

Great Designs in

STEEL 2014!!

Machinability Database for Hot-Rolled Steel

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- Machinability Sub-Committee
 - Members
 - Objective
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- Using the Machinability Data Base
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Machinability Sub-committee

Steel Market Development Institute

– Bar Applications Group

• Machinability Sub-committee

- Composed of representatives from automotive OEMs, academia and the steel industry, the Bar Machinability Sub-Committee develops information needed by the machining industry for material selection, process development and for improving understanding of the factors that influence the machinability of steel.



Machinability Sub-Committee - Members

American Iron and Steel Institute

Bradley University

Chrysler Group LLC

Colorado School of Mines

EMI/Michigan Technological University

Ferris State University

Finn Metalworking and Cutting Solutions

General Motors Company

Gerdau

Materials Technologies

Niagara LaSalle

Nucor Corporation

Sandvik Coromant

Steel Market Development Institute

Timken Steel Corporation



Machinability Sub-Committee - Objective

Develop machinability data on popular bar steel grades for the automotive industry

- Task 1
 - Provide access to machinability data for design selection of grades and parameters in single point turning of “autosteel” bars with *uncoated* tungsten carbide (WC) cutting tools
- Task 2
 - Provide access to machinability data for design selection of grades and parameters in single point turning of “autosteel” bars with *coated* WC cutting tools

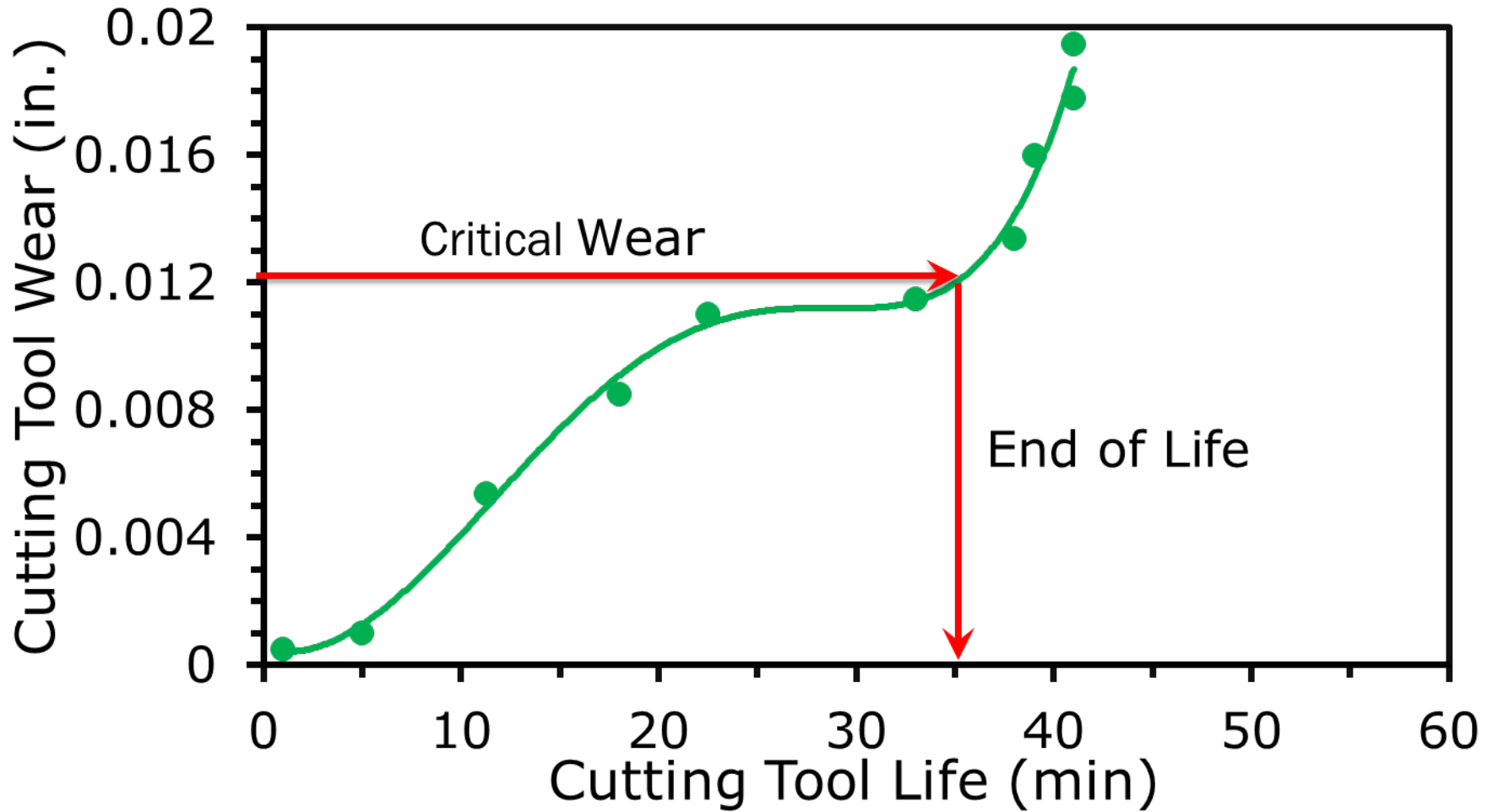


Machinability Testing Method

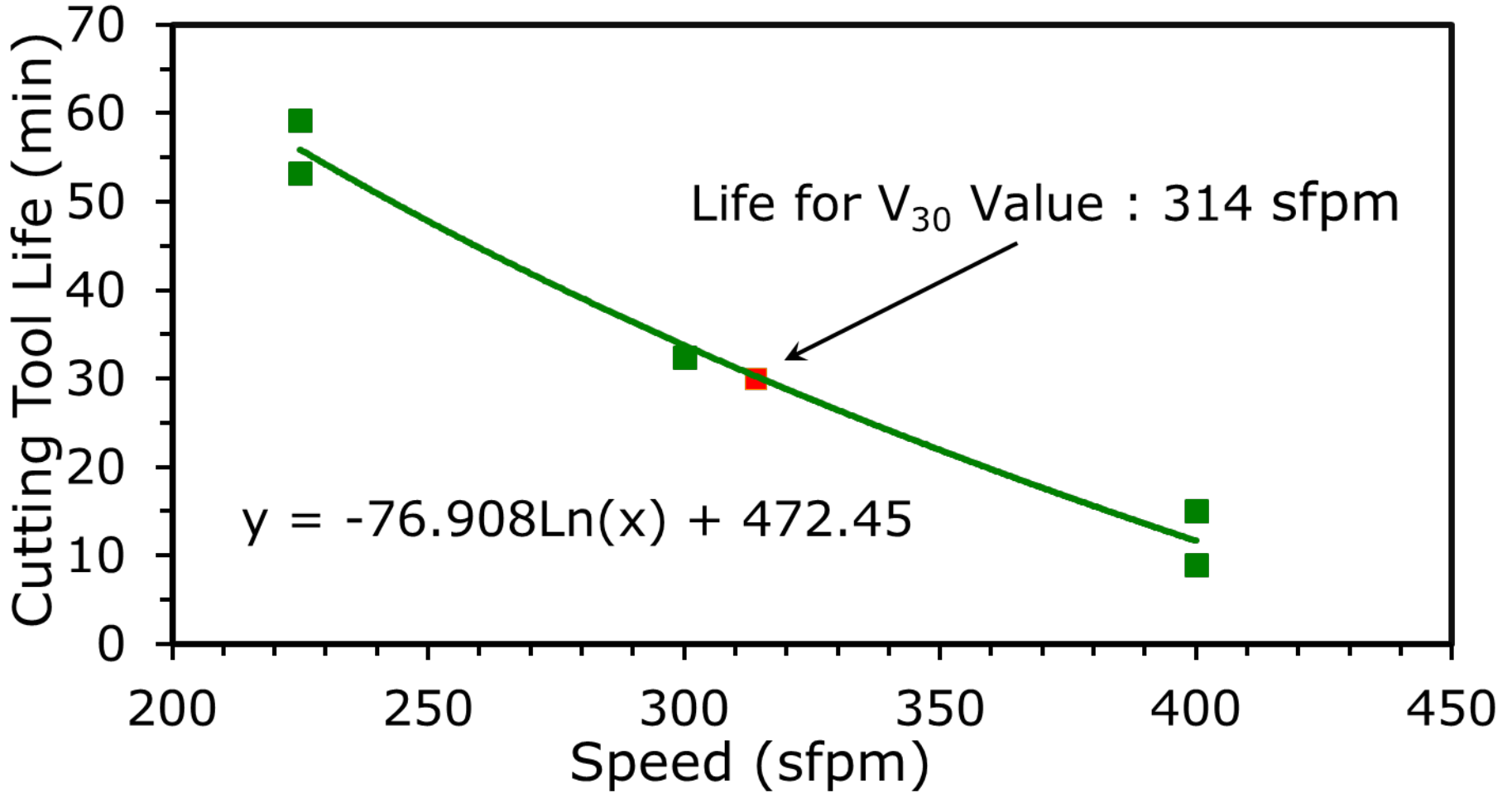
- Select speed to provide 5 to 60 minute wear test
 - Feed rate of 0.010 ipr (0.254 mm/r)
 - Depth of cut of 0.100 in (2.54 mm)
 - WC cutting tool (Valenite VC-5)
 - Dry cutting
- Measure wear of flank until it reaches 0.012 inches and record time
- Repeat at different speeds (minimum of 5 tests, 2 at low, 1 at middle and 2 at high speed)
- Plot cutting tool life curves



Machinability Testing Method



Machinability Testing Method



Using the Machinability Data Base

Steel Marketing
Development
Institute website:
www.autosteel.org

From the Programs Tab
select Bar
Machinability from the
drop-down menu

The screenshot shows the website interface for the Steel Market Development Institute. At the top, there is a navigation bar with links for 'THE STEEL NETWORK', 'NEWS', 'VIDEO', 'IMAGES', 'EVENTS', 'SHOP', and 'CONTACT'. A search bar is located on the right. The main header features the institute's logo and the word 'AUTOSTEEL'. Below the header is a large image of a green car. A news banner below the image reads: 'Steel's continued reinvention: New advanced steel grades meet growing automaker demands'. The main navigation menu includes 'ABOUT AUTOSTEEL', 'PROGRAMS', 'RESEARCH', 'GREAT DESIGNS IN STEEL', and 'SUSTAINABILITY'. The 'PROGRAMS' menu is open, showing a list of options: 'Bumpers', 'Fuel Tanks', 'Future Steel Vehicle', 'Bar Machinability' (highlighted), 'Long Products', 'ULSAB', 'ULSAB-AVC', and 'ULSAC'. A 'News' section on the right contains two articles: 'How Honda R&D Engineers Safer Structures' and 'College Students Unveil Renderings at Steel Market Development Institute's Steel Wheel Design Competition Awards Presentation'.

Using the Machinability Data Base

- Lists the V_{30} Machinability Value for 36 AISI grades of bar steels used by automotive manufacturers
 - The V_{30} Machinability Value is the maximum cutting speed for a 30 minute cutting tool life
- Include values for turning the bars steels with uncoated cutting tools

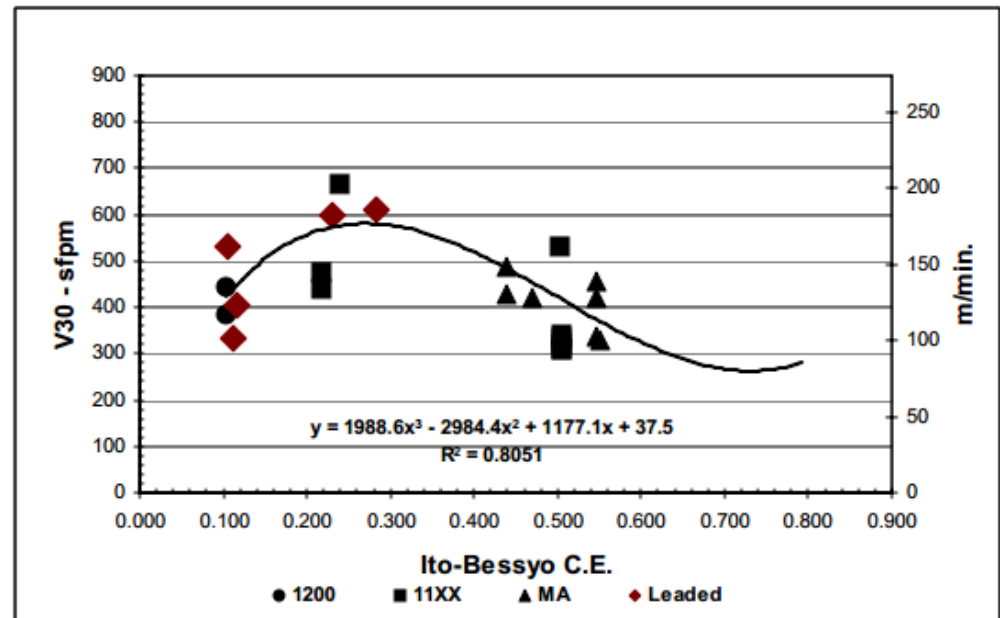
**Automotive Bar Steel Machinability Under
Single-Point Carbide Turning Conditions**

Grade	V30	
	ft/min	m/min
1018V	574	175
1018	584	178
1038	480	146
1045	395	120
10V45	330	101
1050	368	112
1070	309	94
1070AI	273	83
(C-70)	240	73
1080	225	69
1080 Sph Ann	238	73
1117	448	137
1141	303	93



Using the Machinability Data Base

- Determines the relative estimate of production cost for machining a different steel grade in a new design specification
- Aids the selection of machining parameters for a steel grade in a new design specification



Using the Machinability Data Base

A machinability estimator is available on SMDI website: (www.autosteel.org/Programs/Bar Machinability)

- For steel grades not on the database list
- The estimator is based on a best fit curve of the machinability values plotted with their carbon equivalent (developed by Ito-Bessyo)



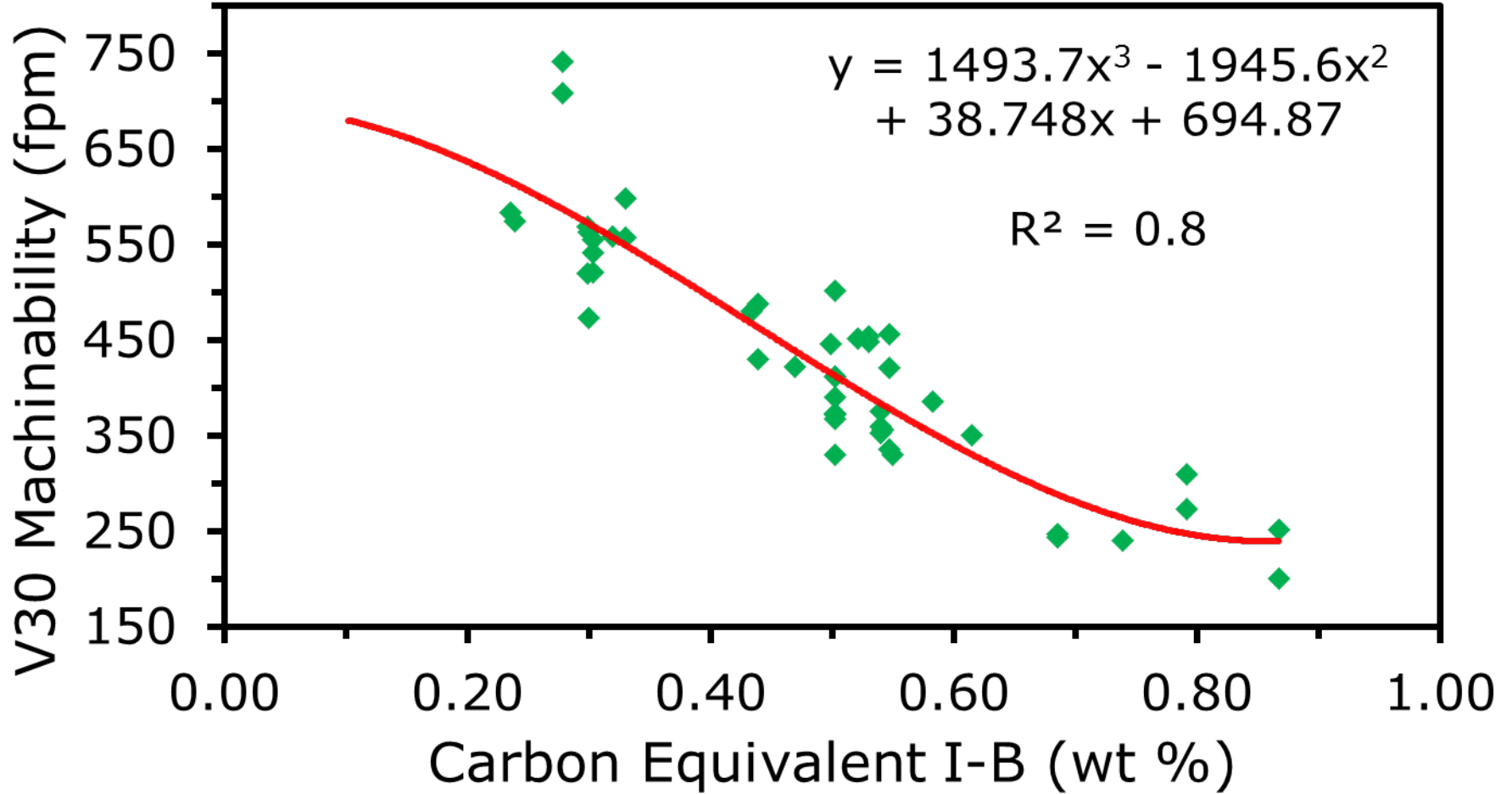
Bar Machinability Estimator

The Machinability Estimator was developed for carbon and alloy steels using uncoated carbide tools. The estimates resulting from this estimator are use only as a guideline or relative comparison of workpiece materials in selecting materials and/or machining set-ups and are in no way intended to represent an absolute value.

Estimator: non-coated carbide tools | Estimator: coated carbide tools (under development)



Using the Machinability Data Base



Using the Machinability Data Base

- The unlisted steel composition is submitted by the user in the prompts for the Estimator to obtain the Ito-Bessyo Carbon Equivalent as follows:

- $$CE = \%C + \%Mn_{\text{eff}}/20 + \%Si/30 + \%Ni/60 + (\%Cu + \%Cr)/20 + \%Mo/15 + \%V/10 + \%5 * B$$

Where $Mn_{\text{eff}} = Mn - (1.71 * S)$



Using the Machinability Data Base

- The Estimator will calculate and return the V_{30} Machinability Value from the best fit curve (*3rd order polynomial when using uncoated cutting tools*)

$$y = 1493.7x^3 - 1945.6x^2 + 38.748x + 694.87$$

Where $y = V_{30}$ Machinability Value,

and $x = CE$ developed by Ito-Bessyo



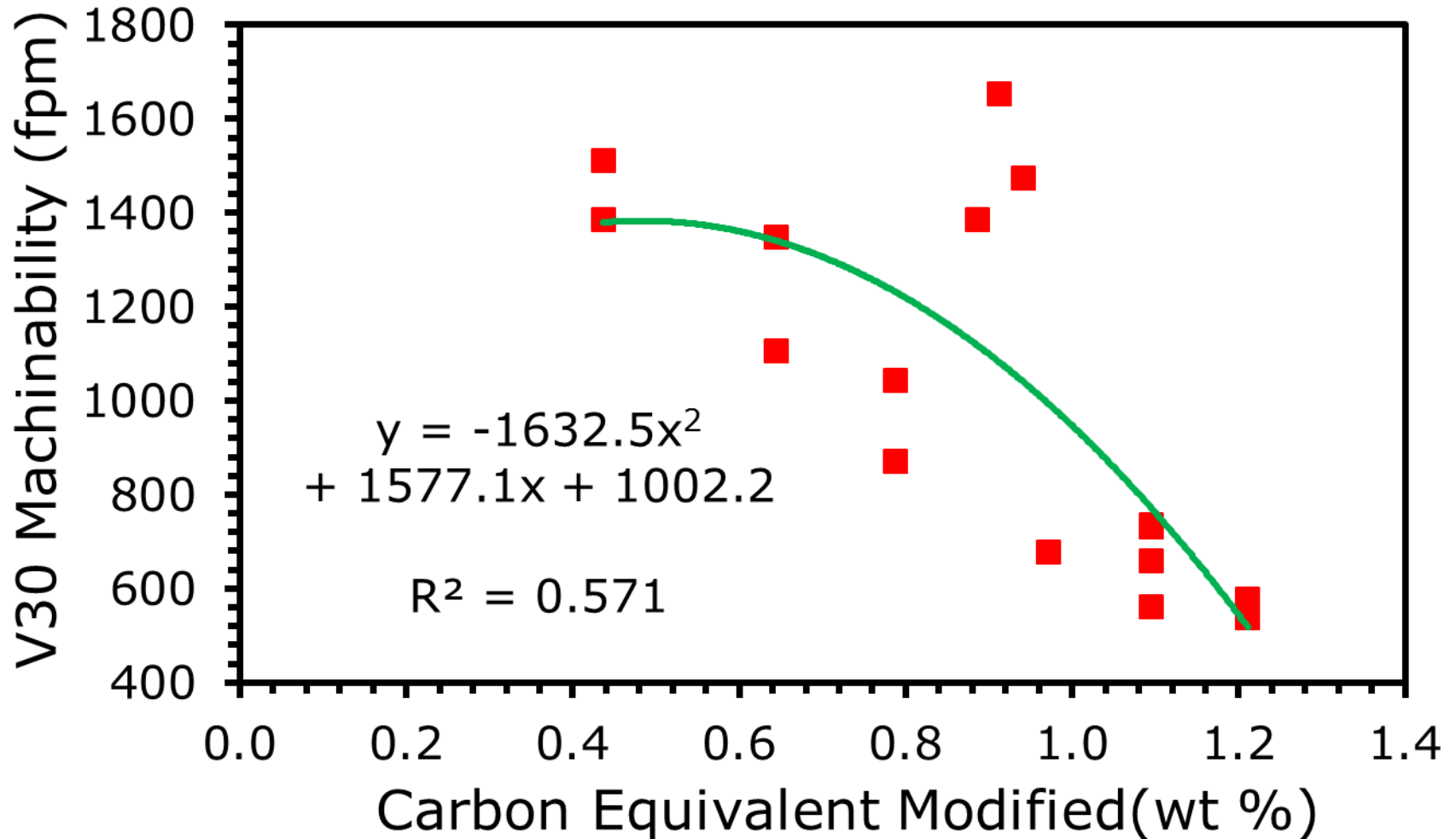
Using the Machinability Data Base

- The Estimator for the machinability value while turning steel bars with *coated* cutting tools is calculated from the best fit curve of the V_{30} value plotted with a modified carbon equivalent equation as follows:
- $$CE = \%C + \%Mn/4.5 + \%Si/6 + \%Cr/4 + (\%Cu + \%Ni)/15 + \%Mo/2.5 + (\%V) * 1.8$$



Using the Machinability Data Base

Tentative (pending update to CE equation)



Availability of Machinability Data

- A review was conducted on the availability of information on machinability of other ferrous and non-ferrous metals at several metal and manufacturing societies.
 - ASM International
 - Sells print and online digital handbooks to members and non-members. The Machining Handbook has multiple references to machinability tables from Metcut's Machinability Data Center
 - Society of Manufacturing Engineers
 - Sells print and online digital articles and handbooks with a focus on machining parts from many metal alloys to members. Members may also ask for machinability information from discussion groups, such as the Machining and Material Removal Community



Availability of Machinability Data

- American Foundry Society
 - Sells print and online digital articles and handbooks with limited information on machinability to members. Members may order a new handbook on a procedure for machinability testing of gray and ductile cast iron.

- Ductile Iron Society
 - Sells print and online digital articles and handbooks with limited information on machinability to members. Members may order reprints or read an article online about a comparison of machining ductile castings to machining steel forgings for an automotive gear application.



Availability of Machinability Data

- Precision Machined Products Association
 - Has a help line for members with machining questions. PMPA staff use tables from the Metcut Machinability Center with recommendations to machine deeper and faster with coated cutting tools. They also refer members to cutting tool suppliers for recommendations. PMPA does not provide information on machinability of metal alloys.

- Copper Development Association
 - Has machinability ratings listed online in their copper alloy database in the fabrication properties section of each alloy. The ratings do not include machining parameters. The online information is available to members and non-members.



Availability of Machinability Data

- Conclusion:
 - The machinability data compiled by the BAG Machinability Subcommittee and available on the Steel Market Development Web Site at www.autosteel.org is unique.



Summary

- The BAG Machinability Subcommittee has developed a machinability test for “autosteel” bars and measured the machinability value while turning 36 steel grades with uncoated and coated cutting tools
- The machinability data is available for design engineers on the Steel Market Development Web Site at www.autosteel.org
- Other metal alloy and manufacturing societies do not have machinability data bases that may be correlated to metals like the one on the Steel Market Development Web Site.



Acknowledgement

A **BIG** thank you to

- The American Iron and Steel Institute for its generous support of this study
- Member steel bar makers for supplying the steel bars for the project
- Member organizations for testing the steel bars and determining the machinability values



Acknowledgement

Thanks for Listening!

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