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PREFACE

This *Transactions* volume disseminates critical research results in the manufacturing technical field, following in the tradition of the bound, journal-format publication established in 1989 by the North American Manufacturing Research Institution of the Society of Manufacturing Engineers (NAMRI/SME). Prior to that time, the Institution published its technical papers in the format of a conference proceedings from 1972 to 1988. Many important scientific and technological milestones have been set over the past 34 years by renowned researchers. The annual publication of the *Transactions of NAMRI/SME* has both stimulated and faithfully documented the tremendous evolution of manufacturing science and technology.

For the 2006 *Transactions*, a total of 104 papers were submitted for review. For each paper, at least three reviews were solicited from a panel of international experts on the NAMRI/SME Scientific Committee. Opinions from other respected colleagues as guest reviewers were also sought. These included reviewers in academia, industry, and government from around the world who have been recognized for their excellence in the field. According to the comments of the reviewers, many papers were conditionally accepted with required revision and improvement, and were re-reviewed. Ultimately, 79 papers were accepted for publication in this year's *Transactions of NAMRI/SME*, Volume 34, 2006. The United States, Korea, Canada, India, Japan, Malaysia, Singapore, Poland, Taiwan, Italy, France, and Hong Kong are represented by this year's authors. The research studies include work performed in and submitted from university, industry, government, and independent research laboratories. In addition to the more traditional topics of material removal, material forming, and manufacturing systems, many other manufacturing-related areas, including metrology, design, micro-devices/systems, environmental issues, polymers, and composites, are also represented in this year's *Transactions*.

This is the final year of my term as Chair of the Scientific Committee, and I sincerely thank the community for all the encouragement and support. Particularly, my appreciation goes to the members of the Scientific Committee for their outstanding service in providing important paper assessments that have upheld the quality of the *Transactions*. I am also thankful to the guest reviewers for their significant contributions. In addition, I am grateful to Mark Stratton, Nancy Nowitzke, Ellen Kehoe, Dianna Helka, and other staff of the Society of Manufacturing Engineers for their patience and assistance, and for their dedication and support for this publication and the Institution. Kyle Kim and Otto Widera and their colleagues at Marquette University have arranged the papers into a cohesive set of technical sessions in the fine tradition of the North American Manufacturing Research Institution of SME.

K. Scott Smith University of North Carolina at Charlotte Chair, NAMRI/SME Scientific Committee

NORTH AMERICAN MANUFACTURING RESEARCH INSTITUTION OF SME

The North American Manufacturing Research Conference (NAMRC) was organized in 1973 by a group of researchers interested in creating a major forum for the discussion and dissemination of research results in the field of manufacturing. For its first few years, it was known as the North American Metalworking Research Conference, but the word "manufacturing" soon began to be used to recognize the expanding base of research in this important field. From its inception in 1973 until 1981, governance of the North American Manufacturing Research Conference (NAMRC) was facilitated through its Scientific Committee. In 1982, NAMRC became an affiliated organization of the Society of Manufacturing Engineers and became known as the North American Manufacturing Research Institution of SME (NAMRI/SME). Each year since 1973, a bound volume of papers presented at NAMRC has been produced to serve as a permanent record of the research ideas and results presented and discussed at the annual conference. From 1973 through 1988, this volume was known as the *Proceedings of NAMRC*. Starting in 1989, the papers offered for presentation and publication have undergone a rigorous review of the full manuscript by the NAMRI/SME Scientific Committee, and the resulting volume is known as the Transactions of NAMRI/SME. From 1993-1999, a separate volume, called the Technical Papers of NAMRI/SME, was published containing papers describing active work in progress. In 2000, NAMRI/SME returned to publishing a single bound *Transactions* volume.

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DETERMINATION OF PARAMETRIC UNCERTAINTIES FOR REGRESSION-BASED MODELING OF TURNING OPERATIONS

Robert W. Ivester, Laurent Deshayes, Michael McGlauflin Manufacturing Engineering Laboratory National Institute of Standards and Technology¹ Gaithersburg, Maryland

KEYWORDS

Modeling Uncertainty, Robust Optimization, Machining, Smart Machining Systems

ABSTRACT

Uncertainty associated with model-based predictions of machining performance plays an important role in the application of machining modeling. This paper presents a technique for model development and characterization of the uncertainty in the resulting model parameters. This technique provides a pragmatic basis for mathematical optimization of machining with an allowance for uncertainty in model-based predictions. The workpiece material, American Iron and Steel Institute (AISI) 1045 steel, was machined using inserts with four different chip breaker geometries. A regression-based model of process performance based on the Coupled Work Tool (CWT) methodology is calibrated along with the determination of uncertainties with key model parameters. associated Parametric specification of modeling uncertainty

enables robust optimization techniques to allow for variable process performance due to uncontrolled factors in machining operations.

INTRODUCTION

Limitations on repeatability have hindered development of reliable machining models, even for a given combination of machine, tool, material, and environment. A variety of uncontrolled factors affect various measures of process and product quality, such dimensional accuracy, surface quality, process reliability, and tool life. Examples of uncontrolled factors include material and tooling homogeneity, machine repeatability, environmental variability, and coolant effectiveness [Ivester, et al. 2000]. Switching to different environments, tooling, or machines increases variation in process and product quality.

The inability to precisely formulate machining models that are applicable to a wide range of environments, tooling, and machining

¹ Commercial equipment and materials are identified in order to adequately specify certain procedures. In no case does such identification imply recommendation or endorsement by the National Institute of Standards and Technology (NIST), nor does it imply that the materials or equipment are necessarily the best available for the purpose. This is an official contribution of NIST and is not subject to copyright in the United States.