BEHIND THE SCENES

BERT WHYTE

A Professional Viewpoint: An interview with Larry Scully →

Larry, these days your Scully Recording Instrument Co. is mainly engaged in the manufacture of tape recorders, whereas for many years the principal production was of disc recording lathes. Am I correct?

SCULLY: That's right. My father started the business in 1918, after having worked at the Columbia Record Co. from 1905 to 1918. He was in the experimental laboratory. In those early days the record companies had to manufacture all the equipment used to produce a disc. They made their own lathes, made their own soundboxes and megaphones to pick up the sound in the studio, did their own plating, made their own presses . . . the whole works.

Even their own phonographs!
He worked mostly on the development of the disc recording lathe, and from that experience when he left Columbia in 1918 he started to make the lathe on his own, hoping to interest some independents to get into the record business. It took him about a year to build the first machine.

Was this the machine that worked on "gravity drive," and gave rise to the expression of "throwing the weights out of the window"?

SCULLY: Yes, it was a weight-driven machine. The lathe was usually put up on a pedestal at least 5 or 6 ft. high, so that there would be enough of a drop for the weights to drive the machine for the amount of time needed to cut the disc. If they wanted a longer time there was a hole in the floor to give the weights more room, or they raised the pedestal even higher. They had to use platforms to stand on in order to operate the machine.

I understand that although this all sounds relatively crude, this arrangement made the motor drive the turntable very smoothly.

SCULLY: Well, it was very good for the time. The motor was controlled by a governor which made it quite smooth. The entire lathe operated on a purely mechanical basis, of course.

What did they do about lead screws in those days?

SCULLY: They cut their own lead screws, and in those days the pitch was quite coarse, running perhaps 70 to 80 lines to the inch so they had very little trouble with overcutting.

I presume the coarse pitch was practically mandatory, since there were no really quiet sections on a disc and everyone had to bellow into a megaphone in order to drive the cutting stylus.

SCULLY: That's right. It took a lot of acoustic energy to move the diaphragm and the relatively heavy mass of the stylus against the resistance of the wax master.

After your father set up his company, who bought the first lathe?

SCULLY: Well, he didn't really start a company at that time. He bought the necessary machine tools and built the lathe at home. Then he went to New York and sold it to a group that became the Cameo Record Co. My father was a fairly good showman too. He would not bring the machine to New York to demonstrate its performance. Instead he would have them come up to his house, where he used the living room with fancy backdrops and special lighting to set off the machine, which if I may say was pretty impressive.

Sounds like he pre-dated some of our modern merchandising methods! And I quite agree about the appearance of the lathe. The first time I saw one with all the gleaming engine-turned finish, I was reminded of Bugatti racing car engines, or the instrument panel of a Duesenberg "J" model roadster. It was all very confidence-inspiring!

SCULLY: The look of the machine was important and had its advantages. In later years, when transcription recording came into being, some of the broadcasting outfits would keep the lathe in full view to impress their clients.

The "modern" version of the lathe came out about 1938, I believe.

SCULLY: Yes, and except for convenience features dictated by advancing technology and the advent of stereo, the present lathe has the same basic configuration.

What was the original method used for the reduction of rumble in the lathe?

SCULLY: In the initial units there was a motor and a gear-reduction system used to drive the turntable directly. You needed a thrust bearing in order to carry the weight of the turntable, and that meant you had to have either a ball thrust of a plain bearing. The plain thrust bearing produced a lot of friction because of the mass of the table, whereas the ball bearing tended to produce rumble, or worse still, a pattern on the record.

I've never heard of that. What kind of pattern?

SCULLY: A pattern produced by the vibrations. You could practically count the number of ball bearings by the pattern. The ball bearings used to be set in the ball races in felt in order to minimize this problem. Of course the requirements then were far less than they are now. In 1938 we went to the belt drive, primarily to get rid of the thrust bearing involved in a "straight-through" drive.

That was the multiple bearing system, if I recall. At that time, I believe you also had a massive flywheel at the bottom of the lathe, driven by a belt, with the flywheel and the turntable connected by a shaft with a flexible decoupling stage.

SCULLY: Yes, we have this filter drive assembly that cuts down the rumble and also was designed to keep out high-frequency flutter.

Larry, I have heard through the years that in order to take best advantage of all the precision built into the lathe and to keep rumble at the absolute minimum, it is preferable to mount the lathe on a concrete floor. Is this true?

SCULLY: It would be nice to always

have it that way, but it has been my experience that with the type of solidly constructed floors they have in New York, for example, there isn't much of a problem.

What if the floor is the standard wood type?

SCULLY: Well, if it is wood, you can run into troubles.

With resonances, I presume?

SCULLY: Yes, although sometimes you can be lucky enough to be at a null point of the vibrations. Depending on the general construction of the building and the type of wood floor, some type of extra damping would be necessary to use the lathe in such a location.

Many record critics often speak of rumble in a recording, but I have always contended that a well-maintained lathe mounted in an optimum way has rumble so far below signal as to be inaudible, and what these critics are hearing is mold grain due to the electroplating process and subsequent grinding of the stamper in order to make it fit properly in the press.

SCULLY: I would say that is correct, although we must admit that, with the vertical component of the stereo disc, rumble suppression has been made more difficult and you have to keep on top of all the factors involved.

The lathes are still being made in spite of your emphasis on tape recorders these days. That is done in a separate plant, as a different division?

SCULLY: It is not actually a separate division, what we do is combine the lathe work with machine work necessary for the tape recorder.

Singer Jerry Vale in control room, with Scully 280 tape unit at right.

Lathes last a long time, and people generally don't order them by the dozen. I presume that between yourselves and the one other company in field the market is pretty circumscribed.

SCULLY: Yes, even when we had literally the world market to ourselves, it wasn't a tremendous business. The Japanese and the Italians, too, looked at the possibilities of the disc lathe business right after the war and concluded that it was too limited. Today we build the lathes strictly as a custom product.

This limited market was what prompted your move into the tape recorder field. That was about 1961?

SCULLY: That's right. We decided we had a good reservoir of machine tools, trained personnel, and experience which was certainly related in many ways to the manufacture of tape recorders.

In 1961 I presume your first products had to be machines for the full-track and half-track mono and two-track stereo on quarter-inch tape, and three-track stereo on half-inch tape?

SCULLY: No, our first tape machine product was a playback-only unit, the model 270. That unit was designed to be used with automated radio station equipment, which at that time was thought to be a "coming thing." We produced this unit between 1961 and 1963, and when the anticipated sales of the radio station equipment didn't materialize we went into production of our first quarter-inch two-track recorder. Shortly thereafter, the three-track machines were the big thing on the market, and then the four-track, half-inch tape unit was the mainstay of production for several years.

Then about three years ago, the eight-track machines came into being, and then the 16-track and the 24-track . . . and just where will it all end?

SCULLY: Well, from our experiences in the field, it would seem that the 16-track unit seems to be presently favored and is thought by many to have the most versatility.

The 16-track unit uses one-inch tape?

SCULLY: Yes, and we have made some 12-track one-inch recorders as well.

Let me ask what may be a dumb question. As you know, 24 tracks are being used, and these days the studios are in a peculiar bind with these rock-and-roll record producers who insist on all sorts of wild effects, and who are literally forcing many studios into multi-track situations. They feel that an eight-track studio is already "old hat." Wouldn't it be cheaper and technically feasible to sync together two 16-track machines and afford these producers thirty-two tracks?

SCULLY: It might be a distinct possibility since with that many tracks available you could use some of the tracks as control tracks.

Yes, the control tracks would help. And with all the tracks self sync, the effects possible would be almost limitless. Then, too, there shouldn't be much trouble in the eventual mix-down to two-track stereo.

SCULLY: Once the two machines were synced together, everything else would work quite normally.

If the two recorders could be synced together, I wonder if there would be a problem because of small but nonetheless differing degrees of tape stretch on the two recorders? Mylar does stretch, although these days they have that special "pre-stretched" Mylar tape.

SCULLY: I don't think that would be a factor and the degree of displacement between the two tapes would be minute. We make our big multi-track recorders for two-inch tape and all the two-inch machines we have on order at present are for 16 tracks. It doesn't mean that if someone wants to go to 24 tracks that his machine is obsolete; but he would have to get a new head assembly and the additional electronics. So there is a certain degree of flexibility possible before we may have to think about syncing two 16-track units together!

Most of the 4-track units are on half-inch tape, but I understand you have made some 4-track units using one-inch tape.

SCULLY: Yes, these were for the most part for the European market.

I suppose they wanted wider track widths to give them better signal-to-noise ratios. That isn't much of a problem any more with the advent of the Dolby System, I should imagine.

SCULLY: That's right. The Dolby System has helped in this respect. Nevertheless, I don't feel track width should be restricted if it can be avoided.

Is this because distortion is higher at the narrower track widths?

SCULLY: Only marginally so, but the kind of quality our clients seem to

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want is exemplified by their restricting their orders for two-inch recorders to 16 tracks.

Larry, to digress a moment, you know that the Studer Co. in Europe manufactures expensive professional tape recorders, but they also make a little "kid brother" recorder called the Revox which has made quite an impression in this country. Do you think you might ever make a consumer-type tape recorder?

SCULLY: We could design such a machine, and I think we could come up with some new ideas, but the cost would be prohibitive. I think for the forseeable future we will stay out of that market.

With your company's extensive background in machining, a "spin-off" from your lathe production, I assume you machine and manufacture most of your own parts for your tape recorders?

SCULLY: Yes. Only when the requirements for quantity cannot be met with our facilities here do we farm out machine work to appropriate firms.

Do you make your own tape heads?

SCULLY: No, use heads made by Nortronics and by IEM. We order them to a particular configuration and specify inductances and other electronic requirements to conform to our electronics.

You do not make your own motors, do you?

SCULLY: No, we do not. And getting the right kind and quality of motors is a continuing problem.

You mean motors with sufficient torque, cool-running, etc.?

SCULLY: Not that so much as motors that are quiet. This is largely a matter of ball-bearings.

Maybe you need some of those new bearings they say someday will be cast in outer space and which will be perfectly round.

SCULLY: Well, a lot of the bearings are pretty good, but we run into a variety of lubrication problems. You run into greases that are too stiff for your application. By and large, I think our company (and I think most other tape recorder manufacturers would bear this out) has to contend with occasionally noisy ball bearings in the motors and in other areas where they are used. Then there is also the problem of bearing damage in shipping. The rotor of the motor has mass, of course, and it's spring-loaded at the top end to seat it in the ball bearings at the bottom. If the shipping case is dropped so the inertia unseats the rotor shaft and then the spring bounces it back against the ball bearings, tiny "flats" are formed, and this means a noisy motor.

Your capstan motor is a hysteresis synchronous unit. Have you given any thought to what appears to be a coming trend, the servo controlled motor?

SCULLY: Oh yes, we are digging into that, and in fact have been investigating this type of motor for over a year. So far we haven't seen a very great improvement in performance—I'm talking about capstan motors not spooling motors—to warrant replacement. A good hysteresis motor will get you .04 to .06 NAB wow and flutter unweighted. A good d.c.-control-type motor will give you about .04, and it will be a little less "spiky" than the hysteresis motor.

How many poles do you use in your hysteresis motor?

SCULLY: We have six poles and twelve poles in our combination two-speed motor.

You hear these tales going around that the more poles the better the motor. I suppose after a point it's a question of diminishing returns.

SCULLY: It is a matter of construction, a mechanical problem. The outside-in motor can tolerate more poles and still not sacrifice too much of the iron by having too many slots in it.

The idea of the outside-in motor is that it gives you more rotating mass and presumably a smoother drive function?

SCULLY: Yes, that was my original thinking back in 1963, but I have found that the more mass you get the less damping you get. It makes the motor difficult to damp so today, we lean more towards less flywheel action on the capstan motors.

This is unusual! The old way was to supply mass through a big flywheel.

SCULLY: Well, it is good for high-frequency perturbations, but not for low-frequency upsets.

There appear to be many new ideas in

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tape-machine construction that run contrary to some of the old accepted practices. For example, a friend of mine builds a high-quality recorder in which he uses what would seem to be an amateur anachronism: a tiny nylon head pad, which he claims gives much better high-frequency response.

SCULLY: I think all of us would like to use a pad, but head wear gets involved. In the eight-track cartridges they have the little spring-loaded pads that hold the tape tight against the head. This is a big advantage in that particular application in maintaining high-frequency response.

In other words, even though the tape manufacturers have done a pretty good job in giving us smooth tape surfaces, there are, inevitably, little undulations and other discontinuities on the surface which the use of the pads helps overcome and gives the better high-end response. Too bad the wear factor is such a problem. Perhaps the use of ferrite heads would help in this respect. Have you used any of this type?

SCULLY: We use ferrite heads for our erase, but thus far not for record or playback heads.

Well, I have heard the ferrite heads are friable, being easily chipped or broken. But the head-wear aspect is terrific. And many of the crosstalk problems in tape duplicating, due to head grooving and subsequent skewing, have been overcome with these heads.

Getting back to the servo motor again, another thing I was told was, that in addition to the low wow and flutter, this motor has better torque than a hysteresis type.

SCULLY: It has more torque, but it is not much of an advantage in capstan drive. Ideally, if your spooling motors are set right, the capstan motor should not be doing much more than metering the tape as it goes through.

Is there any advantage of the servo motor over the hysteresis in terms of drift, the long-term stability from one end of the reel to the other?

SCULLY: No, it would be subject to the same conditions as the hysteresis unit because of the slippage problem at the end of the reel.

Would you ever consider building your own motor in order to get your ideal specifications? I think you did this once in the old disc-lathe days.

SCULLY: Yes, about 1934 I built a motor for the lathe, but the cost today precludes any such possibility, even if we had the time and the inclination.

I believe you make all your record and playback electronics here?

SCULLY: Yes, the control and ready availability makes this important.

Do you make the printed circuit modules as well?

SCULLY: No, that is subcontracted, and I should have expanded my previous statement in that about 20 per cent of our electronics is by intent made outside so that in the event of a fire or something that might happen here we would not be out of business because of lack of electronics.

Obviously you maintain a complete test facility for both electronic and mechanical components. In its final run-through and check does each machine have its bias adjusted for a particular kind of tape?

SCULLY: Yes, they are adjusted for Scotch low-noise 201. The user is, of course, free to adjust the bias to any other tape for particular characteristics.

One of the basic concepts of your design is the interchangeability of heads and tape guides and electronics. Thus, a quarter-inch two-track machine can be changed to a 4-track half-inch recorder, and so forth. I have always thought this would be a great thing to have on a high-quality amateur recorder, but I suppose that in mass production this would be very difficult.

SCULLY: I'm afraid so. The head block, for example, must be machined to fit into an equally machined place on the top plate. This calls for extreme care, and in this business this means it becomes expensive.

The electronics are all the same, except, I presume, for some special switching which may be on those used with the 8- and 16-track units. Interchangeability is much easier here?

SCULLY: Oh, yes. It is a simple matter of plugging and unplugging until you set up your desired configuration.

The electronics and the heads are all set up for self-sync. By switching, the record head becomes a playback head, and will play back the program while new material is being recorded along with it. This can go on for as long as you have tracks available. The "mix down" to two tracks can get very involved and pass through many generations and is a prime

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reason for recording with the Dolby System to avoid the build-up of noise. Have you ever entertained the idea of building the Dolby System right into your electronics?

SCULLY: We have thought about this, but feel that it would be very expensive in its present form and it is best to leave this sort of thing as something the customer would acquire on his own.

Larry, I know that because of current practices in this country you must equip your recorders with standard VU meters, which we all agree leave something to be desired in ballistics and accurate reading, many people prefering the peak-reading European meters. Have you heard about the electronic light system of Altec that is used as a super-visual level meter?

SCULLY: Yes, but like the Dolby System, building it into a recorder is a matter of money and as yet the light-indicating system has had limited usage. Perhaps it will become low enough in cost someday to be a worthwhile addition to a recorder.

One other subject that has come up recently in regard to innovations on tape recorders is the use of electrodynamic braking, instead of the classic brake-band concept. Have you given any thought to this?

SCULLY: Yes, we have done quite a bit of work on it, and it is a complicated business. In fact, we have worked out a simple tape motion-sensing system that does about as well as electro-dynamic without all the trouble and expense. You know, the best way to stop tape on any conventional recorder is, if you were in rewind, by hitting your fast-forward button. The tape rapidly slows down and virtually stops, and if you hit your stop button, then everything is very positive and gentle. Well, we have a little sensing device, and it determines tape motion and goes through all that sequence I just described automatically. You know there are all sorts of devices and techniques that can be added to a tape recorder, but they are only worthwhile if they can be applied reasonably to a machine to effect a genuine improvement in either tape motion, signal-to-noise ratio, harmonic and IM distortion, and tape-handling controls. That is what a good tape machine is all about. Æ

Disc Mastering

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of acetate, or if suction is changed.

Positioning of the stylus in the cutterhead is very important. A fast and safe method is to use a stand which securely clamps the cutterhead and provides a microscope with a calibrated hair-line reticle. It is a simple matter to rotate the stylus in relation to the hair line to position the cutting edges. The cutterhead is positioned in its suspension by watching reflections of the cutterhead and stylus on an acetate. Another method is to place a small non-metallic block on the turntable under the cutterhead and line up the cutter as it is lowered. The stylus should be perpendicular to the disc surface in all planes. The heater wires should be left slack so that stylus motion is not affected.

The chip pickup tube should be positioned within a quarter of an inch behind the stylus and barely off the acetate surface. The suction should be adjusted to the lowest air flow that will still remove the chip. Excessive air flow can tear the chip out of the groove, or can actually modulate the stylus. In any case the noise it causes makes monitoring difficult. With a low suction it is usually necessary to blow on the stylus as the cutter is lowered to get the chip picked up, but a switching device can be used to increase the vacuum just at the time the cutter is lowered.

The electrical performance of the transfer channel should be checked regularly to make sure it is operating within specifications. Measurements should be made on the whole chain, in addition to individual units. A most important check is an A/B comparison between the master tape and test cuts played on a calibrated turntable.

Mastering is perhaps the most important single step in record production. It is during this process that the product takes its form for the consumer. The most important ingredients are accurate reliable equipment and an engineer with an intimate knowledge of his equipment and the entire process. Æ

ACOUSTICAL MATCHING

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possible for easy operation. The rotary control has been generally abandoned and straight-line attenuators which are easy to operate by touch are in more-common use, allowing the operator to see the action on the stage. It is possible to operate several such controls at one time. Control consoles should be so laid out that they become a map of the stage, perhaps with five or seven controls in front representing the footlight microphones and several others spaced above representing upstage hanging microphones, offstage microphones, or other sources operating through the sound-reinforcement system. An operator running such a control can easily correlate what is happening on the stage and what he is doing on the control console. He can "play" the system, minimizing the number of microphones that are live at any one time and raising the gain on just those microphones that are nearest the actors, so that clarity is maximized. The fewer microphones on at any one time, the higher the clarity will be.

Costs

The cost of a minimum reinforcement system for a high-school auditorium used as a performing-arts hall might run around $15-20,000 today. Cost of reinforcement systems can run as high as $100-200,000 if stereo effects are required for reinforcement and electronic reverberation is provided. If costs must be cut on a system, it is strongly recommended that it be done by removing elements of the system, for example, providing only the basic reinforcement system initially. By providing for future reverberation facilities, as well as possible future tape recorders and disc playback equipment, can reduce costs appreciably. Cutting back on quality can result in the investment for equipment which is not suitable for the purpose and which must be replaced if the system is to perform as required. In the long run, this can raise the cost of the installation. Æ