Introduction
This booklet was developed as a reference document for the enclosed two-disk set. The intent is to describe technical details for those using these disks, including historical information about the recording session and reference data for material contained on the disks. It is our sincere hope that the addition of this choral material to the library of anechoic material will assist, enlighten and inspire those who work in this field.

This anechoic recording project was undertaken after determining there was a lack of choral source material available for auralization. When initial discussions began at Wenger Corporation in late 2001, several challenges were identified: 1) Finding an accomplished choir willing to undertake the very challenging task of singing in an anechoic chamber; 2) Locating an anechoic chamber large enough to accommodate a group of 80 singers on risers; 3) Obtaining the necessary recording equipment to capture this event; and 4) Coordinating the overall logistics.
**Choir**

St. Olaf College in Northfield, Minnesota, was contacted due to their international reputation for strong choral music programs, including eight official ensembles. Initial discussions were held in fall of 2002 and Dr. John Ferguson and his 80-member St. Olaf Cantorei were selected based on the group's mixed arrangement of men and women. Instead of the traditional Soprano-Alto-Tenor-Bass configuration, Cantorei members are "scrambled" in small groups of sopranos, altos, tenors, basses which leads to greater proximity for the hearing of all parts. It was thought that this arrangement of singers would provide a greater level of aural support, an important consideration when singing in an anechoic chamber.

While such a large choir was more challenging to record – compared to a vocal quartet, for example – it more closely approximated a typical, real-life choral concert.

Dr. Ferguson is a nationally recognized church musician and teacher, with a large number of published organ and choral compositions. His choral work *Who Is This?* was one of the six songs performed in the anechoic chamber.

After many discussions and a site visit to the anechoic chamber, it was decided that Cantorei members would not use electroacoustic support (headphones). Instead, to prepare for this unsupportive acoustical environment, the choir rehearsed outdoors on the St. Olaf campus, away from buildings and other objects that would provide reflections.
Anechoic Chamber
3M in St. Paul, Minnesota, was contacted because they have a large anechoic chamber and a reputable acoustics laboratory. Wenger had previously conducted some product research in this chamber. It was constructed as a concrete "building within a building" for optimal sound isolation.

The chamber and nearby reverberation rooms are now used to support research, material and application development for Thinsulate™ Acoustic Insulation and 3M's worldwide acoustic businesses. 3M generously donated the use of these facilities, along with support personnel to assist the project.

The inside of the anechoic chamber measures 25 ft (7.6 m) wide, by 30 ft. (9.1 m) long, by 20 ft. (6.1 m) high with a suspended grid 5 ft (1.5 m) above the absorptive wedge floor. The fiberglass wedges providing internal absorption in the room are 36 inches (91 cm) in depth. One unique feature of the chamber is a curved "track" installed at grid level, enabling heavy items to be rolled out into the chamber. The center part of this track is 36 inches (91 cm) wide, with 10 inches (25 cm) of grid spillway on either side. The remainder of the "floor" is comprised of the suspended wire system.

The track was judged capable of supporting the 80-member choir and risers – an estimated total weight of 6.5 tons (5,966 kg.) Six Wenger Signature® 3-step choral risers were used during the recording.

Recording Equipment
Selection of equipment was driven by the desire to capture as much information – of the highest quality – as possible. The session was captured on 24 tracks of 24-bit digital audiotape, using a wide variety of microphone configurations. These ranged from matched pair omni-directional microphones to shotgun microphones; a more detailed equipment list is found later in this booklet. All microphones were mounted on an 8-foot (244 cm) bar suspended from the chamber's ceiling.

The "control room" for the session was directly adjacent to the chamber, in a reverberant room that had been converted by the addition of a substantial amount of Thinsulate to the wall surfaces. Only monitoring was conducted in this room. All tracks were recorded directly from the microphones through a preamplifier directly to the 24-track recorder. To support the technical activities, engineers from Minnesota Public Radio's Studio M were contracted for setup, recording and post-production assistance.
Logistics
Preparation and coordination efforts were extensive. Necessary recording equipment was rented from a firm in New York City and Studio M. Bus service was arranged for transporting the choir to and from the 3M facility.

The Recording
The recording session took place on the afternoon of October 21, 2003, and lasted approximately 90 minutes. It was decided beforehand that overdubs and insert recordings would not be done, in the interest of time and trying to capture as much material as possible. A video link and talkback system enabled communication between the chamber and control room.

The choir did an outstanding job during the challenging recording session. Ventilation to the chamber was cut to reduce the background noise during recording. Eventually, this led to warm temperatures in the chamber. Ventilation was later switched on during song breaks to help reduce the heat.

Originally the recording had been scheduled for two sessions (afternoon and evening) but as the first session progressed, it was decided that enough high-quality material was being captured, making the second session unnecessary.

As soon as the choir left the anechoic chamber, a dodecahedron speaker was set up on the middle step of the center-most riser, as close as possible to where the center of the choir had been located. This spot was 13 feet (4 m) from the microphone array. A 60-second section of pink noise was recorded on all 24 tracks. The SPL at the microphone array was measured using a Larson-Davis 2900B Analyzer. Information from the analyzer is presented on the back cover of this guide and included in a .pdf file on the DVD.
Post-Production
It was decided that the information from the recording session would be presented in two formats: 1) Audio CD for real-time convolution utilizing equipment such as Lake Technology's family of convolvers; 2) DVD to store the digital data from the 24 track recordings in .wav file format for use with various acoustic auralization programs.

From the 24 tracks at the recording session, six tracks were not usable due to microphone problems with the Neumann SM69 and Calrec Soundfield microphones.

After the recording, microphone sets were auditioned at MPR's Studio M, which offered a better critical-listening environment than 3M's reverberant chamber. Three microphone sets were selected as providing the best results when using real-time convolvers or post-processing convolutions. These three sets were included on the audio CD. The main differences were in the apparent stereo image width, which translated somewhat differently in the auralization process. Endings were also selected from these same microphone sets. Finally, the pink noise reference tracks for these three mic sets were also included on the audio CD.

The DVD includes all usable microphone tracks from the recording session. A list of the microphone sets and tracks is included later in this booklet. Included in the microphone selection were four "shotgun" microphones for experimentation when used as multiple sources in auralization programs in an attempt to create a "wider" source, which a typical choir would represent aurally.
Anechoic Choral Recordings
Song List

- Beati Quorum Via - Charles Villiers Stanford (1852-1924)
- Alleluia - Randal Thompson (1899-1984)
- Almighty and Everlasting God - Orlando Gibbons (1532-1625)
- Who Is This? - John Ferguson (b. 1941), assisted by Professor Charles Gray, viola
- Psalm 150 - Ernani Aguiar (b. 1950)
- Kyrie from Missa Brevis #4 - Healy Willan (1880-1968), sung in alternation with chanted hymn, DIVINUM MYSTERIUM, "Of the Father's Love Begotten" (with hand bells)
Recording Equipment

Microphones & Methods
- DPA 4003 matched pair of omni directional microphones (130V); A-B spaced pair, 24 inches (61 cm)
- B&K 4007 pair of omni directional microphones (48V); A-B spaced pair, 36 inches (91 cm)
- Neumann KM140 pair of cardioid directional microphones; ORTF method
- Schoeps CMC5 - MK5 pair of cardioid directional microphones; ORTF method
- B&K 4011 pair of cardioid directional microphones; A-B spaced pair, 48 inches (122 cm)
- Neumann KM184 pair of cardioid directional microphones; A-B spaced pair, 24 inches (61 cm)
- Audio Technica AT4073A set of four "shotgun" cardioid microphones; one pair at spaced at 36 inches (91 cm), the other pair spaced at 90 inches (229 cm); each microphone aimed at ¼ of the choral group
- Schoeps X/Y CMXY cardioid stereo microphone; XY method at 90 degrees
  - Neumann SM69; XY method (not used during the recording)
  - Calrec Soundfield MKIV microphone; ambisonic method (not used during the recording)

Preamps
- 3 - Millennia Media HV-3D 8 channel preamps

Recording Decks
- 3 - Tascam DA98HR 8 Track/24 bit digital recorders

Monitoring
- Genelec Model 1030A near field monitors
- Soundcraft Spirit M Series and FX16 mixers
Post-Production
Studio M at Minnesota Public Radio (MPR)

**Monitoring**
- Genelec S30D monitors
- Genelec 1030A near field monitors
- Genelec 7071 subwoofer
- Neve V1 Series Console 36x36x36.

**Editing**
- ProTools
- Tascam DA78

**Mastering**
- Digidesign 192 HD (24 bit/44.1kHz)
- Audio CD - 16 bit, 44.1kHz
- MasterList
- Data DVD - 16 bit, 44.1 kHz and 24 bit, 44.1 kHz (.wav file format)
- Titanium Toast
Credits

3M
John Alexander - Product Manager
Linda Bellows - Senior Administrator Assistant
Debra Breister - Corporate Technical Aid
Ron Gerdes - Design Engineer Specialist
Greg Meyer - Senior Technologist
Richard Pieper - Technical Service Specialist

St. Olaf College
Dr. John Ferguson, Director of the St. Olaf College Cantorei
Professor Charles Gray, Violist
Jeffrey O’Donnell, Production Assistant

Wenger Corporation
Ron Freiheit - Director of Design Engineering
Dann Rypka - Technical Support Manager
Kathy Peterson, Dave Hamer, Bob Hrdlichka and Jerome Spindler

Additional Assistance
Tom Mudge - Recording Engineering; Studio M, MPR
Craig Thorson - Recording Engineer; Studio M, MPR
Steve Barbar - LARES Associates
Warren Djerf - Public Relations; Brookside Communications
Melanie Shaw - Dreamhire NYC
Audio CD Quick Start Information

The anechoically recorded tracks were all recorded at the same relative level with no adjustments made during the recording process. All songs were recorded as a single take with no overdubs or intercuts. A list of the song titles and times are located on page 15.

❑ The Audio CD contains:
  o 6 choral songs recorded anechoically with three different microphone techniques
    • ORTF\(^1\) (T1-T6)
    • A-B\(^2\) (T7-T12)
    • XY\(^3\) (T13-T18)
  o Same 6 choral songs recorded anechoically with three different microphone techniques (endings only)
    • ORTF (T19-T24)
    • A-B (T25-T30)
    • XY (T31-T36)
  o 3 Pink Noise Reference\(^4\) Tracks anechoically recorded with three different microphone techniques
    • ORTF (T37)
    • A-B (T38)
    • XY (T39)

\(^1\) ORTF Microphone method: Near-coincident pair of cardioid microphones angled at 110 degrees part, spaced apart 7 inches (17cm) horizontally. ORTF stands for Office de Radio diffusion Television Françoise-French Broadcasting.

\(^2\) A-B Microphone method: Spaced pair of matched omni directional microphones 24 inches (61 cm) apart.

\(^3\) XY Microphone method: Coincident pair of cardioid microphones mounted next to each other set in a 90 degree angle from each other.

\(^4\) Reference level @ 4.0 meters from the microphone(s); 60.8 dB @ 1kHz, dodecahedron located on the center riser, middle step.
Audio CD Song List

- Beati Quorum Via - Charles Villiers Stanford (1852-1924)
  Time: song 2:53, ending 00:44

- Alleluia - Randal Thompson (1899-1984) Time: 4:27, ending 00:47

- Almighty and Everlasting God - Orlando Gibbons (1532-1625)
  Time: song 1:44, ending 00:47

- Who Is This? - John Ferguson (b. 1941), assisted by Professor Charles Gray, viola.
  Time: song 4:19, ending 00:41

- Psalm 150 - Ernani Aguiar (b. 1950) Time: song 2:00, ending 00:26

- Kyrie from Missa Brevis #4 - Healy Willan (1880-1968), sung in alternation with chanted hymn, DIVINUM MYSTERIUM, "Of the Father's Love Begotten"
  Time: song 3:11, ending 00:35
### Audio CD Track List

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Data DVD Quick Start Information

The anechoically recorded tracks were all recorded at the same relative level with no adjustments made during the recording process. All songs were recorded as a single take with no overdubs or intercuts.

The DVD contains both 16 bit and 24 bit .wav file formats at 44.1kHz sampling rate. Each file is a mono .wav format allowing for user mixing and editing of the raw audio tracks as desired. It also supports those programs that allow for multiple source files as part the convolution process. A list of the file titles appears in the DVD.

It is suggested that the selected data files for use first be copied to your local hard drive for best performance during playback. Not all computer-based DVD players will support high quality, real-time playback of the files directly from the DVD disk.

- The DVD contains:
  - 126 files, 16 bit 44.1kHz .wav formats for all songs
  - 126 files, 24 bit 44.1kHz .wav formats for all songs
  - For each song: individual mono files for Right and Left channels for each of the following microphones:
    - DPA 4003 matched pair of omni directional microphones
    - B&K 4007 pair of omni directional microphones
    - Neumann KM140 pair of cardioid directional microphones
    - Schoeps CMC5 - MK5 pair of cardioid directional microphones
    - B&K 4011 pair of cardioid directional microphones
    - Neumann KM184 pair of cardioid directional microphones
    - Audio Technica AT4073A set of four "shotgun" cardioid microphones
    - Schoeps X/Y CMXY cardioid stereo microphone
  - Pink Noise Reference files anechoically recorded with each microphone selection.
  - PDF file with the Pink Noise Reference information.

1 A-B Microphone method: Spaced pairs of microphones the indicated distance apart.
2 ORTF Microphone method: Near-coincident pair of cardioid microphones angled at 110 degrees part, spaced apart 7 inches (17cm) horizontally. ORTF stands for Office de Radio diffusion Television Françoise-French Broadcasting.
3 XY Microphone method: Coincident pair of cardioid microphones mounted next to each other set in a 90 degree angle from each other.
4 Reference level @ 4.0 meters from the microphone(s); 60.8 dB @ 1kHz, dodecahedron located on the center riser, middle step.
Data DVD File Format

The file title format for the data files on the DVD is in the following sequence: title, microphone method, microphone model, bit resolution, channel and file type.


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**LARSON-DAVIS**

**Date and Time:** 18 DEC 03 15:44  
**Data Type:** SPI spectra  
**Recalled from file:** 3M, record: 1

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