C600 Theatre Organ Project
Part-2

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Making it Work

Everything was double-checked wiring-wise before the power was applied with the current limitation control set for a low current in case of trouble. It all seemed to be satisfactory and the computer board (CCC-6B) seemed to be functioning so the current setting was advanced somewhat. The pistons would be checked out first as they would be necessary to invoke diagnostic routines.

The display registered the correct information so the piston diagnostic mode was entered by selecting a DIP-Switch on the computer board. All the piston addresses checked out properly and the switch was restored to normal. UP and DOWN pistons were then tried as was the SETUP mode piston. All seemed well and Set-Up mode #72 was selected so that the tab switches could be checked out.

Alas, all was not well for they all showed up with numbers 128 greater than they should have done and there were none higher than 192 (the maximum allowed for in this organ) — the Solo division stops did not show at all. Furthermore, in trying tab test #73 (to test magnet operation), the tabs would move on but not off. How could that be? It was obviously linked to the wrong switch numbers, for the Classic system used the switch data to tell each tab whether to move or not. If the switch was off, the magnets would be told to move on but the off ones would already be sensed as off (from a non-existent stop 128 away) and therefore not energised. The problem was traced to a problem found when adding the BIO-5 bus strip to the input section of the CCIO-3 board. It had to be physically shifted up by a couple of positions otherwise it would not have fitted in the space allotted but the electrical connections had not been moved to compensate for this. Two positions meant 2x 64 inputs — the exact difference. This was corrected for by moving each of the Board Enable connections up two pins. That fixed the Test #73 problem as well and the tabs could then be energized both on and off.

Some tabs did not work properly but most of these could be fixed by a simple repositioning of the reed switch with the fingers to place the switching point in the centre of the travel range. One tab unit was found to have a shorted On coil and was replaced (the drivers have short-circuit protection built in). Several had loose tabs and to tighten them up meant removing the stop unit because the top-accessed screw was out of sight under the wooden rail. This was a major headache for the stops had obviously been installed originally when the horseshoe was out on the bench and slot-drive screws had been used with plain washers over the mounting slots. Trying to reinstall these slot-driven screws now that the horseshoe was in the console was virtually impossible. You needed a long, thin screwdriver and there was simply not enough room inside the console to see what you were doing when you leaned over the top and tried to insert the screw into the hole. Each screw had to be positioned in its location, including the washer, using the fingers or pliers and then the screwdriver offered up to it with the slot in the proper orientation or the screw would be knocked out of position with the slightest twitch. Of course, the screws are some two inches forward from the rear of the tab mechanism and there are festoons of wires in the way as well as the wiring support rail. Large fingers are useless even if you can see what you are doing!

The problem was alleviated to a great extent by using square-drive (Robertson) headed brass screws. Why brass and Robertson? These could be placed securely on the end of the screwdriver together with the washer and offered up to the mounting holes with a fair assurance that they would not fall off. Brass screws avoided the problem of the nearby stop magnets pulling the screws off the screwdriver tip as you were getting close! As many tabs were loose, several did not get fixed because of this difficulty. Those that did had a piece of double-sided tape added between the tab and the tongue so that they would not work loose again.

So now we had a full set of working tabs (about 164). Operating the General Cancel was not good though as the power supply did not have enough current capability to move all the tabs at once because the heavy magnet load dropped the output voltage so far that the control board simply stopped working. The loss of power also crashed the display, which did not recover even though the organ computer restarted automatically. If no more than two-thirds of the tabs were to be moved it all worked as intended. With a few more it would be marginal but a second press would finish the job. The reason for this is that the Classic system moves only those tabs needing to be moved. So if some had moved, there would be fewer to move the next time and the power supply could cope. The Classic system includes adjustments for sticky tabs whereby the system would re-energise tabs several times after a suitable delay and eventually get them all off. However, it was obvious that a beefier power supply was needed. The magnets measured 26 Ohms, which meant that some 80 Amps was necessary at 12 Volts, but only for a short time — a hefty power unit indeed. The one in use could supply only 50 Amps but would do for the time being. Large capacitors, typically 10,000 µF or more, could be added to the output rail to cater for short-term loads (if you did not make too many General Cancels in a short time). Use of a car battery on trickle charge would be an alternative but some means of quickly disconnecting it would be an absolute necessity in case of wiring shorts. It would also need some kind of overload protection and there would be no on/off switch. A battery would have another disadvantage too; it might be necessary to run the organ system at a lower voltage for better stop-magnet operation and that could not be done too easily.

The new power supply. 70 Amps regulated at 12V.

Meanwhile, the display was given its own d.c. power supply using a standard wall-adaptor and that solved its crashing problem. It introduced another one, though. Whenever the console music-rack light was switched, the display filled with random characters. The lamp used a transformer and a halogen bulb, so there was obviously a surge problem due mainly to high magnetizing current in its toroidal transformer (no air gap). The display characters would clear, though, if you did something that changed the display content. Nevertheless, it was a nuisance and had not occurred when the main power supply was used. The solution was to use power bars with independent anti-surge filters for the supplies and to increase the supply rail filter capacitor size on the display board.

The right side showing the fluorescent display, effects pistons in the cheeks and some of the control pistons on the piston rails. There is room for more stops.

Driving Hauptwerk

There were still a lot of odd little jobs to be done on the console, such as regluing parts of the decorative mouldings and cleaning up the paintwork, but it was now time to see if it could be made to drive anything. The software program was revised and various new routines added and checked out on the test set. As we were not sure how to tackle Hauptwerk in our software, we decided to use the sequencer MIDI output from the Classic system and configure Hauptwerk to accept keyboard and tab note-on/note-off messages. This was the only way to get MIDI outputs for keys without using MIDI for the tabs. MIDI is limited to 16 channels and there were far more stoptabs than that. With the sequencer output, each keyboard transmits note on/off messages on a particular channel assigned to that keyboard, some eight at most for this organ (Pedal first and second touches, Accompaniment first and second touch, Great first and second touch, Solo and Effects). Each channel would not send anything unless at least one of its tabs was on. At this stage we were not concerned with operating pistons or couplers, only in making something happen to evaluate the possibilities before the software was revised. The sequencer MIDI outputs comprise only note-on/note-off signals for keys and stops, and expression shoe data for each playable keyboard. No other controls output any MIDI messages. All inter- or intra-manual coupling is done within the organ system. Consequently, it would be necessary to use the couplers in the Hauptwerk organ. Since the console had three manuals and the Virginia WurliTzer had only two, that was going to be a limitation. Another major snag was that none of the console pistons could control anything in Hauptwerk since they did not produce any MIDI messages either. However, we were anxious to see how Hauptwerk worked and what it sounded like. It was not apparent before deciding to operate the program in this manner that while manually moving a tab on the console would move a tab on the screen, moving the same tab with a piston would not do so. Hence, no combinations would be possible.

Configuring Hauptwerk

Hauptwerk was installed on a fast Windows-type computer running XP-Pro with 2 G-Bytes of RAM (a maximum of 4 being possible) and this was connected up to the Sequencer MIDI output via a MIDI-to-USB converter. A multi-channel GigaPort™ sound module with USB input was added and connected up to a pair of amplifiers and self-powered speakers. Initially, only a stereo audio system was configured to see what would happen. The virtual organ was the Virginia Theatre WurliTzer. A problem was immediately clear — it took several minutes to load the organ and to make any changes also required a minute or two to become active. Nevertheless, the various configuration screens were invoked and everything set up to accept MIDI messages from the organ to make the console tabs operate their WurliTzer equivalents. Just a few entries were made to start with to see what would happen. This was not an easy task as there were a lot of items in the on-screen menus and some of the terminology was unusual and confusing.

A snag soon became apparent which was that only one console function could operate any one Hauptwerk function. It would not be possible to have the same Hauptwerk stop on two manuals. This meant that the console would not be able to use any more of its tabs than the original WurliTzer had. Hauptwerk is capable of being run on a unified rank basis rather than by individual tabs but this requires a lot of MIDI processing with a consequent speed bottleneck if you play too many notes at a time. However, that could be thought about later on. For the moment, none of the Solo stops were used and the Great division was used to control the Virginia WurliTzer Solo.

Success — some tentative pressing of tabs and keys caused organ-like sounds to play from the speakers but at a very low volume! There was no reverberation control and the samples were very dry — obviously recorded up close to the pipes.

Nothing seemed to be wrong with the amplifier system so we changed the filter board resistors for more gain and tried again. The increase was not enough so the values were changed again. This time all seemed well. Eventually, we discovered that there was a master volume control in the Hauptwerk program and it was set at only 50%. We could perhaps have saved ourselves some work had we found that earlier!

At this point, it was decided that a strictly-alphabetical listing of stop names and various controls was highly confusing as they were all mixed up in a non-logical manner with the most important words at the end of the names. Configuring the stops would take many hours to do for the whole organ as the name of every stop on the console had to be typed into the Hauptwerk configuration so that it could be linked to a Hauptwerk stop. Scrolling up and down through several hundred functions would be tedious to say the least as each one required some seven settings to be altered in pull-down lists. As all lists showed up in alphabetical order, all the console tab names were re-entered starting with three-digit numbers (using leading zeroes) followed by the division name to match my stop listing so that they could be found more easily as they would now be listed in the proper tab order by division. All possible spares were also included so that they could easily be assigned in the future. It would not matter that they were not assigned now.

Eventually, all the stoptabs that could be assigned were assigned. Rather surprisingly, though not totally unexpectedly, as most theatre organs are similar, there was a pretty good correlation between most of the console tab names and the Virginia WurliTzer tabs. Any WurliTzer tabs that did not appear on the console were assigned to other similar console tabs. As the whole virtual organ amounted to only about a half of the tabs on the console, the ones that had been assigned were marked with yellow stick-on dot labels. Some of the stops could not be assigned as they were in divisions such as second-touch. Although linked, these did not work and would have to be investigated later. There were many pitfalls in assigning all these stop names and they often resulted in stops that would not turn on or turn off due to having chosen the wrong command lines. This all had to be done while seated at the console and there was nowhere convenient to put the mouse and keyboard. The job was made a little easier by using a wireless keyboard and mouse but one developed a crick in the neck from looking up at the monitor all the time! A laptop computer would definitely have been better – if one could be found with enough horsepower to run Hauptwerk.

Effects

Next, our attention was turned to the effects pistons. These were quite spectacular when played via the mouse on the monitor screen. Unfortunately, they would do nothing from the console because they were not included in the CCC's MIDI sequencer output. They did, however, activate the General-MIDI sound card in the console and that produced sounds on its headphones output. This had been included as a matter of course before Hauptwerk was even considered, so that any of the 46 General MIDI percussion sounds on Channel-10 could be accessed via a patch system from the 12 keycheek effects pistons (and four toe pistons if they were to be installed at a future date). So any 16 of these effects could be used (in combinations, too, if diodes were used for the links). They were controlled via an extra Classic SIB-4 board driven as though it was another keyboard. In the software this had been set up so that it would not be affected by the transposer, otherwise the various sounds would all change if you changed the pitch. The effects keyboard had its own MIDI channel so could be recorded and played on an external sequencer as for any other keyboard. That was the original effects and traps scheme for the console and could still be employed in addition to Hauptwerk.

The organ software was changed to include the effects pistons as MIDI messages to Hauptwerk for when a proper driver had been created.

The six-channel audio amplifier and three of the six bi-amped speakers.

Audio

The audio system was explored more fully and a six-channel amplifier system installed driving six identical full-range speakers. Problems were discovered here because when the audio routing was made in Hauptwerk, it used three sets of stereo outputs. Each set provided a block of four adjacent notes in stereo for all octaves: C to D#, E to G and G# to B. This obviously required all six speakers to be identical and capable of rendering low bass notes as well as high frequencies. That was going to be expensive and require a lot of space. Perhaps some improvement could be made by changing the configuration to give six mono channels with only two adjacent notes each? It is possible to separate out some part of a keyboard to its own channel but that is not satisfactory as it would include high-pitched stops as well as low ones and would need to be done to all keyboards. What is needed is a six-channel audio mixer with a low-pass filter/amplifier driving a single woofer. The six normal channels would also need matching complementary high-pass filters to remove the low bass. Then these six identical speakers could be smaller and less expensive with less powerful amplifiers.

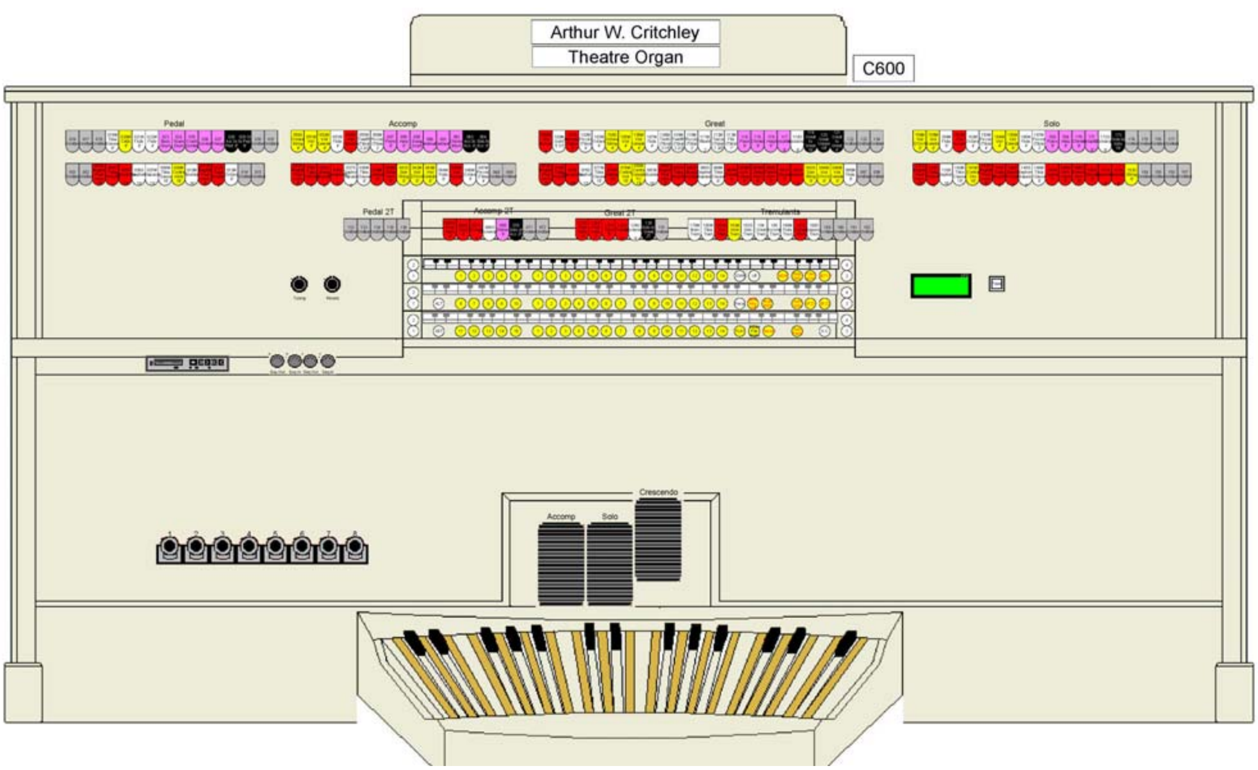
Another problem was that of a loud bang as the audio came on line from Hauptwerk. This is undoubtedly due to having unbalanced audio signals from the GIGAPort unit. The Classic amplifiers used had muting to prevent this at both turn-on and turn-off but they were fully operational long before Hauptwerk got going. The short-term answer was to switch the organ on only after Hauptwerk was operational and likewise to switch it off before turning off Hauptwerk.

One cute observation is that various non-tonal organs sounds such as blower noise, expression shade motors and stop-tab ‘thunks’ were to be heard as the organ was operated. They could be turned off in configuration windows but certainly add some realism.

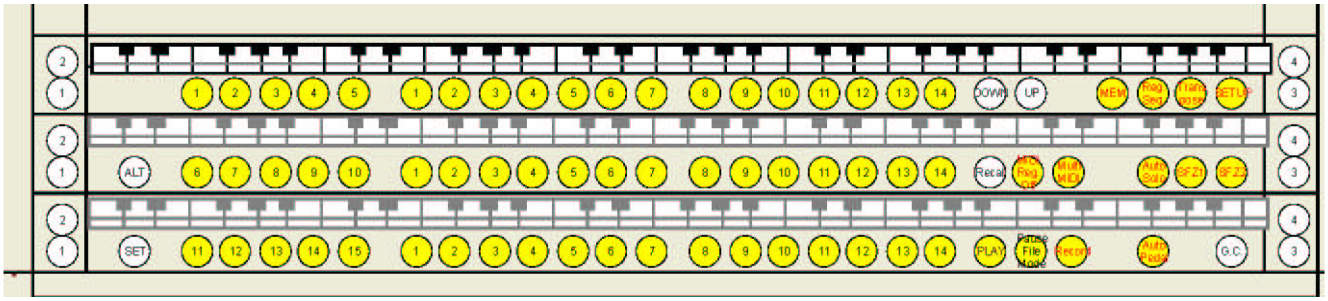
Despite all these shortcomings, the organ was demonstrated at the Open House and approved by all who heard it. The question of low bass and audio channeling could be left until more pressing problems had been solved with controlling Hauptwerk.

Speaker Cabinets

Only five of the ten speaker cabinets that came with the organ were in a decent working condition. The rest were suffering from disintegration of the foam plastic cone surrounds due to age and possibly high-volume use. The remaining five good ones were tested out and the two largest — obviously bass cabinets — were found to be completely lacking any bass. This seemed strange as they had fifteen-inch speakers but these were emitting only treble sounds while the tweeters were doing nothing at all. There had to be something wrong so one was opened up. It was immediately apparent that it had never been wired properly — despite there being clear markings on the cross-over filter board inside — such that the input signal went straight to the tweeter while the bass speaker was being fed via the series capacitor meant for the tweeter. The wiring was soon sorted out but the tweeter needed replacing having been burned out! However, the bass speaker seemed to be in good condition through lack of use. The second such cabinet was found to be exactly the same. Whoever had wired these cabinets obviously had no idea about speakers. Another cabinet was a high-frequency horn and that seemed to be alright. There was a Leslie cabinet that also seemed to be in reasonable condition. Since six identical speakers were required, none of these could be put to use for the moment, though the bass cabinets would eventually be useful although they were of a poor design bass-wise. They would only need to reproduce 16ft. tones — down to 32 Hz — as there was nothing lower on the organ and that should be well within their capabilities.



Diagrams from the OrganWorks file for this project.



Driver Software for Hauptwerk

Having established in principle that the Hauptwerk virtual organ was feasible and realistic, the console software now needed a major revision to include a proper driver routine so that the various Classic console features could be implemented properly. This was written and the various tab and control assignments completely redone in Hauptwerk. The effect of this software change was that the MIDI outputs now come out of the MIDI Expander jacks so that control messages, such as for effects pistons, could be sent as SysEx commands — almost everything that moved on the console would come out as a MIDI message of one kind or another. The keys sent note-on/note-off messages on MIDI channels appropriate to their divisions (1 to 7) while the tabs and the expression shoe (only one was used) sent Systems-Exclusive (SysEx) messages on Channel-16. At last, all the console couplers could be used while the combination pistons would work as they should to give combinations since these, together with the Crescendo shoe, operated entirely within the console software. Only their results on the tabs were sent out as tab changes on the SysEx channel.

But the effects pistons still did not operate the Hauptwerk effects even though they still operated the GS-MIDI effects via channel-8. A change was made to the Classic software to incorporate the effects pistons above the normal range of the key and stop numbers so that they would generate MIDI messages and that solved the problem. At last, the whole organ was playable like a real one.

However, while the effects pistons would then play Hauptwerk, they were not captured by the built-in sequencer. This is because the sequencer uses only data from keys, stops and expression shoes – not pistons. The pistons operate console functions and the results are what affect the tabs and hence what is recorded. The basic reason was that the number range of the keys, tabs and shoes does not extend to where the pistons are. Simply adding these extra numbers would exceed the design limits of the software. It could be done but might cause the whole organ to slow down. After some thought, it was decided to “borrow” some of the unused spare tabs and use these for effects pistons. The organ software was modified to activate these tab numbers when the pistons were pressed and the data shipped out as effects switches. Hauptwerk was reconfigured to suit and, Voila! The pistons played Hauptwerk directly and could be recorded and played back.

Many annoying problems remained. Probably some of these could be overcome by getting more familiar with the program while some may be due to the way that the Classic and Hauptwerk software operates.

Incidentally, there is no good reason why a similar driver routine should not be written for MidiTzer so that it could be used at the same time to double the quantity of ranks. Of course, a second computer would be necessary to run that program with the MIDI data looped through from one to the other as well as a second set of amplifiers and speakers. The actual tab outputs would be the same for both and if all possible tabs were sent out, the two virtual organs would recognise whichever ones they were assigned to. The various MidiTzer stops would be similar to those of Hauptwerk since both programs simulate 8-rank WurliTzers, but could probably be filtered to sound differently as they would be coming from different amplifiers and speakers. Indeed, the MidiTzer Solo division could possibly become the console Solo division while both programs would contribute to the other divisions.

The Classic software also has provision for driving Ahlborn Archive modules and the Viscount CM-100 add-on expanders. These could also be used in moderation (since they are for classical organs) for some of the more exotic stops. (After writing this, MidiTzer released a 3-manual, 19-rank WurliTzer virtual organ and Hauptwerk will soon have a 3-31.)

C600 Organ Problems

After having got the console to work like a real organ, the Hauptwerk program was explored more fully and version-2.10 was installed. Some things were noted:

1. Hauptwerk takes a lo-o-o-o-n-n-g… time to load up, even with a fast computer — typically two minutes after upgrading to version 2.10, but it used to be six minutes — as the organ definition is loaded into RAM. However, this is only after the initial power-up. Even so, after any configuration change a delay of several tens of seconds is needed. Putting the PC into standby mode at power-off would help. Maybe a solid-state drive would improve matters too.
2. Tedious to set up from scratch as there are many things to be configured.
3. For best results, there need to be at least six audio channels. But then we get each channel handling a block of keys (typically four) so that two channels should give stereo, then two more do the next four notes in stereo, while the next four notes are also in stereo. The sequence then repeats for similar keys. In this way, all the C-D# keys come from the same two speakers, etc., no matter which octave pitch and whatever the rank. However, mutation stops play from other keys out of the same speakers (5 1/3' and 2 2/3' play F-G#, 1 3/5' plays G#-B). This is costly if good bass is required as all audio channels must be identical, requiring matching full-range speakers and amplifiers. However, it is better than allocating certain ranks to particular speakers.
4. There was no separate output for low frequencies the way we had it configured but it is possible to allocate some keys to a different channel for part of a keyboard. This was not done.
5. A separate bass output system is required with all-channel mixing and low-pass filtering. Then only one expensive woofer is needed, all other speakers can be smaller (and cheaper) and easier to spread around. Bass sounds are not very directional so a single bass speaker will be sufficient.
6. The expression shoe works only if a stop tab is down. The Classic program does not send data unless a tab is on.
7. Replaying a Flash performance sometimes caused ciphers. They were not on the original recording and not on Flash when checked. They only appeared after the organ was powered down and later powered up. This was due to a software bug in the Classic console program.

Many earlier problems have been addressed in version 2.20+ of Hauptwerk while some due to Classic have been fixed. Version-3 promises to be even better. See the list of problems at the end of Part-5, Appendix.

I am grateful for approval to publish this series of articles and I acknowledge that several of the illustrations are taken from websites or documents created by Crumhorn Labs Ltd., Milan Digital Audio LLC and Presonus Audio Electronics Inc.

If you would like to know more about this project, contact Classic Organ Works at 905-475-1275 or 1-888-812-9717 and ask for me. Alternatively, and preferably, e-mail me at AWC@organworks.com or organawc@sympatico.ca