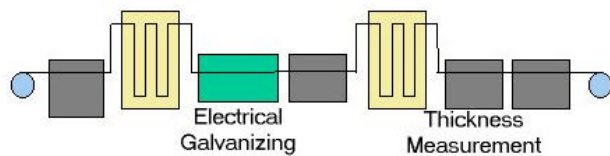
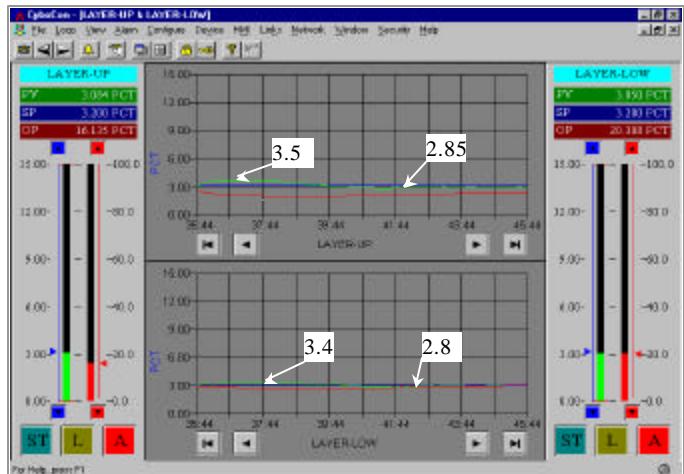


# Model-Free Adaptive Control on Metal Galvanizing Lines

<i>Use of MFA Control</i>	<i>Benefits</i>
Anti-delay and Feedforward MFA effectively handles large or varying delays.	Thickness of precious metal (tin or zinc) is automatically controlled during product changeovers and disturbances.
Prevents over-plating.	Tin or zinc consumption is reduced.
Prevents under-plating.	Number of defective parts is sharply reduced.
Increases production flexibility.	Production throughput is improved.
Improves efficiency & productivity.	Full investment is returned in weeks if not sooner.



Speed changes due to product changeovers cause major quality problems in tin thickness. On the display at right, two Anti-delay and Feedforward MFA controllers manipulate the electrical current (red) quickly to tightly control the tin thickness (green) on both top layer and bottom layer.



## Case History: MFA to control quality variables at Wuhan Iron & Steel Corporation

In a rolling mill, a galvanizing process produces tinned plating. Plating thickness is key to product quality. Plating that is too thick or thin causes an economic loss.

The tinning processing line of Wuhan Iron & Steel (Group) Co. (WISCO) performs large-scale continuous, high-speed tinned plating. Like on most plating lines, thickness could only be controlled manually. Differences in operator skills led inevitably to unstable product quality.

To keep plating continuous, buffers that store strip up to 150 meters long are arranged on both sides of the tank. The outlet buffer stores strip when cutting while the inlet buffer supplies strip when welding. Thickness of the plate is manipulated by the galvanizing current that must be calculated according to the thickness, width and speed of strip, depending on the concentration and temperature of the galvanizing liquid, etc. Behind the outlet buffer, a

sensor with a range of 0–15 g/m<sup>2</sup> measures plating thickness online.

A Modicon PLC is used for logic control and a Windows based PC with SCADA software monitors the system.

Plating thickness could only be controlled in open loop. Large disturbances of strip speed affected thickness even though current was adjusted based on a process model. The buffer between the tank and the sensor creates a large and random time delay that changes from 30 to 150 seconds and cannot be predicted. A variation in sizes of products (over 20 types per day) causes frequent changes in process dynamic behavior. On-site disturbances affect product quality and also make automatic control extremely difficult.

An Anti-Delay MFA controller was chosen for closed loop control of plating thickness. A Feedforward controller was used to overcome the speed disturbance. A

CyboCon software package was installed in the PC and connected to the Modicon PLC by using CyboLink for Modbus, a serial communication driver.

MFA control succeeded in reaching the objectives defined by WISCO:

- Control of plating thickness to within  $\pm 0.5$  g/m<sup>2</sup>. MFA controllers maintain thickness within  $\pm 0.3$  g/m<sup>2</sup> even if strip speed changes severely.
- Ease of installation and operation. Thirty minutes after connecting to the PLC, MFA controllers for Top-Layer and Bottom-Layer were launched and controlled plating thickness immediately. Commissioning was completed in two days; no maintenance is required.
- Return-on-investment is achieved in a short period of time due to automatic control of the quality variables.