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WFMFT, the dream child of Bernard and Rita Jacobs, was founded in 1951. Their goal was to share the music they enjoyed with their listeners. Although WFMT is a commercial operation, advertisers were sometimes skeptical of a classical radio station broadcasting in the new medium of FM. Money was sometimes tight, and it often became necessary to "make do." High fidelity was becoming popular with serious music listeners, and the owners of WFMT wanted to make their station sound as true to life as possible.

In the effort to provide the best possible fidelity to its listeners, WFMT has always been an innovator and a pioneer. In 1961, before the approval of the current FM stereo broadcasting system, WFMT cooperated with Chicago's public television station, WTTW/Channel 11 in stereophonic broadcasting. The left channel was carried on the television station while the right channel was on WFMT. This prepared the listeners for stereo broadcasting which began on WFMT in 1962, when history was made by broadcasting the first live stereo concert series anywhere.

CONSOLE MODIFICATION

At the time broadcast consoles capable of stereo were available, but were not as good as the high-fidelity equipment available to consumers. To solve this problem, WFMT's engineers modified a monophonic RCA broadcast console for stereo. When finished, about the only resemblance it had to the original was the cabinet and front panel controls. The electronics had been completely rebuilt. High-fidelity turntables and phono cartridges were used rather than so-called broadcast turntables to get better performance. WFMT was using the same type of equipment on the air that many of their listeners had at home!

Magnetic tape has always been a major source of programming for WFMT, so to get better performance from their tape machines, WFMT obtained a Dolby A301 in 1969. This unit was the predecessor to the ubiquitous Dolby A361, found in most recording studios today.

In April, 1969, WFMT moved to new studios on Chicago's Michigan Avenue. Due to the age of most of the equipment then owned by WFMT, virtually all equipment for the new studios was to be purchased new. A search began for a stereo broadcast console that was truly high-fidelity and would meet our needs. The only consoles that met the desired audio specifications were recording studio consoles. They provided many features, but did not have some that were deemed essential. In addition, the cost of such these consoles was prohibitively high. As a result, we decided that we would build our own consoles. These consoles were designed and built by WFMT's Chief Engineer, Al Antlitz. These consoles had audio performance that was unexcelled in both the broadcast and recording world.

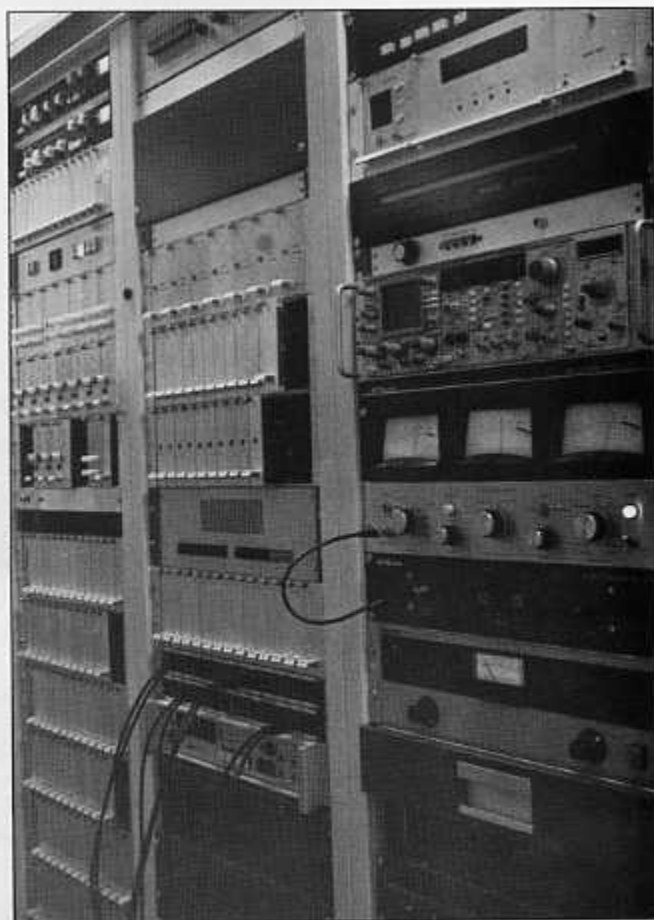
The 1970s were a time of discovery and invention in the audio world. Pioneers in the industry were discovering more and more factors that affected audio quality. The Mincom Division of 3M Company had produced a professional tape recorder using the

patented "Iso-Loop" transport that addressed many of the problems of tape recording. These machines greatly reduced scrape flutter and had many other innovations such as dual-pitch screws for the azimuth adjustment to provide greater stability and fully modular electronics using the latest technology. Two of these machines were purchased in 1/4-inch versions for WFMT's main broadcast studio.

In the early 1970s the hot topic in the audio world was no longer stereo, but quadriphonic sound. A number of matrix systems were developed to provide quadriphonic sound on only two channels. WFMT experimented with this new technology, and in September, 1971, broadcast what is believed to be the first live quadriphonic (matrix) full-length opera production, *Semiramide*, from Chicago's Lyric Opera.

By the mid 1970s our changing needs necessitated some revisions in the studio equipment. The monitor and intercom facilities in the studios were found to be inadequate, so we designed a new monitor and intercom system.

Figure 11. WFMT's central equipment room. The modular card cages are all WFMT-built equipment.



While this was a relatively small project, and did not make any changes in the station visible to the public, many new techniques such as CMOS logic control, audio integrated circuits, and cmos analog switches were tried at this time. This laid the groundwork for future projects.

PROCESSING PROBLEMS

Classical music poses some unique audio processing problems. Although FM has a limited dynamic range, even under the best of conditions, classical music has a wide dynamic range which is an integral part of the enjoyment of the music. Processing equipment that will deal with the full range of classical music without any undesirable artifacts and still deal with the 75 micro-second pre-emphasis requirement for FM is very difficult to find. After much research, we felt that we could do a better job than anything that was currently being built. Al Antlitz set out to design an audio processor that provided low distortion, accurate control of the audio, and was psycho-acoustically pleasing. The first incarnation of this device, called "The Antlitz" by WFMT staff, was put on the air in the early 1970s. However, development of the device continued and the second

generation, called the "Moduplex I" was put on the air in 1976. Research and development on this problem continues to this day.

When it became time to replace the aging exciter and stereo generator (the heart of the transmitter), we investigated all the equipment available at the time. After visiting the two leading manufacturers for demonstrations of their latest and best equipment, we found an exciter/stereo generator package we liked, but were not satisfied with the stated specifications. The demonstration showed that the equipment was capable of much better performance than was shown on the specification sheets. Negotiations with the manufacturer led WFMT to purchase their exciter, but with the demonstrated performance being guaranteed. This purchase allowed WFMT to broadcast what was probably the best signal at the time. Such performance is now routinely achieved by most leading manufacturers of such equipment.

As our operation expanded the necessity for more tape recorders became evident. The Mincom recorders were no longer available, so the search began for new machines. Two machines from Philips were tried, but they had

some problems with acoustical noise in the control room that restricted their usefulness. By the next time recorders had to be added to the operation, Studer had opened their own facilities and distribution in the United States. A machine was tried for a month, and now, over 13 years later, is still performing as well as it did the day it was new. Since then, Studer recorders have become the standard for WFMT. Even though the initial cost is higher than other makes of recorders, the total cost of ownership has proven to be much less.

During the summer of 1978 WFMT's management determined that a tape duplication facility was needed for the growing Chicago Symphony Orchestra syndication, with more than 300 stations taking the weekly two-hour concerts. High-speed duplicators could not provide consistent stability while dealing with 10-1/2 inch reels without a great deal of time being devoted to quality control. WFMT's engineering department proposed that the tape duplication be done in real time. In order to provide quality control, a scanning monitor system was devised that allowed the operator to monitor the output of all tape copies as they are being made. Since the scanning system allows comparative monitoring of each output, anything unusual is easily noticed. This relieves the operator of the need to discern the absolute quality of the tapes. This system gained WFMT the reputation of having the best quality tapes of any classical music syndicator.

In 1978 WFMT participated in the first stereo-sound-only relay of a live performance by domestic satellite. Then, in June of 1979, we became America's first radio "superstation," being delivered by satellite to cable companies throughout the United States.

A MAJOR UPDATING

By 1980 we had outgrown our facilities on Michigan Avenue and began looking for new quarters. We moved to Chicago's Illinois Center in the fall of 1981, where we were finally able to realize a dream—a music-performance studio. This move also allowed for the first major updating of studio equipment since our last move in 1969. As available equipment was investigated, we decided that we should once again design and build our own studio equipment.

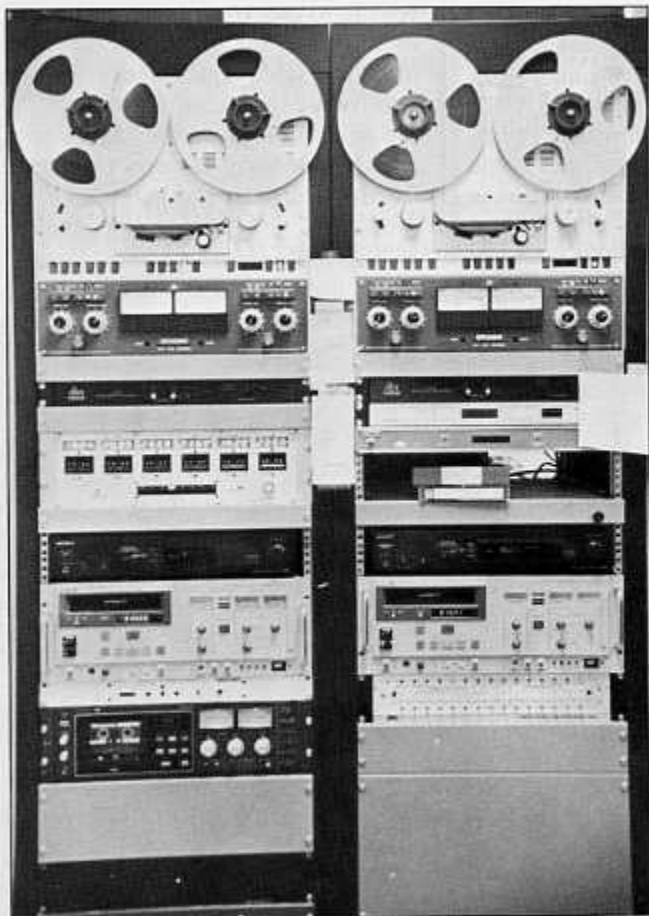


Figure 12. The up-link automation facility for Concert Music Consortium and Beethoven Satellite Network.

A total system plan was devised so that all equipment would be as interchangeable as possible. Modular microphone pre-amps were designed using Jensen transformers and 990 op-amps. The consoles were designed using VCA technology and CMOS switching to that no audio passes through any faders or mechanical contacts. Many other features not available on other consoles were built into the WFMT consoles, such as soft turn-on and turn-off of channels.

Since WFMT broadcasts more live remotes than most radio stations, we rely heavily on telephone lines. The proper interface for equalized lines was designed and incorporated into modular amplifiers. These amplifiers are used throughout the facility for interface and distribution applications as well.

All control and production rooms are fully self-contained, but may need to interface to remotes or other rooms. To accomplish this with a minimum of crosstalk, all lines to and from each room were run to a central equipment room. In this room is all equipment that is to be shared by the rooms, as well as the termination point for all telephone lines. Since patch bays can be confusing and unreliable if not used frequently, all signal routing is done by a routing switcher designed by WFMT's engineering staff. Switching is placed where it is most logical to reduce wiring and crosstalk, and the control is located at its most logical point. CMOS analog switches are used for all signal routing, and the status of the system can be read at the control point in English on an LCD display. Total system performance at WFMT is better than many radio stations are able to achieve with only a console.

Each room in the studio/control room complex is provided with a monitor and intercom system. As is the case with the routing switcher, the audio is switched in the central equipment room, along with the volume control and muting functions. This reduces the amount of audio wiring required as well as the crosstalk. The intercom system allows each room to talk to any other by pressing a single button. This system is interfaced to the muting and warning light system so that it is impossible to call a room that has an open mic. Also, signalling is provided so that the person being called knows what room is calling, without the caller having to identify his location.



Figure 13. The tape duplication facility.

All turntables in the facility are on vibration isolators to prevent footfalls from being heard on the air. The turntables are Technics SP-15s with Signet tone arms and Shure V15 Type V cartridges. These phono cartridges were selected to provide the best reproduction of records while still allowing for ease of maintenance.

SEARCH FOR BETTER WAYS

During the Summer Consumer Electronics Show in Chicago in June, 1982, Sony provided WFMT with a prototype compact disc player and some discs. We were the first radio station in

the world to broadcast a compact disc. Within two years CDs were an integral part of WFMT's programming.

The search for better ways to record concerts and recitals never ends at WFMT. For years remotes were done using two Nagra IV-S portable reel-to-reel recorders. These were small and provided good fidelity, but were inconvenient to use. We did an experimental broadcast in the early days of digital using the Stockham/Soundstream system. While the sound was impressive, the equipment was bulky and expensive. When Sony came out with the PCM-F1 digital converter and the

Figure 14. Some of the many Studer tape recorders at WFMT.



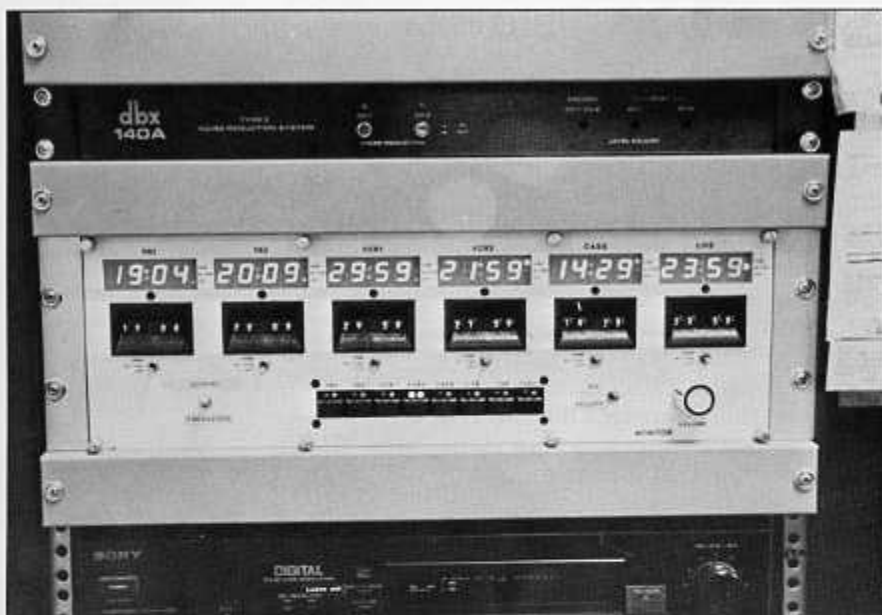


Figure 15. A close-up of the automation controller.

SL2000 portable VCR, it seemed that the solution for remote recordings had been found. The equipment was light, portable, and easy to use. Recording time was longer than reel-to-reel tape and the fidelity was better. Editing was a problem, but this was solved by transferring to Dolby A processed tape in the studio. In essence, a generation of tape was saved, since masters are not edited. The technique has become popular at WFMT, and now there are almost as many VCRs at WFMT as there are analog recorders.

A DIGITAL BROADCAST

The PCM-F1 converter and its successors have enabled us to do things other than simply make recordings. In 1983 WFMT broadcast a complete performance of *Götterdämmerung* live from the Bayreuth Music Festival in Germany. The audio was digitized in Europe and sent to the United States by satellite where it was converted back to audio and was distributed by National Public Radio to stations throughout the United States. The audio quality for this broadcast was better than most domestic broadcasts. Shortly after this, we began using the PCM technology to relay our main audio signal by video microwave from our studios to the transmitter in Chicago's John Hancock Center. This technique provides better signal-to-noise than is available by conventional microwave STLs or telephone lines.

In 1986 WFMT launched the Beethoven Satellite Network, a live format service available to radio stations by satellite. With studios located in downtown Chicago, the problem was to get the audio to the uplink, more than ten miles away without severe degradation. Once again PCM technology was utilized over a microwave link to relay the signal to the uplink.

EVERYTHING FROM CHICAGO

Within a few months after the start of the Beethoven Satellite Network, the Concert Music Consortium, of which the WFMT Fine Arts Network is a major participant, decided to do all their uplinking from Chicago. Concert Music Consortium distributes classical music programming to subscriber stations throughout the United States via satellite. The source material is a variety of taped concerts and programs, both on analog as well as PCM on video tape. A facility was set up to perform this function, but economics as well as practicality demanded an automated system. After some investigation, we found that there were no commercially available automation systems that could do the job as desired. Again, WFMT's engineering department was called on to design a system to do the job. The automation system that was built relies on human operators to load the tapes and set the automation system, when then starts programs automatically and on time.

TELCO USE

As was mentioned earlier, we rely heavily on leased telephone lines for remote broadcasts. Due to escalating costs over the last few years, we have developed a method of using low-cost circuits from the telephone company for the broadcasts. Special amplifiers were designed to provide proper sources and loads for the lines and do the necessary equalization. To get adequate noise performance, we use Dolby SR on the lines. This technique provides better quality than the telephone company could provide for a fraction of the cost.

TO THE FUTURE

WFMT was the first station to broadcast DAT in the United States, again with the assistance of Sony. WFMT is now using DAT for some remote recordings, dubbing to Dolby SR analog tape for editing, much as with PCM tapes. PCM on video tape is still used, and will probably still be around as long as equipment and repair parts are still available. It is unclear if DAT will become a large part of our operation or not. We have also been evaluating some of the new digital editing and storage systems, but have been unable to purchase anything to this point.

TO THE FUTURE

What the future holds is uncertain. Digital audio seems to be the wave of the future, but the form (DAT, recordable CD, or some other format) is still uncertain. However, regardless of the means to the end, the goal is clear—to provide the best possible quality within the technical and economic restrictions of the medium.

WFMT has an advantage with good equipment, but consistently high performance standards is a direct product of the people involved. Proper maintenance of the equipment is as essential as having the right equipment. While perfection will never be obtained, it is still the ultimate goal. The pursuit of that goal, not the equipment, is what sets WFMT apart.

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