

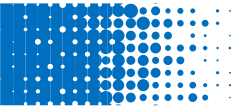


## Training Courses Syllabi



### Are You Ready to Enroll in a Course?

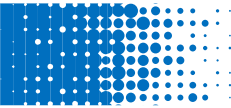
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## TRAINING COURSES TAUGHT AT MAKINO MASON (MM) OR AUBURN HILLS (AH) FACILITIES. MOST COURSES CAN BE TAUGHT AT A CUSTOMER'S FACILITY.

### Operations:

PRO 6 Operations with FANUC 31i Control	2.5 Days
PRO 5 Operations with FANUC 31i Control	2.5 Days
PRO 3 Operations with FANUC 16i/18i Control*	2.5 Days
MAS-A5 Software Operations & MMC2	2.5 Days
High Performance Machining	4.5 Days
Slim3n with PRO S Control	2.5 Days

### Maintenance:

a40 HMC Maintenance	4.5 Days
A Series HMC Maintenance	4.5 Days
NX HMC Maintenance	4.5 Days
DA300 Maintenance with PRO 6 Control	4.5 Days
MAG1 Maintenance*	4.5 Days
MAG3 Maintenance*	4.5 Days
T1 Maintenance*	4.5 Days
T2 Maintenance*	4.5 Days
MMC2 Maintenance and Recovery*	2.5 Days
Slim3n with PRO S Maintenance and Recovery	3.5 Days

### Advanced Maintenance:

A Series HMC Advanced Maintenance with PRO 6 Control*	4.5 Days
NX HMC Advanced Maintenance with PRO 6 Control*	4.5 Days
MAG1 Advanced Maintenance*	10 Days
MAG3 Advanced Maintenance*	10 Days

### Programming

Manual Part Programming	4.5 Days
Macro Programming	2.5 Days

### EDM

BX3 Maintenance	3 Days
Wire EDM Maintenance (Hyper-I Control)	3 Days
RAM EDM Maintenance (Hyper-I Control)	3 Days
Wire EDM Operations (Hyper-I Control)	3 Days
ED CAM Software Training	1 Day
RAM EDM Operations (Hyper-i Control)	3 Days

**\*PLEASE NOTE:** Some courses can only be taught at the customer's facility due to equipment availability. If a course you want is not listed, or if you have questions, please contact us at [Training@Makino.com](mailto:Training@Makino.com) to check course availability and whether or not it can be taught on-site.

## Are You Ready to Enroll in a Course?

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## OUR MISSION

At Makino, our primary goal has always been to consistently provide high quality products and services which far exceed our customers' expectations. This is accomplished daily through our **INTEGRITY** and commitment to nothing less than **EXCELLENCE**.

Each employee's **DEDICATION** and **DETERMINATION** are how we achieve this goal. Our collective efforts continually focus on **INNOVATION** and ongoing improvements to meet the advancing needs of our customers.

We measure our success by the satisfaction of those who produce, sell, and use our products daily. We achieve this **SUCCESS** through **RELIABILITY** and **ACCURACY**.

### About Our Instructors:

Makino's technical course instructors are committed both personally and professionally to providing our customers with high quality training in a top-notch environment. Our technical instructors are vastly experienced in not only the daily operations of Makino's products, from the 1 Series to the MAG machines, but in the maintenance and technical support of maintaining our state-of-the-art equipment and machinery. Most importantly, they are committed to improving the understanding and confidence of each student to ensure they are better able to perform their jobs.



## Are You Ready to Enroll in a Course?

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## OPERATIONS COURSES:

### PRO 6 Operations with FANUC 31i Control – 2.5 Days (MM)

**Description:** This competency-based course provides operators with a working knowledge of the terminology, procedures, codes, formats, and the ability to use all control functions necessary to operate the machine in a safe and efficient manner. Students will receive an overview of all machine safety features, operator control stations, machine components and functions. Detailed instructions are presented on the control's functions and screens, setup procedures, and minor recovery operations. The FANUC 31i control (in Makino PRO 6 configuration) is featured with heavy emphasis on the typical Horizontal Machining Center (HMC) application. Some activities are directed at the specific models and options of customer machinery for each student where possible.

Course Outline:

*Day One:*

- Explanation of Basic Safety Functions
- Machine Components and their Functions
- Basic PRO 6 Screen Navigation

*Day Two:*

- Pro 6 Control and FANUC Backup
- Coordinate Systems
- Setting Work Coordinate Offsets
- Tools and Tool Offsets
- Program Management and Editing

*Day Three:*

- Malfunction Prevention and Program Recovery
- Tool Monitoring
- Random Mode Operation

### PRO 5 Operations with FANUC 31i Control – 2.5 Days (MM)

**Description:** This competency-based course provides operators with a working knowledge of the terminology, procedures, codes, formats, and the ability to use all control functions necessary to operate the machine in a safe and efficient manner. Students will receive an overview of all machine safety features, operator control stations, machine components and functions. Detailed instructions are presented on the control, including its functions and screens, setup procedures, and minor recovery operations. The FANUC 31i control (in Makino PRO 5 configuration) is featured with emphasis on typical Horizontal Machining Center (HMC) application. Some activities are directed at the specific models and options of customer machinery for each student when possible.

Course Outline:

*Day One:*

- Explanation of Basic Safety Functions
- Machine Components and their Functions
- Basic PRO 5 Screen Navigation

*Day Two:*

- PRO 5 Control and FANUC Backup
- Coordinate Systems
- Setting Work Coordinate Offsets
- Tools and Tool Offsets
- Program Management and Editing

*Day Three:*

- Malfunction Prevention and Program Recovery
- Tool Monitoring

## Are You Ready to Enroll in a Course?

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- Random Mode Operation

## PRO 3 Operations with FANUC 16i/18i Control– 2.5 Days\*

**Description:** This competency-based course will provide operators with a working knowledge of the terminology, procedures, codes, formats, and the ability to use all control functions necessary to operate the machine in a safe and efficient manner. Students will be provided with an overview of all machine safety features and procedures, operator control stations, and machine components and functions. Detailed instructions are presented on the control, including its functions and screens, setup procedures, and minor recovery operations. The FANUC 16i/18i control (in Makino PRO 3 configuration) is featured with heavy emphasis on the typical Horizontal Machining Center (HMC) application. Some activities are directed at the specific models and options of customer machinery for each student when possible.

**\*PLEASE NOTE:** PRO 3 Operations can only be taught on-site at the customer’s facility. Contact [Training@Makino.com](mailto:Training@Makino.com) for more information concerning on-site training.

### Course Outline:

#### Day One:

- Explanation of Basic Safety Functions
- Machine Components and their Functions
- Basic PRO 3 Screen Navigation

#### Day Two:

- PRO 3 Control and FANUC Backup
- Coordinate Systems
- Setting Work Coordinate Offsets
- Tools and Tool Offsets
- Program Management and Editing

#### Day Three:

- Malfunction Prevention and Program Recovery
- Tool Monitoring

## MAS-A5 Software Operations & MMC2 – 2.5 Days (MM)

**Description:** This course provides cell management, operators, and programmers with the ability to effectively define, input, control, and operate the MAS-A5 System Software; the functions, locations, and principles of operation for the major components of the MAS-A5 Software are also covered. Emphasis is placed on software data entry and system operation. Students will learn through practical experience by setting up an automatic operation using simulators.

**Prerequisite:** Familiarity with the fundamentals of machining and machine tools as related to MMC systems

### Course Outline:

#### Day One:

- Introduction to MAS-A5 Operations and Safety
- MMC2 Cell Overview and Components of a Cell
- Basic Cell & MAS-A5 Operations and Navigation
- How to Start/Stop Cell Controller/Client
- MAS-A5 Data Entry and Steps including NC Programs & Work Offset Files, Tooling Data, Part Data Setup, Pallets & Fixtures and Order Entry & Material Input
- Process to Remove Data
- Quick and Automatic Data Entry\*
- Common Fixtures\*

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- Operator Work Set Station Interface Including Clamp/Unclamp Qty's & Cancel, Normal/Scrap & Re-Machining
- CMM/Gauge Inspection\*

#### *Day Two:*

- Diagnostic Tools including Pallet and Process Diagnosis
- Tool Set, Tool Data Comparison and Process Assigned to Machine
- Manual Pallet Moves Using MAS-A5 Pallet IN/Pallet OUT, Remote Handy & Handy Terminal Controller and Manual Moves for Part Prove-Out
- MMC2 Cell and Pallet Recovery
- High Level Maintenance\*
- Machine, Work Set Station and Vehicle Recovery
- Work Data Reset
- MAS-A5 Reports
- Export Formats

#### *Day Three:*

- Customer Specific Topics
- Miscellaneous Questions
- Final Review and Wrap-up

**\*PLEASE NOTE:** Some training topics listed here may not be applicable to every MAS-A5 Software Operations training course, since the parameters may or may not be set for specific functionality within the MAS-A5 software.

## High Performance Machining – 4.5 Days (AH)

**Description:** This course will provide operators and programmers with the necessary knowledge and materials to make appropriate decisions related to tooling and programming part geometry, which support high-performance machining applications. Students will receive 1-day of essential PRO 6 Control operations training as well as a half day of tool measurement probing operations training.

### Course Outline:

#### *Days One thru Three:*

- Class and Machine Overview
- Tool Holders and Cutting Tools Suitable for HPM
- Applications of Tools to Real Life Machining
- SGI, Machine Communications and Transfer
- HPM Feeds and Speed Calculations

#### *Day Four:*

- Basic PRO 6 Screen Navigation and Coordinate Systems
- Setting Work Coordinate Offsets, Tools, and Tool Offsets
- Program, Management and Editing
- Malfunction Prevention and Program Recovery

#### *Day Five:*

- Calibration
- Bull Nose/Ball Nose Checks
- Final Review and Wrap-up

## Are You Ready to Enroll in a Course?

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## Slim3n with PRO S Operations – 2.5 Days (MM)

**Description:** This competency-based course provides operators with a working knowledge of the terminology, procedures, codes, formats, and the ability to use all control functions necessary to operate the machine in a safe and efficient manner. Students will receive an overview of all machine safety features, operator control stations, machine components and functions. Detailed instructions are presented on the control, including its functions and screens, setup procedures, and minor recovery operations. The FANUC Oi control (in Makino PRO S configuration) is featured with emphasis on the Makino Slim3n machine.

### Course Outline:

#### *Day One:*

- Explanation of Basic Safety Functions
- Machine Components and their Functions
- Basic PRO S Screen Navigation

#### *Day Two:*

- PRO S Control and FANUC Backup
- Coordinate Systems
- Setting Work Coordinate Offsets
- Tools and Tool Offsets
- Program Management and Editing

#### *Day Three:*

- Malfunction Prevention and Program Recovery
- Tool Monitoring

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## MAINTENANCE COURSES:

### a40 HMC Maintenance with PRO 5 Control – 4.5 Days

Description: This course will provide maintenance personnel with the ability to perform a40 machine maintenance, effectively determine a machine's fault and its probable causes. Students will also learn how to perform basic electrical and mechanical adjustments as well as general and periodic maintenance procedures. The functions, locations, and principles of operation for major machine units are described. Emphasis is placed on troubleshooting a machine fault, by use of the various diagnostic functions available on the machine tool and the PRO 6 control. Course consists of classroom sessions and hands-on training.

#### Course Outline:

##### *Day One:*

- Introduction to Machine Components
- Safety Precautions and Procedures
- Basic Operations and Screen Navigation

##### *Day Two:*

- PRO 5 Control and FANUC Backup
- Troubleshooting via Machine Side and Control Side Screens and Diagnostics
- Major Machine Units, their Principles of Function, Specifications, and Hands-on Checks/Adjustments
- Spindle

##### *Days Three and Four:*

- Major Machine Units, their Principles of Function, Specifications, and Hands-on Checks/Adjustments (contd.)
- Feed Axes
- Table
- ATC, APC and Auxiliary Units
- Periodic Maintenance

##### *Day Five:*

- Reading Maintenance Drawings
- Hands-on Problem Solving (Alarms, Faults, etc.)
- Final Review and Wrap-up

### A Series HMC Maintenance – 4.5 Days (MM)

**Description:** This course will provide maintenance personnel with the ability to effectively determine a machine fault and its probable causes as well as teach them how to perform basic electrical and mechanical adjustments. Students will also learn general and periodic maintenance procedures and practice machine recovery. This course covers a51/a61/a71/a81 machines.

#### Course Outline:

##### *Day One:*

- Intro to Machine Components
- Safety Precautions and Procedures
- Basic Operations and Screen Navigation

##### *Day Two:*

- Data Backup
- Troubleshooting via Machine Side and Control Side Screens and Diagnostics
- Description of Major Machine Units, Principles of Function, Specs and Hands-on Checks/Adjustments
- Spindle

## Are You Ready to Enroll in a Course?

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## *Days Three and Four:*

- Description of Major Machine Units, Principles of Function, Specs and Hands-on Checks/Adjustments (contd.)
- Feed Axes
- Table
- Automatic Tool Changer (ATC)
- Tool Magazine
- Automatic Pallet Changer (APC)
- Auxiliary Units
- Periodic Maintenance

## *Day Five:*

- Reading Maintenance Drawings
- Hands-on Problem Solving (Alarms, Faults, etc.)
- Final Review and Wrap-up

## NX HMC Maintenance – 4.5 Days

**Description:** This course will provide maintenance personnel with the ability to effectively determine a machine fault and its probable causes as well as teach them how to perform basic electrical and mechanical adjustments. Students will also learn general and periodic maintenance procedures and practice machine recovery. This course covers a51nx/a61nx/a71nx/a81nx machines.

### Course Outline:

#### *Day One:*

- Intro to Machine Components
- Safety Precautions and Procedures
- Basic Operations and Screen Navigation

#### *Day Two:*

- Data Backup
- Troubleshooting via Machine Side and Control Side Screens and Diagnostics
- Description of Major Machine Units, Principles of Function, Specs and Hands-on Checks/Adjustments
- Spindle

#### *Days Three and Four:*

- Description of Major Machine Units, Principles of Function, Specs and Hands-on Checks/Adjustments (contd.)
- Feed Axes
- Table
- Automatic Tool Changer (ATC)
- Tool Magazine
- Automatic Pallet Changer (APC)
- Auxiliary Units
- Periodic Maintenance

#### *Day Five:*

- Reading Maintenance Drawings
- Hands-on Problem Solving (Alarms, Faults, etc.)
- Final Review and Wrap-up

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## DA300 Maintenance with PRO 6 Control – 4.5 Days

**Description:** This course will provide Maintenance personnel with the ability to perform a51nx/a61nx machine maintenance. The function, location, and maintenance requirements for the major machine units are described. Emphasis is placed on troubleshooting machine faults by use of the diagnostic functions available on the machine and the PRO 6 control. Course includes classroom sessions and hands-on activities in the shop.

### Prerequisites:

- Ability to Read Mechanical Drawings, Hydraulic Diagrams and Electrical Schematics
- Understanding of Mechanical Systems and Basic Electricity
- Familiarity with the Tools Used to Check and Repair Mechanical, Hydraulic, and Electrical Systems
- Familiarity with Shop Practices and Safety Requirements

### Course Outline:

#### *Day One:*

- Introduction to Machine Components
- Safety Precautions and Procedures
- Basic Operations and Screen Navigation
- How to Troubleshoot from Spindle Bump or Crash

#### *Day Two:*

- Data Backup
- Troubleshooting via Machine Side and Control Side Screens and Diagnostics
- Description of the Major Machine Units, Principles of Function, Specifications, and Hands-on Checks/Adjustments
- Spindle
- Runout
- Distention
- Orientation
- Sealing Rod Replacement

#### *Days Three and Four:*

- Feed Axes -Straightness -Squareness
- Grid Shift
- Table
- Automatic Tool Changer (ATC)
- Tool Magazine
- Auxiliary Units
- Periodic Maintenance

#### *Day Five:*

- Reading Maintenance Drawings
- Hands-on Problem Solving (Alarms, Faults, etc.)
- Final Review and Wrap-up

## MAG1 Maintenance – 4.5 Days (MM)

**Description:** Students will learn to perform basic electrical and mechanical adjustments as well as general and periodic maintenance procedures. The function, location, and principle of operation for the major machine units are described. Emphasis is placed on troubleshooting a machine fault, by use of the various diagnostic functions available on the machine tool and the PRO 6 control. Course consists of classroom sessions and hands-on training.

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## Course Outline:

### *Day One:*

- Introduction to Machine Components
- Safety Precautions and Procedures
- Basic Operations and Screen Navigation

### *Day Two:*

- Data Backup
- Troubleshooting via Machine Side and Control Side Screens and Diagnostics
- Major Machine Units, their Principles of Function, Specifications and Hands-on Checks/Adjustments
- Spindle

### *Days Three and Four:*

- Major Machine Units, their Principles of Function, Specifications and Hands-on Checks/Adjustments (contd.)
- Feed Axes
- Table
- Automatic Tool Changer (ATC)
- Tool Magazine
- Automatic Pallet Changer (APC)
- Auxiliary Units
- Periodic Maintenance

### *Day Five:*

- Reading Maintenance Drawings
- Hands-on Problem Solving (Alarms, Faults, etc.)
- Final Review and Wrap-up

## MAG3 Maintenance – 4.5 Days

**Description:** This course provides the information necessary to perform essential machine maintenance. The function, location, and principle of operation for the major machine units are described. Emphasis is placed on troubleshooting a machine fault, by use of the various diagnostic functions available on the machine tool and the CNC control. The course consists of classroom sessions and hands-on training.

## Course Outline:

### *Day One:*

- Introduction to Machine Components
- Safety Precautions and Procedures
- Basic Operations and Screen Navigation

### *Day Two:*

- Data Backup
- Troubleshooting via Machine Side and Control Side Screens and Diagnostics
- Major Machine Units, their Principles of Function, Specifications and Hands-on Checks/Adjustments
- Spindle

### *Days Three and Four:*

- Major Machine Units, their Principles of Function, Specifications and Hands-on Checks/Adjustments (contd.)
- Feed Axes
- Table
- Automatic Tool Changer (ATC)

## Are You Ready to Enroll in a Course?

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- Tool Magazine
- Automatic Pallet Changer (APC)
- Auxiliary Units
- Periodic Maintenance

#### *Day Five:*

- Reading Maintenance Drawings
- Hands-on Problem Solving (Alarms, Faults, etc.)
- Final Review and Wrap-up

## T1 Maintenance – 4.5 Days\*

**Description:** This course will provide Maintenance personnel with the ability to perform basic electrical and mechanical adjustments as well as general and periodic maintenance procedures. This course also provides the information necessary to perform basic machine maintenance. The function, location, and principle of operation for the major machine units are described. Emphasis is placed on troubleshooting machine faults by use of the various diagnostic functions available on the machine and the CNC control. The course includes classroom sessions and hands-on training.

**\*Please Note:** T1 Maintenance Courses can be taught at the customer's facility by special request. Contact Makino Technical Training for information on scheduling T1 training.

#### Course Outline:

##### *Day One:*

- Introduction to Machine Components
- Safety Precautions and Procedures
- Basic Operations and Screen Navigation

##### *Day Two:*

- Data Backup
- Troubleshooting via Machine Side and Control Side Screens and Diagnostics
- Machine Hands-on Detailed Advanced Tasks
- Spindle: Checking Electrical Connections, Spindle Exchange, Air Pipe Replacement

##### *Days Three and Four:*

- Machine Hands-on Detailed Advanced Tasks (contd.)
- Rotary Axes: Rotary Seal Replacements, Backlash Adjustments, A-B Axes Grid Shift and Comp Offsets, B-axis Backlash Check/Adjustment, Partial Disassembly
- Linear Axes, Y/V and X/U Synchronization, Ball Screw Pre-Tensioning, Scale Troubleshooting
- ATC: Arm Backlash Adjustment
- ASI System: I/O Device Troubleshooting and Replacement, ASI Analyzer Procedures

##### *Day Five:*

- Auxiliary Units: Hydraulic Unit Recovery, Balluff Tool ID System
- Hands-on Problem Solving (Issues and Solutions, etc.)
- Summary of Knowledge Sources
- Final Review and Wrap-up

## T2 Maintenance – 4.5 Days\*

**Description:** This course will provide Maintenance personnel with the ability to effectively determine a machine fault and its probable causes. Perform basic electrical and mechanical adjustments as well as general and periodic maintenance procedures. Practice machine recovery. This course also provides the information necessary to perform basic machine maintenance. The function, location, and principle of operation for the major machine

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units are also described. Emphasis is placed on troubleshooting machine faults by use of the diagnostic functions available on the machine and the control. The course includes classroom sessions and hands-on training.

**\*Please Note:** T2 Maintenance courses can be taught at the customer's facility by special request. Contact Makino Technical Training for information on scheduling T2 training.

## Course Outline:

### *Day One:*

- Introduction to Machine Components
- Safety Precautions and Procedures
- Basic Operations and Screen Navigation

### *Day Two:*

- PRO 6 Control and FANUC Backup
- Troubleshooting via Machine Side and Control Side Screens and Diagnostics
- Major Machine Units, their Principles of Function, Specifications and Hands-on Checks/Adjustments
- Spindle

### *Days Three and Four:*

- Major Machine Units, their Principles of Function, Specifications and Hands-on Checks/Adjustments (contd.)
- Feed Axes
- Table
- Automatic Tool Changer (ATC)
- Tool Magazine
- Automatic Pallet Changer (APC)
- Auxiliary Units
- Periodic Maintenance

### *Day Five:*

- Reading Maintenance Drawings
- Hands-on Problem Solving (Alarms, Faults, etc.)
- Final Review and Wrap-up

## MMC2 Maintenance and Recovery – 3 Days

**Description:** This course explains the function, location, and maintenance requirements for major machine units. Emphasis is placed on troubleshooting machine faults by use of the diagnostic functions available on the machine and the control. The course includes classroom sessions and hands-on activities in the shop.

## Course Outline:

### *Day One:*

- MMC2 Overview of Functions & Components
- MAS-A5 Cell Controller Overview
- Manual Pallet Transport & High-Level Maintenance
- Facility Tour

### *Day Two:*

- Manual and Maintenance Modes
- SRM Remote Operations
- Teaching Pallet Locations
- Recovery Overview
- Recovery at MMC

## Are You Ready to Enroll in a Course?

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- Overview of Switches
- Troubleshooting Activities on MMC2

*Day Three:*

- Preventative Maintenance Overview
- Preventative Maintenance Activities on Machine
- Final Review and Wrap-up
- Evaluation of Class

## Slim3n with PRO S Maintenance and Recovery – 3.5 Days

**Description:** This course will provide maintenance personnel with the ability to effectively determine a machine fault and its probable causes as well as teach them how to perform basic electrical and mechanical adjustments. Students will also learn general and periodic maintenance procedures and practice machine recovery.

### Course Outline:

*Day One:*

- Introduction to Machine Components
- Safety Precautions and Procedures
- Facility Tour
- Basic Operations and Screen Navigation
- PRO S Control and FANUC Backup

*Day Two:*

- Troubleshooting via Machine Side and Control Side Screens and Diagnostics
- Major Machine Units, their Principles of Function, Specifications and Hands-on Checks and Adjustments

*Day Three:*

- Major Machine Units, their Principles of Function, Specifications and Hands-on Checks and Adjustments (contd.)
- Feed Axis
- Table
- Automatic Tool Changer (ATC)
- Tool Magazine
- Automatic Pallet Changer (APC)
- Auxiliary Units
- Periodic Maintenance

*Day Four:*

- Reading Maintenance Drawings
- Hands-on Problem Solving (Alarms, Faults, etc.)
- Final Review and Wrap-up

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## ADVANCED MAINTENANCE COURSES:

### A Series HMC Advanced Maintenance w/PRO 6 Control – 4.5 Days

**Description:** This course provides the information necessary to perform advanced a51/a61/a71/a81 machine maintenance. The function, location, and principle of operation for the major machine units are described. Emphasis is placed on the tear-down and rebuilding of major machine units. The course consists of classroom sessions and hands-on training.

#### Prerequisites:

- Previous Attendance and Completion of a51/61 Maintenance Class

#### Course Outline:

##### *Days One and Two:*

- PRO 6 Control Advanced Procedures and History Operations
- Machine Hands-on Detailed Advanced Tasks
- Spindle: Checking Electrical Connections, Spindle Exchange, Air Pipe Replacement

##### *Days Three and Four:*

- Machine Hands-on Detailed Advanced Tasks (contd.)
- Rotary Seal Replacements, Backlash Adjustments, A-B Axes Grid Shift and Comp Offsets, B-Axis Backlash Check/Adjustment, Partial Disassembly
- ATC: Arm Backlash Adjustment
- ASI System: I/O Device Troubleshooting and Replacement, ASI Analyzer Procedures
- Auxiliary Units: Hydraulic Unit Recovery, Balluff Tool ID System

##### *Day Five:*

- Final Review and Wrap-up
- Issues & Solutions, Summary of Knowledge Sources

### NX Series HMC Advanced Maintenance w/PRO 6 Control – 4.5 Days

**Description:** This course provides the information necessary to perform advanced a51nx/a61nx/a71nx/a81nx machine maintenance. The function, location, and principle of operation for the major machine units are described. Emphasis is placed on the tear-down and rebuilding of major machine units. The course consists of classroom sessions and hands-on training.

#### Prerequisites:

- Previous Attendance and Completion of NX Maintenance Class

#### Course Outline:

##### *Day One:*

- Machine Walkaround & Component Overview
- Control Navigation
- Facility Tour
- PRO 6 Control and FANUC Backup

##### *Day Two:*

- Spindle Overview
- Spindle Replacement
- Spindle Checks & Alignments

##### *Day Three:*

- Feed Axis Overview

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- Ball Screw Replacement
- Linear Guide Replacement

#### *Day Four:*

- Rotary Table Overview
- Rotary Table Rebuild

#### *Day Five:*

- ATC and Tool Magazine Overview
- APC Overview
- Electrical Troubleshooting

## PROGRAMMING COURSES:

### Manual Part Programming – 4.5 Days

**Description:** This course provides a working knowledge of the codes, formatting, and processes necessary to write part programs in CNC language for Makino machines. Additionally, students will learn how to develop part programs for use on Makino Machining Centers. The focus of this course is Part Boundary Programming (using print dimensions). This includes an explanation of the formats and codes used to produce a program on a Makino machine.

#### Course Outline:

##### *Day One:*

- Discuss and Review G Codes and M Codes
- Review How G0, G01, G02 and G03 Work
- Format Program Sheets (Step by Step and Line by Line)
- Create Program Template on Note Pad
- Cover G90 and G91
- Learn How to Write Several Programs for Practice
- Cover Radius (G02 and G03) as well as I and J Arcs
- Learn Cutter Comp. (G41 and G42), Feeds and Speed Calculations
- Basic CAM Theories and Techniques

##### *Day Two:*

- Review Canned Cycles
- Write Advanced Programs
- Write a Part Program Final (Consisting of tool changes canned cycles etc.,)

##### *Days Three and Four:*

- Start Last Personnel Program
- Find Pictures and Draw on Grid Paper
- Programming
- Set up Work Off Set
- Run Part on a51 PRO 5 Machine

##### *Day Five:*

- Finish Programming and Machine Time
- Complete Written Test

### Macro Programming – 2.5 Days

**Description:** This course is designed to provide an understanding and working knowledge of macro programming techniques and capabilities and allow the student to become a more efficient programmer, reducing their part

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programming. Each day will conclude with customer discussion of techniques in order to address and properly teach customer-specific needs.

**Prerequisites:**

- Previous attendance in and completion of Makino's Manual Part Programming course or at least three months programming experience on a FANUC controller
- Ability to read part prints and use algebra, geometry, and right-angle trigonometry

Course Outline:

*Day One:*

- Introduction to Macros
- Basic Macros
- Local & Common Variables
- Arithmetic Commands

*Day Two:*

- Macro Calls
- Logic
- System Variables
- Error Traps

*Day Three:*

- Advanced Macro Discussions (including Makino-Specific Macros)

## EDM COURSES:

### BX3 Maintenance – 3 Days

**Description:** This course provides information about maintenance and the intermediate adjustment necessary for the BX3 platform and is applicable to all standard BX3 machines. Standard Maintenance Training begins at 8:30 on Mondays and consists of shop floor discussions and hands-on training to facilitate prompt learning.

**Prerequisites:**

- Familiarity with base machine control navigation
- Familiarity with indicator use in geometric adjustments

Course Outline:

*Day One:*

- Plumbing Familiarization
- Pneumatic Familiarization
- Axis Alignment Checks

*Day Two:*

- ATC/AGC Maintenance
- W Axis Maintenance
- Rotary Table Maintenance

*Day Three:*

- Pick up Preparations
- Ring Gauges and Renishaw Probes
- Tooling and Guide Plate Preparations

## Are You Ready to Enroll in a Course?

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## Wire EDM Maintenance (Hyper-i Control) – 3 Days

**Description:** The Wire EDM Maintenance training is applicable to the U3, U6, Uj, U86, U1310, and UPV WEDM machines. This course provides maintenance personnel and operators the necessary knowledge to understand and effectively determine a machine fault and its probable causes. It will also teach them how to perform basic electrical and mechanical adjustments. Students will also learn general and periodic maintenance procedures and practice machine recovery for their Makino Wire EDM. This class is recommended for new maintainers of any Makino Wire EDM machines and Makino maintenance procedures. The course consists of a combination of classroom lectures and hands-on training to facilitate quick learning of the machine.

### Course Outline:

#### *Day One*

- Introduction to EDM
- Machine Layout
- Control Navigation

#### *Day Two*

- Basic Manual Navigation
- Basic Machine Maintenance
- Wire Path Maintenance and Adjustment
- Machine Calibrations from Preparation Page
- Taper/Granite Jig and Vertical Alignment Cut

#### *Day Three*

- Basic Diagnostics and Troubleshooting
- Parameter and Data Backups

## RAM EDM Maintenance (Hyper-i Control) – 3 Days

**Description:** The Sinker/RAM EDM Maintenance training is applicable to the EDAC, EDFH, EDAF, and EDNC-Series Sinker EDM machines. This course provides maintenance personnel and operators the necessary knowledge to understand and effectively determine a machine fault and its probable causes. It will also teach them how to perform basic electrical and mechanical adjustments. Students will also learn general and periodic maintenance procedures and practice machine recovery for their Makino Sinker/RAM EDM. This class is recommended for new maintainers of any Makino Sinker/RAM EDM machines and Makino maintenance procedures. The course consists of a combination of classroom lectures and hands-on training to facilitate quick learning of the machine.

### Course Outline:

#### *Day One:*

- Introduction to EDM
- Machine Layout
- Control Navigation

#### *Day Two:*

- Basic Manual Navigation
- Basic Machine Maintenance
- Common Mechanical Adjustments

#### *Day Three:*

- Basic Diagnostics and Troubleshooting
- Parameter and Data Backups

## Are You Ready to Enroll in a Course?

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## Wire EDM Standard Operations (Hyper-i Control) – 3 Days

**Description:** The Hyper-i Control training is applicable to the U3, U6, Uj, U86, U1310, and UPV WEDM machines. This course provides operators and programmers with the necessary knowledge to understand and operate the Hyper-i control for their Makino Wire EDM. This class is recommended for all new users of any Makino Wire EDM machines or for any operators needing a refresher course on the current control and maintenance procedures. The course consists of a combination of classroom lectures and hands-on training to facilitate quick learning of the machine.

**Prerequisites:**

- Basic Understanding of CNC 3 Axis Machines
- Familiarity with G/M-Code Programming
- Basic Machine Hand Tool Operation (Calipers, Micrometers, Indicators, etc.)

**Course Outline:**

*Day One:*

- What Exactly is an EDM?
- Machine Introduction
- Basic Maintenance
- Basic Machine Controls
- Machine Vertical Alignment

*Day Two:*

- Programming Basics
- G and M Code
- Taper
- Selecting Cutting Conditions
- Program Screen
- Loading and Editing Programs
- Setup Screen
- Picking up Work Piece and Setting Work Coordinates
- Run Screen
- Starting a Job and Selecting a Program

*Day Three:*

- Miscellaneous Control Functions
- Onboard Manuals
- Run Sample Programs

## RAM EDM Standard Operations (Hyper-i Control) – 3 Days

**Description:** This training provides information about the machine parts, movements, controls, and maintenance. The process of loading, selecting, and running a program is covered. Programming basics, available orbit patterns, selection of cutting (burn) conditions, and Setup functions are covered before a sample part will be processed. Navigation of EDM Assist (onboard manuals), E-Tech Doctor, and Record functions will be explained. The Hyper-i Control training is applicable to the EDAC, EDFH, EDAF, and EDNC-Series Sinker EDM machines.

**Prerequisites:**

- Background in tool and die and/or part manufacturing
- Familiarity with G/M-code programming
- Basic machine hand tools operation (calipers, micrometers, indicators, etc.)

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## Course Outline:

### *Day One:*

- Machine Parts, Movements, and Controls
- Part Setup, Detailed Pick-up Cycles, and Setting Work Coordinates
- Basic Maintenance

### *Day Two:*

- Program Creation (Project Process, Burn Conditions, Orbit Patterns)
- Selection and Modification of Cutting Conditions
- Select and Run Sample Programs

### *Day Three:*

- Special Machine Option Functions (Carbide Circuit, HS-Rib, etc.)
- Explanation of Miscellaneous Functions
- Select and Run Sample Programs
- Location and Navigation of Onboard Manuals

## Subject Matter Expert (SME) Training:

**Description:** This rigorous training is in alignment with the same technical standards that Makino Field Service Engineers (FSEs) complete. It consists of six week-long lessons offered once a month and is designed to enable maintenance technicians to take ownership of more complex maintenance and machine troubleshooting problems. Upon completion of this program, students will be able to proficiently inspect and diagnose Makino machines after a collision or alarm, support Makino machines with a higher skill level and maintain machines at optimal efficiency.

### Week One: Machine Operations

- Skills Assessment to Determine Current Knowledge
- Advanced Control Overview
- Electronic Machine Manual Navigation and Overview
- [myMakino](#) Introduction and Enrollment
- Researching and Submitting Online Part Orders
- FANUC Features and Troubleshooting
- Control Restoration and Backup
- Functions used During Machining Operations
- Programming for Maintenance Activities
- Machine Networking and PC Fundamentals
- Remote Technical Support Setup
- Makino Service Department's Introduction

### Week Two: Machine Maintenance

- Spindle Troubleshooting
- Axes Troubleshooting
- Reference Adjustments
- Surface Finish Troubleshooting
- Post-Crash Machine Evaluation
- Complete Ball Screw Replacement
- Magazine Alignments Post-Crash
- Hydraulic and Pneumatic Troubleshooting
- Broken Tool Sensor (BTS) Adjustments and Troubleshooting

### Week Three: Machine Metrology

- Foundations for Precision Machining
- Machine Geometry Introduction

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- Inspecting Machine Geometry
- Interpreting Machine Geometry Inspection Reports
- Multi Point Leveling and Adjustment
- Post-Crash Inspections and Reports
- Hands-on Machine Evaluation, Geometry Troubleshooting and Adjustment

## Week Four: Machine Audit & PM Training

- Machine Performance History Tracking
- Machine Performance Audit
- Preventative Maintenance Program Planning
- PM Part Number Research and Ordering
- Spindle Preventative Maintenance Inspections and Component Replacements
- Coolant System Preventative Maintenance Inspections
- Conveyor Chain Tension Adjustment and Replacement
- Coolant Pump Rebuild
- Rotary Union Replacement
- Machine Belt Adjustments and Replacements
- Matrix Magazine Inspections and Adjustments
- Chiller Flushing after Contamination
- Machine Filters Overview

## Week Five: Electrical Print Reading and Troubleshooting

- In-Depth Machine Tool Electrical Overview
- Electrical Component Overview and Identification
- Alarm Troubleshooting
- FANUC Alarm Troubleshooting
- Machine Component Electrical Maps
- Transformers and Power Supplies
- ATC Inverter Parameters and Adjustments
- Spindle Chiller Temperature Sensor Inspections
- Overview of Machine Switch Types
- In-Depth Hands-on Troubleshooting

## Week Six: Advanced Maintenance

- Spindle Replacement
- Ball Screw Replacement
- Spindle Inspections Post Replacement
- Table Rebuild and Adjustments
- Machine Repair Parts Research
- Automatic Pallet Changer (APC) Rebuild
- Automatic Tool Changer (ATC) Replacement
- Linear Motion Guide Replacement
- Final Program Completion Assessment

## MAKINO TERMS AND CONDITIONS FOR TRAINING COURSES

*The following terms and conditions apply to all technical training courses conducted by Makino. Any additional terms/conditions shall be submitted in writing; such additions shall not be effective until agreed to by Makino. Any attempt to substitute or add terms/conditions will be rejected and shall be of no effect.*

*Makino offers our customers many formal training opportunities on selected topics and products. Content is based on specific skill sets and objectives and is designed to transfer a working knowledge and understanding of the specific machine tool systems and related processes.*

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*Makino Training Credits may be provided with machine purchases based on machine type and/or machine purchase agreements. These credits must be used during the first year after purchase. Training for additional personnel or after the standard first year period has elapsed must be purchased separately.*

*Training credits for EDM and Milling Machines are determined by the terms of the purchase proposal. Customers wishing to enroll in Makino Technical Training Courses should refer to their purchase proposal for Training Credit details. Additional training must be purchased separately.*

## PRICING AND TERMS OF PAYMENT

*Payment for training courses is due prior to attending the course. Makino reserves the right to refuse attendance in a class if payment has not been received.*

*Rescheduling of a course registration is done at no charge if Makino is notified within 15 working days of the start of the course date. Rescheduling is subject to a fee of 20% of the course tuition if notice is received less than 15 working days from the start of the course date. The full tuition fee will be charged for those students who fail to attend the course or fail to notify Makino's Training Department of cancellation.*

*For students with training credits, one training credit will be used if the attendee's company fails to notify Makino of cancellation or if the attendee fails to attend course.*

**PLEASE NOTE:** There is a maximum of six students per class. Please contact us to discuss options and possible additional charges, if you would like to register for a larger class size.

## COURSE DAILY SCHEDULE

Course length and meeting times may vary by subject and training type. Typically, courses begin at 8:30 a.m. and conclude at 4:30 p.m. You will be notified in advance should this time vary. All training courses enforce the following rules unless otherwise noted.

## FACILITY RULES

- Makino is a non-smoking facility.
- Students are required to always wear a security badge when attending courses held at any Makino facilities.
- Safety glasses with side shields and steel-toed safety shoes that meet ANSI standards are required during course time spent in the shop. Students without these items will not be allowed on the shop floor and must reschedule their attendance. We recommend for your own comfort that you bring your own safety glasses to your course.
- Business casual attire is requested. We ask that NO shorts, sweatpants, sleeveless shirts, T-shirts with writing, or sandals be worn to training courses.

## DRUG FREE WORKPLACE

It is the policy of Makino that the use, sale, transfer, or possession of alcohol and/or drugs on premises, work sites, or in any private vehicles parked on Makino's property is prohibited. Additionally, Makino prohibits individuals from attending any training class under the influence of alcohol and/or drugs. If a Makino instructor determines that an individual attending a training course is under the influence of alcohol and/or drugs, the individual will be asked to leave the premises immediately.

## COURSE REGISTRATION

Makino provides classroom space on a first-come first-served basis. If a requested course is filled, applicants are notified and will be placed on a waiting list or rescheduled for the first available later course date. Additional courses are scheduled, when possible, if the number of people on the waiting list fills a course to minimum capacity. If the waiting list does not warrant scheduling additional courses within a 6-month period, an attempt will be made to try to accommodate individual training needs on a "special" basis. To provide the best possible training environment, Makino reserves the right to limit class size.

### Registration Process:

All students are required to fill out an enrollment form to register for training courses. Due to the demand for courses, enrolling as early as possible is recommended. Students are not considered enrolled for a course until

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they have received confirmation that their application for the course has been accepted. We recommend that enrollment forms be received by Makino at least 15 working days prior to the course start date. To prevent missing vital information, we request that students not conduct other business during course instruction.

**PLEASE NOTE:** Enrollment in **any** Makino Technical Training course must be done through our website.

Ready to Enroll in a Training Course? [\(Please Click Here\)](#)

Simply fill out the enrollment form and click submit. Proper photo identification (i.e., driver's license or approved alternative photo ID) must be provided by all attendees on the first day of training. Foreign national attendees must provide passport identification prior to attending class. Makino reserves the right to refuse training or technology transfer to anyone who does not provide the required documentation.

## CANCELLATION POLICY

Makino reserves the right to cancel a course at any time. If a course should be cancelled, registrants will be notified prior to the scheduled course start date. Students registered for a cancelled course will be given priority for rescheduling for future courses or placed on a waiting list if no other course is available.

Attendees should not make non-refundable travel arrangements for courses. Due to possible course cancellations, it is recommended that only refundable tickets be purchased for transportation to training courses. Makino is not responsible for travel arrangements made for training courses.

If you have any difficulty, questions or concerns with the registration process, please do not hesitate to contact our Training Department for assistance with registration.

For further assistance please call: **1-888-Makino4** and ask to speak with our Technical Training Department.

## TRAVEL ARRANGEMENTS

### TECHNICAL TRAINING LOCATIONS:

Makino Mason (MM)  
7680 Innovation Way  
Mason, OH 45040-8003  
Phone: 513-573-7200

Makino Auburn Hills (AH)  
2600 Superior Court  
Auburn Hills, MI 48326  
Phone: 1-800-552-3288

### Airports:

*Makino Mason:* Flight arrangements can be made through either (CVG) –Cincinnati/Northern Kentucky International Airport or (DAY) – Dayton International Airport.

***Please Note:*** Occasionally Dayton (DAY) offers lower rates and might be a shorter commute.

### Cincinnati/Northern Kentucky International Airport (CVG)

3087 Terminal Drive  
Hebron, KY 41048  
Phone: (850) 767-3151

### Dayton International Airport

3600 Terminal Drive  
Dayton, OH 45377  
Phone: (937) 454-8200

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*Makino Auburn Hills:* Flight arrangements can be made through Detroit Metropolitan Airport (DTW)

Detroit Metropolitan Wayne County Airport (DTW)

1 Detroit Metro Airport  
 Detroit, MI 48242  
 Phone: (734) 247-7678

Hotels:

**Disclaimer:** Makino has no affiliation with and does not receive any compensation for travel arrangements made by course enrollees with any of the facilities listed below. Hotel reservations are solely the responsibility of the attendee(s). Makino cannot guarantee accommodations provided by these external services. As a professional courtesy, Makino training attendees qualify for a discounted rate at the following hotels:

Mason, OH	Auburn Hills, MI
<b>Candlewood Suites</b> – Mason 5070 Natorp Blvd Mason, OH 45040	<b>Crowne Plaza</b> – Auburn Hills 1500 N. Opdyke Rd Auburn Hills, MI 48326
<b>Drury Inn</b> – Mason 9956 Escort Drive Mason, OH 45040	<b>Hampton Inn</b> – Detroit/Auburn Hills South 2200 Featherstone Rd Auburn Hills, MI 48326
<b>Hampton Inn &amp; Suites</b> – Mason 5232 Bardes Rd Mason, OH 45040	<b>Holiday Inn Express &amp; Suites</b> – Auburn Hills 907 N. Opdyke Rd Auburn Hills, MI 48326
<b>Hilton Garden Inn</b> – Mason 5200 Natorp Blvd Mason, OH 45040	<b>Springhill Suites</b> -Detroit/Auburn Hills 4919 Interpark Drive Orion Twp, MI 48359
<b>Holiday Inn Express &amp; Suites</b> – Blue Ash 4660 Creek Rd Blue Ash, OH 45242	
<b>Holiday Inn Express and Suites</b> – Mason 5100 Natorp Blvd Mason, OH 45040	
<b>Homewood Suites by Hilton</b> Mason (Extended Stay) 5325 Natorp Blvd Mason, OH 45040	

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