requirements.

Each machine's test results are archived and are used for future re-calibration and re-certification of the machine in the field by service technicians.

The MVT process virtually eliminates new machine start up problems because the testing that is done during the run-off immediately detects out-of-limit conditions. With an extensive database of test results, causes of test failures can be quickly pinpointed and corrected, without delaying machine lead times.

After taking the human factor out of the initial machine setup, the range of machine parameters was tightened up dramatically.