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EDITORIAL

< What's in this issue? >

In this issue, Caleb Stuart contributes our main feature, an article on Yasunao Tone. Caleb Stuart is a doctoral candidate, who is also involved in the "What is Music?" experimental music festival. Caleb Stuart's article features award-winning composer Yasunao Tone, and his work with sound-production systems. Online, the article is accompanied by digital audio examples of Tone's work to download.

In 2002 Yasunao Tone received the Golden Nica for Digital Musics at the Ars Electronica Awards for Man'Yo Wounded 2001. The award honours his seminal role in contemporary composition and as a composer involved in the avant garde arts in Tokyo in the 1960s and in America after relocating in 1972. Tone's work combines contemporary digital music with the historical avant garde.

Whilst his use of indeterminate techniques date back to the early 1960s, Tone is also firmly placed at the forefront of the current interest in glitches, cracks and unstable systems for sound production, all of which use a measure of indeterminacy and chance. Yasunao Tone was at the centre of the Tokyo Fluxus movement in the 1960s and had close links originally through Group Ongaku with Fluxus artists including Toshi Ichianagi, Takehisa Kosugi, Nam June Paik, Yoko Ono, as well as composers such as John Cage and David Tudor. Tone's compositions while harsh in their intensity and volume are also compelling in their radical use of indeterminacy to generate unexpected outcomes.

Also in this edition, Leonardo Digital Reviews Editor in Chief, Michael Punt highlights a surprising review article by Harry Rand. A long-standing and highly valued contributor to LDR, Harry Rand reviews an unusual choice of book to inform us about technology and art.

FEATURE

< Yasunao Tone's Wounded and Skipping Compact Discs: From Improvisation and Indeterminate Composition to Glitching CDs >

by Caleb Stuart, <caleb@laudible.net>.

< Ed Note: Listen to Tone's audio online in MP3 format >

Technical Note: Some English transliterations of Japanese words use macrons (a straight horizontal line above a letter (`). Since such formatting is lost in text-only coding, we have indicated letters that should have macrons over them with an asterisk following each appropriate letter in a word (e.g. "Shu*ko*"). This is not to be confused with the asterisks preceding and following the title of a work (e.g. *Water Music*), which indicate italicization of that title. - Ed.

The Prix Ars Electronica was inaugurated in 1987 as an award for digital innovation in the arts. The Austrian award was originally divided into three categories: Two-Dimensional Graphics, Computer Animation and Computer Music. Changes have since been made to keep abreast with innovation in the various fields. In 1997, the Computer Music category came under fire for being out of step with digital technology and sound, academic computer music no longer being held as cutting edge [1]. Consequently, the competition was opened to include music created on computers from outside of universities. Music technology had progressed quickly and the possibilities for new music creation had expanded while the range of music being explored by academic computer musicians had become fixed and rigid. In 1999, the award changed the name of the category from "Computer Music" to "Digital Musics." This name was meant to include a wider range of possible entries for

the award, and the jury was filled with current practitioners in the audio arts, as opposed to only academics.

In 2000, Yasunao Tone received an honorary mention in the Prix Ars Electronica for the work *Wounded Man'yo 2/2000,* and in 2002 he received the Golden Nica for Digital Musics at the Ars Electronica Awards for *Man'Yo Wounded 2001.* The award honors his seminal role in contemporary composition and as a composer involved in the avant-garde arts in Tokyo in the 1960s and in America after relocating in 1972. Tone's work links contemporary digital music with the historical avant-garde. While his use of indeterminate techniques dates back to the early 1960s, Tone is also firmly placed at the forefront of the current interest in glitches, cracks and unstable systems for sound production, all of which use a measure of indeterminacy and chance.

The work *Man'Yo Wounded 2001* was created on a number of levels of composition and production, all of which utilize indeterminate techniques. Tone uses layers of structured chance in the composition, ending the process with a technique that he calls "wounded CDs." The technique prepares the CDs in such a way as to cause them to radically skip, jump and stutter through the playback. Tone has employed wounded CDs since 1985 and they have become a signature approach for the composer.

Born 31 March 1935, Tone studied at the national Chiba University in Japan, but did not study music. He recalls:

"I simply sat some classes of musicology in the Tokyo Art College. I started playing alto saxophone first, and other instruments that belonged to the ethnomusicology department. I studied literature and wrote a graduate thesis on Dada and Surrealism in my college . . ." [2]

Tone was a founding member of Group Ongaku, along with Takehisa Kosugi, Shu*ko* Mizuno, and Mieko Shiomi [3]. Group Ongaku was founded in August 1960 as an improvisational music unit, although they had been playing together before this date. Mizuno was a classmate from Chiba University and introduced Tone to Kosugi after they graduated. Kosugi and Mizuno asked Tone to join their duo, although he did not know how to play any instruments. This was not a problem for Kosugi, who sold Tone his alto saxophone; Tone bought a textbook on how to play sax and started from there. During this time, while the Tokyo National University of Fine Arts and Music was a conservative university, a small number of students involved in the art and ethnomusicology departments are of particular interest. The composition and ethnomusicology group met regularly for improvisational sessions. Tone describes these sessions:

"We played together in the ethnomusicology department studio. We found many ethnic musical instruments as well as Western musical instruments. Before long, we realized we were playing any instruments we could touch. That extended to any objects that made sound. . . We were recognized as vanguards of contemporary music by musical journalism and we had very good responses from visual artists. . ." [4]

The first group concert by Group Ongaku was entitled "Improvisation and Objet Sonore" and was held at S>getsu Hall, in Tokyo, on 15 September 1961 [5]. The performance was the group's first formal outing, though they had previously played impromptu concerts at such places as the Tokyo Pier, in a car driving down the freeway, and often at friends' houses. These performances can

be heard as some of the first instances of what we now call free improvisation.

The debut was to be Group Ongaku's first and only public performance as a collective, due to a disagreement about presentation. Kosugi and Tone wanted to run all the pieces together, creating a performance in which pieces overlapped, the beginnings and endings to be lost somewhere in between. A compromise was sought and the pieces were played separately, although some were played off-stage, in the hall-way and the aisles. The performance was described by Tone as "a rumble of sounds, leftover sounds, actions, water, bells, glasses, blowing [6]."

The name Group Ongaku literally means "Group Music," the paradox being that what they were creating might not be heard as music at all; that is, they were trying to produce "anti-music." At the time, the Japanese avant-garde was waging a war against art, commercialism and the Americanization of Japan. The artists involved in this protest took part in an institutional critique of the arts using forms of intermedia, happenings and conceptualism, questioning the notions of art and creativity [7]. Reiko Tomii comments on the generation of Anti-Art practitioners that emerged in the late 1950s and early 1960s:

"In retrospect, the label of Anti-Art, which originated in an art critic's off-hand remark that instantly entered the art lexicon, aptly points to what was fundamentally at issue: Art, with a capital A. That is to say, the goal of Anti-Art was to question and dismantle Art (geijutsu) as a cultural and metaphysical construct of modern times" [8].

Tone was at the center of this movement as a musician, composer, writer and collaborator.

Japan - especially Tokyo - was a hive of artistic activity in the 1960s, with various branches of contemporary and avant-garde practice connected with movements in Europe and America. As Alexandra Munroe writes:

"The correspondence of thought and attitude among Euro-American and Japanese artists in the 1960s was no coincidence. The activities of both groups represented an interest in early twentieth-century anarcho-cultural sensibilities, specifically Dada. In Japan as elsewhere, this legacy taught outrage against the staid idealism of bourgeois culture and prompted the defiant pursuit of an aesthetic of negation of art: negation of art as an illusion rather than presentation of reality: and negation of the boundaries between object and action, word and image, art and life" [9].

The influence of composer/performer Toshi Ichiyanagi was significant to Tone's development. Ichiyanagi was well versed in the various theories that were to constitute Fluxus, and especially Cagean theory. Ichiyanagi had studied at the Juilliard School in New York between 1954 and 1957 and attended John Cage's classes at the New York School for Social Research in 1959. This workshop ran between 1956 and 1960, and many of the artists who were to be associated with Fluxus attended. At this time, Ichiyanagi and his wife Yoko Ono were regulars in Cage's circle [10]. Ichiyanagi returned to Tokyo in the summer of 1961, bringing with him current ideas from America and encouraging Tone and the group in their method of composition.

1961 is seen as a watershed for experimental music in Japan. The year witnessed an "emergence of an overflowing experimental spirit," according to Ichiyanagi [11]. Several experimental music events occurred, firstly a music festival organized by the 20th Century Music Institute and led by Hidekazu Yoshida. The festival included work by John Cage, Morton Feldman, Earle Brown, Christian Wolff, Stefan Wolpe and Ichiyanagi. Ichiyanagi recalls that the "festival created a sensation, as it was the first encounter by Japanese audiences with accidental or indeterminate music" [12]. In September, Group Ongaku performed and, in October, Yu*ji Takahashi performed John Cage's *Water Music* in its entire 90-minute form, a Japanese premiere. In November, Ichiyanagi performed Japan's first electronic music happening.

The musicians involved in Group Ongaku formed part of what was later called Tokyo Fluxus. Ichiyanagi had returned with a mission from Fluxus leader George Maciunas to organize Japanese musicians for a Tokyo-based Fluxus group and Fluxus ideals fit well with the then current trend towards anti-art [13]. Tone has said that Fluxus:

" . . . didn't try to make art, but to abolish the boundary between art and life. So we made everything no-art-art. Artists made calculations, or slept for a while . . . washing your face, everything could be art" [14].

Other members of the Fluxus movement spent time in Tokyo in the early 1960s. These included Nam June Paik, who was there from 1963 to 1964. While there, he performed his recent compositions, which had earned him notoriety in Germany. Paik spent time with the members of Group Ongaku and it seems they shared a common interest in the use of all media towards a musical practice. Yoko Ono had also spent time there earlier, and she returned in March 1962. It was at the time of Ono's stay that the Japanese Fluxus artists began to exhibit in Fluxus performances and publications. For Tone, this included having *Anagram for Strings* performed in the Fluxus Festival in Copenhagen and other tape music played in various Fluxus festivals in Paris, Dusseldorf and Wiesbaden, between November and December 1962. In September 1965, Tone co-organized "The Fluxus Week, A Tokyo Fluxus festival," with Toshi Ichiyanagi and Kuniharu Akiyama.

Tone's first solo concert was held 3 February 1962, and was comprised of 15 pieces, which had all been written in less than two months. He recounts:

"I didn't like the concert hall situation and I was hoping to use the space of Minami Gallery . . . Then, the gallery was moving next door and old space was still available, but the gallery owner Kusuo Shimizu wanted me to have a concert for the grand opening of the new space. I persuaded him to use the old space, where I found the floor had wall-to-wall straw carpet, so I could have the audience sit on the floor, not on chairs [15]."

The show ran for five hours, from 5:30 pm to 10:30 pm. During the concert, many of the pieces overlapped as members of Group Ongaku performed Tone's pieces along with Yuji Takahashi, who played *Music for Reed Organ* and Toshi Ichiyanagi, who played *Door.*

Tone also made use of computer technology from very early on, co-organizing Biocode Process, Japan's first computer art festival, in April 1966. Tone was part of the group Team Random. He premiered two pieces for the festival, *Theater Piece for Computer* and *Signal.*

Tone had been offered the use of a Univac computer, housed in the Urban Design department of the national University of Tokyo. The use of a computer was vastly different from the early group improvisations. Musicians in the earlier events were free to play how they desired and sound was immediately emitted. These early computers, however, took hours to calculate a few notes and engineers had to be employed to actually write the code and programs for Tone:

" . . . There was no such thing as improvisation with computer. We were talking about on-line performance as a dream. Some people wrote a program and left it for the engineer and [the] next day he would get the result. . . . People involved with that kind of music believed a machine like [a] computer could make art in place of humans But I'd have liked to make music (or anti-music, more precisely) that nobody had made before with only a computer" [16].

Throughout the 1960s, Tone was involved in a range of activities centered in avant-garde practice. His own intermedia practice encompassed composition, performance, event-based work, theater, dance and criticism. Tone arrived in New York in June 1972 and continues to be active in the arts scene. He has composed a number of pieces utilizing indeterminate techniques for the Merce Cunningham Dance Company, including *Geography and Music,* which was performed with the dance work *Roadrunner.*

Tone's work since the 1960s has focused on exploring various methods of composition that introduce random events and indeterminate compositional techniques. His score for *Anagram for Strings* (1962), for example, asks performers to draw a line that intersects with various circles; on the intersection, the performer is asked to play different downward glissandos. *Geodesy for Piano* (1962) asks performers to place an acetate sheet with lines over a topographical map and work out various heights, angles and positions from which to drop objects from a ladder onto the strings of a piano [17]; in *Molecular Music* (1983), the performers fix photosensitive detectors to a wall and project characters and photographs onto the wall, the detectors being in turn connected to oscillators; *Paramedia Music* (1990) directs performers to record the phone numbers of various people in the audience of a concert, then call them and use the voice messages on their answering machines as the audio source. These works point to Tone's interest in the boundaries of systems and their various outcomes, and how these can be used to create compositions.

In 1984, Tone came across a method that he thought could be used to cause discrepancy in the playback of the then very new CD technology. While working on a composition, Tone read a book entitled *Science Seminar for the Familia,* where a chapter on digital recording included this paragraph:

"Digital recording is a wonderful audio technique, since it has almost no noise and produces sound very faithful to the original. However, when it misreads 1 with 0, it makes very strange sounds due to the binary code becoming a totally different numerical value" [18].

This passage exemplified the emphasis that was placed on the lack of noise in digital recording technology. It hinted, however, that the new technology could be used to make noise by overriding

the error correction system. Tone recounts:

"I called my audiophile friend, who owned a Swiss-made CD player, and asked about it. It was a simpler method than I suspected. I bought a copy of Debussy's *Preludes* and brought it to my friend's place. By his engineer friend's suggestion, we simply made many pinholes on bits of Scotch tape and stuck it on the bottom of a CD. I had many trials and errors. I was pleased [with] the result, because the CD player behaved frantically and out of control. That was a perfect device for performance" [19].

The result changed the pitch, timbre, rhythm and speed of the piece. The CDs also produced a 'stuttering' that was different each time the disc was played. The stuttering CD extended the possibilities of performance in a number of ways: Tone's skips push the functionality of the system to the extreme, the mechanism jumping around the disc and playing random sections in a confused manner. The sounds produced by the effected discs are never quite the same. This means that in performance, the performer has no clear idea of what is going to happen, making such things as scoring very difficult. Tone commented: "Playing Prepared CDs according to the score was like advancing in a maze where ambush was everywhere, and that made the performance situation all the more interesting" [20]. Tone literally banged the player with his hand to jump it from one glitch to the next - just where it would stop and on which sound it would stutter could not be known from one playing to the next. At the first performances of this piece, it is quite conceivable that many in the audience had never actually seen a CD player and yet, here was a composer pushing it to the point of breakdown, causing it to stutter and skip madly and loudly.

Here lies the indeterminacy of the piece. It is not completely random, as it is still working within a system designed by Tone, but the outcome is not fixed and the precise manner in which the CD player will handle the wounded CD cannot be guessed. The technique has been extremely productive for Tone, who has used it from 1985 through to the present day. He has said:

"A new technology, a new medium, appears, and the artist usually enlarges the use of the technology . . . Deviates . . . The manufacturers always force us to use a product their way . . . however, people occasionally find a way to deviate from the original purpose of the medium and develop a totally new field" [21].

Thus, one year after CD technology was released in America, Tone figured out a way to override the error correction system and the mechanism designed to allow seamless playback was forced to glitch [22]. The idea of a playback technology that could play pure clean audio was displaced by Tone's noisy, glitching CDs. The silence of digital audio was made to produce noise; the purity of the new medium was damaged and the technical imperfection was utilized as a performance tool to create an outburst of abstract audio.

When Tone was first approached to release a CD of his music, he believed that none of his pieces were appropriate for release. Due to the indeterminate nature of his compositions, he had little interest in releasing recordings of such performances. Tone is well aware of Cage's approach to the recording medium and issues both around live and recorded performance, as well as those raised by the reproductive process of recording and its static repetition. Like Cage, he is more interested in the live

performance, or the one-off, than in the recording of the event. As Cage wrote:

"A performance of a composition that is indeterminate of its performance is necessarily unique. It cannot be repeated. When performed for a second time, the outcome is other than it was . . . A recording of such a work has no more value than a postcard; it provides a knowledge of something that happened, whereas the action was a non-knowledge of something that has not yet happened [23] .

Tone's answer to this dilemma was to make a piece that could not be played live and was totally predicated on the CD release for its realization. *Musica Iconologos* (Lovely Music, 1993) is Tone's first released work, a composition comprised of computer-generated snippets of noise. *Musica Iconologos* is described by Craig Kendall, in the liner notes to the release, as "one of the most extreme and original applications of the current digital recording medium" [24] . For the piece, Tone turned the characters of the Chinese poems *Jiao Liao Fruits* and *Solar Eclipse in October* into sonic analogs. The piece was created from scanned images of Chinese characters and photographs, which Tone thought represented the script. 187 scans were run through an "optical music recognition" program and the sound files produced were treated digitally, with no personal judgement used to exclude or repeat any of the audio. The outcome is extreme noise, the piece moving through the characters in brief bursts of digital audio. Tone states that this CD did not exist as music until it was mastered, so that the production of the CD was part of the work's process:

"The result was noise in all senses . . . when you play that CD, what you receive is not images as message, but sound which is simply an excess . . . [one of] the French word[s] for noise, "parasite," indicates [that] it is parasitic on a host Ð that is, message. But, in this case there is no host, only parasite on the CD. Therefore this CD is pure noise" [25] .

Musica Iconologos created a problem in itself, as the piece existed solely in the digital recording process and could not be played live. Tone, although mostly interested in live performance practice, had created a major work that could not be played live in a way that interested him. His answer to this problem lay in his use of the wounded CD - he took copies of the *Musica Iconologos* CD and prepared them with scotch tape, performing the piece with CD players. The work was radically re-mixed as it stuttered, skipped and jammed throughout the performance - the piece now held the conditions that interested Tone in performance, those of indeterminacy and chance. Tone had set up the conditions for the piece, that is, prepared the CDs, and then let them loose in the playback equipment. In this sense, the piece is indeterminate as Tone does not have final control of the outcome of the performance, only on its limits. He has, however, released a recording of a performance of the piece, entitled *Solo for Wounded CD* (Tzadik, 1995) [26] . This is a remix of his original computer-generated noise through the stuttering of the damaged and modified CD. In this case, Tone sees the release as simply a documentation of a performance [27] .

Tone's technique of re-mixing and re-working his releases was also used in a 2000 work entitled *Wounded Man' yo 2/2000.* The work, which won him an honorary mention at the 2000 Prix Ars Electronica, is based on his CD-ROM *Musica Simulacra* [28] . *Musica Simulacra* is made in similar fashion to *Musica

Iconologos.* The software Projector was used to scan images formed by Tone to relate to the text *Man'yo-shu* (this text, a collection of some 4,500 poems compiled in the eighth century, is the oldest anthology of poetry from Japan). For *Wounded Man'yo 2/2000,* Tone recorded a number of CD-ROMs from the original CD-ROM of *Musica Simulacra.* He then "wounded" the CD-ROM copies and used the prepared discs in performance [29]. At this point, then, the final recordings had gone through many levels of indeterminacy.

Tone has been involved in contemporary compositional practice since the early 1960s, and his methods have much in common with contemporary digital music practices, as evidenced by his Golden Nica award. We can also see commonalities with experimental sound practices in such sub-genres as "Glitch" or "Microsound" [30], which use glitches and cracks in digital media to produce a new aesthetic in music. As these approaches have developed, many of the indeterminate features of the style have been lost as sounds become sampled and sequenced, the risk and chance lost in a perpetual loop. Tone, however, has never stopped using indeterminate techniques and his development of the "wounded CD" technique has been an extremely productive approach in his later compositions.

REFERENCES AND NOTES

1. Christine Schoepf, e-mail correspondence with author, 28 June 2000.
2. Yasunao Tone, from a transcript for an interview published in *Revue & Corrige,* no.46 (2001). Note all quotes from this interview come from the original English transcript, which was then translated into French for publication.
3. An archival CD of Group Ongaku, entitled *Music of Group Ongaku* (Hear 002), was released in 1996. The CD includes two recordings of performances on 8 May, 1960 at Mizuno's house and 15 September, 1961 at Sogetsu Hall. Mikio Tojima, Yumiko Tanno and Genichi Tsuge were also involved in Group Ongaku activities.
4. Yasunao Tone, *Revue & Corrige.*
5. Yasunao Tone refers to the evening as "Improvisation and Objet Sonore" in his resume, but in the above interview calls it "Concert of Sound Object and Improvisational Music." It is important to note here that the word "objet" is a French-derived term and encompasses, in the Japanese art world, both "readymade and found objects" and "object-based work, such as combine, assemblage and junk art." See Reiko Tomii, "Concerning the Institution of Art: Conceptualism in Japan," *Global Conceptualism: Points of Origin, 1950s-1980s* (New York: Queens Museum of Art, 1999), p. 19 and endnote no. 35.
6. Yasunao Tone, quoted in Alexandra Munroe, "A Box of Smile: Tokyo Fluxus, Conceptual Art, and the School of Metaphysics," *Japanese Art After 1945: Scream Against the Sky,* edited by Alexandra Munroe (New York, Harry N. Abrams Inc, 1994) p. 218.
7. Reiko Tomii, "Concerning the Institution of Art," p. 17.
8. Reiko Tomii, "State v. (Anti-)Art: Model 1,000-Yen Note Incident by Akasegawa Genpei and Company," *Positions,* vol. 10, no. 1 (2002) p. 147. The critic's off-hand remark was made by

To*no Toshiaki in response to the questionnaire on "Tomorrow's Art, Tomorrow's Artist," *Geijutsu Shincho*,* May 1960. Tomii states in endnote No. 15:

The Japanese language has two distinct words, "geijutsu" and "bijutsu," that correspond to the English word "art." Geijutsu is an elusive term that can be translated as "the arts," "Art," or simply "art," depending on the context. Bijutsu is "art," conventionally consisting of painting and sculpture.

Hence, there is a difference between the translated "Art" and "art" - the tendency here is "Anti-Art" and not "Anti-art."

9. Alexandra Munroe, "A Box of Smile: Tokyo Fluxus, Conceptual Art, and the School of Metaphysics," *Japanese Art After 1945: Scream Against the Sky,* edited by Alexandra Munroe (New York, Harry N. Abrams, 1994) p. 215.

10. Alexandra Munroe, "The Spirit of YES: The Art and Life of Yoko Ono," *Yes Yoko Ono* (New York: Harry N. Abrams, 2000) p. 19.

11. Toshi Ichiyanagi, essay for *Japanese Art, 1960s* <<http://www.arttowermito.or.jp/1960/music-e.html>>.

12. T. Ichiyanagi [11] .

13. Yasunao Tone, *Revue & Corrig e.*

14. Yasunao Tone, quoted in "On Tone," Christiane Kort, catalog essay for Loos Music Festival in The Hague, Netherlands, October 1999.

15. Yasunao Tone, *Revue & Corrig e.*

16. Y. Tone [15] .

17. Both *Geodesy For Piano* and *Anagram for Strings* owe something to John Cage's scores for pieces such as *Cartridge Music* in their use of chance combinations and even the acetate sheet. Tone has stated in correspondence (21 July, 2001) that he knew little about Cage before Ichiyanagi's return to Tokyo late in 1961. He had an idea of Cage's use of chance but no knowledge of indeterminacy. His original understanding of chance had come from music journalism and was very sketchy. The dates for both these pieces are 1962; therefore, they were written soon after Ichiyanagi returned and must owe much to Tone's newfound knowledge of Cage and the New York School.

18. Yasunao Tone, liner notes to *Solo for Wounded CD* (Tzadik, 1997).

19. Yasunao Tone, *Revue & Corrig e.*

20. Yasunao Tone, liner notes to *Solo for Wounded CD.*

21. Yasunao Tone, quoted from an interview with Christian Marclay, in *Music,* no. 1 (1997) p. 43.

22. Note that early reviews of the new technology went to great lengths to override the system in an attempt to discover just how good it was. See David Ranada, "Digital Debut: First Impressions of the Compact Disc System," *Stereo Review,* vol. 48, December 1982.

23. John Cage, "Indeterminacy," in **Silence** (London: Calder & Boyars, 1973) p. 39.
24. Craig Kendal, liner notes to **Musica Iconologos** (Lovely Music, 1993).
25. Yasunao Tone, "John Cage and Record," **Intercommunication** (Japan), no. 35, 2000, text sent by Yasunao Tone to author.
26. The title for the piece comes from a work by Fluxus artist Alison Knowles, entitled **Wounded Furniture.** The work, composed in 1965, is for ". . . an old piece of furniture in bad shape. Destroy it further, if you like. Bandage it up with gauze and adhesive. Spray red paint on the wounded joints. Effective lighting helps. This activity may be performed with one or more performers, and simultaneously with other events." See "Events by Alison Knowles,"
<<http://www.nutscape.com/fluxus/homepage/aknowles.html>>.
27. Yasunao Tone, correspondence with author, 9 July 2000.
28. Yasunao Tone, **Musica Simulacra** (Harvestworks Digital Arts Center, 1996).
29. See Hannes Leopoldseder & Christine Schöpf (eds.), **Cyberarts 2000** (Wein: Springer, 2000) p. 217.
30. These terms have become common in recent years but are problematic in their programmatic definitions.

Caleb Stuart is a doctoral candidate at the University of Canberra in Australia. His thesis is about cracked and broken media in 20th century experimental music. The thesis focuses on the use of manipulated, broken and destroyed objects for the creation of new sound and compositional devices in experimental music particularly through the use of turntables and CDs. Caleb Stuart produces a regular sound event in Sydney called *impermanent.audio*, evenings of electronic experimentation in new audio practices and has featured both local and international musicians. He is also involved in the local experimental music festival 'What is Music?'

LEONARDO DIGITAL REVIEWS 2002.09

This month, the sequence of posting and reporting for Leonardo Digital Reviews has been disrupted slightly by the preparations for the October/November LEA special edition. However, by the time you receive this, the new reviews for August will be posted. They include a re-posting of the following review article by Harry Rand, a long-standing and highly valued contributor to LDR. All new reviews are available at the usual URL:
<<http://mitpress.mit.edu/e-journals/Leonardo/ldr.html>>.

Michael Punt
Editor-in-Chief
Leonardo Digital Reviews

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< The Oldest Technologies >
Review Article by Harry Rand

The Cambridge Complete World History of Food (2 vols.)
Kenneth F. Kiple and Kriemhild Cone Ornelas, eds.
Cambridge University Press, 2000, \$175.00

Two years ago the massive and grandly titled *Cambridge Complete World History of Food* was published (3,200 pages in two volumes) [1]. Although purportedly a compendium on food, there is not a single recipe in it. Yet, despite what might seem a subject worthy, at best, of aesthetic consideration, this work has a lot to tell the readers of *Leonardo* about technology and art. That may come as a surprise to the book's authors as much as to *Leonardo* readers. In recent years it has become fashionable, almost irresistible, to link the word "technology" with advanced (often electronic) devices and procedures. The allure of new software and hardware directs our attention as gold or spices lured our ancestors into new territory; we conceive our best selves in pursuit of, or as the progenitors of, bio-tech or electronics and its computational gifts. This may prove an inflated estimate of our accomplishments and the spirit of the era.

Every generation over-rates itself, exulting in the efficiency it has introduced. The horse collar was as great a breakthrough as the invention of soap; between the daring of the flying buttress or the potentiality of paper, both changed the world; the wheel and inclined ramps to haul stones made the world a better place for hominids. But today, only specialists conjure the past according to these milestones of technology. Mostly, the past is furnished with other, gaudier, images and the personalities of the inventors are, sadly, overshadowed. We, too, happily mislead ourselves about our "ultimate" accomplishments.

The present era will probably not be known as the epoch of the computer or the new electronic technology. We must disentrall from the allure of the future and reckon only what has actually been accomplished. What has decisively and dramatically differentiated our age from previous human history has been the advent of two technologies, neither of them electronic. First, anesthesia and antibiotics produced authentic medicine capable of effectively intervening against insults to the body; secondly, the hydrology of sewers and pure water delivery dramatically reduced preventable deaths and altered everything about how we live and expect to dwell. Neither the medical nor the hydrological glows with the Buck Rodgers aesthetic that, only recently, came to be associated with the word "technology"; nevertheless, these two quintessentially modern developments, more than anything else, shaped modern expectations.

Yes, biotech and electronic advances do revivify the idea of progress, and this is no small matter during a cynically ironic era when modernism's progressive outlook must, somehow, survive in the public imagination. The alternative is ghastly. Currently, infatuation with progress is not widespread, being too easily linked with the complex issues of globalization and the universal

leveling of local cultures before the behemoth of world civilization. Only the most recent variety of technology earns popular allegiance although the really important stuff is not brand-new. The precursors of today's knowledge are often lost. And what is technology if not the ability to ameliorate the world?

We have spent a lot of time trying to make the world more hospitable, hundreds of thousands of years already. The old technologies have never been replaced, but built upon; added to, but not superseded. They have faded into the background, becoming so commonplace as to become invisible. We use them still. That is where the Cambridge Complete World History of Food begins us thinking. Preeminent among the old technologies is language. Having appeared less than half a million years ago, language is our oldest technology and still, in some ways, the most resplendent. The "information age" presumes language and language is the reason we need an information age. Every other creature communicates through the same channels by which it senses the world. Insects taste and smell to make a picture of the world and they (mainly) converse with pheromones, i.e. tastes and smells [2]. Cuttlefish and squid see and also communicate with colors (watching a cuttlefish "think" in color is ample invitation to an alien intelligence). Dogs smell the world more than they see it, and marked with their own odors and a thousand other scents, the terrain is a very different place for a dog and its owner out for a walk. Dolphins and whales hear and speak the world (not "their" world) into being, everything a sound. Yet, people see the world as a visual array but communicate sonically through organs that make the air vibrate at low frequency.

Our species is distinctly bi-modal and comments through sound about what the other senses perceive. Accordingly, we are always "translating"; we make approximations in speech of what has occurred in the dimensions of heat, weight, smell, taste, etc. Translation creates symbols: thought. There is no information without thought. This oldest technology of speech is not yet understood in its origins, operations, maximum capacities and limitations. Mainly, it is invisible amid the glitter of our gadgets. We do it and generally do not think about speech unless we are linguists or poets. That is, we are still mining the possibilities of this first technology.

The next great advance was the invention and mastery of the fiber arts. The idea is so counter-intuitive - why dismantle a perfectly warm and durable sheepskin and create threads or yarn? Why turn a sturdy stalk of flax into flimsy fibers? A string will not keep you warm; even a wrapping of string is not as useful as the sheepskin from which it was derived. Making threads followed - that is, ensued conceptually and not just chronologically - the formation of purposeful intentions; the idea of weaving and knotting as technology had to precede the practice [3]. (Exactly this same pattern of yearning requited by technology marked the development of aviation.) From string came knots and packages (tied bundles of loose objects anticipated the commutative adding of disparate things; many loose items become one tight parcel). Eventually, after thousands of generations of experimentation with tied loops and dense braids, early fabrics and weaving on the loom emerged. But, although we are all clothed, few of us are weavers. This is one more basic technology which we, for the most part, do not think about except as hobbyists or economists.

The most spectacular leap accompanied the mastery of pyrotechnics. Fire was friend and threat, servant and enemy, but

at least it could be an ally when summoned as opposed to an unrelenting foe when appearing unbidden. Fire gave warmth and comfort, which conserved calories so that food supplies were extended [4]. Fire's light meant night's curtain no longer dropped, ending most activity; fire extended the hours for social exchange and deliberation and, thereby, the evolution of thought accelerated. Fire repelled animals and supplied a zone of safety around the hearth; the hairless and bipedal prey animal - arisen from scurrying nocturnal mammals - was spared predation after sunset. Fire also produces chemical changes whose transmutations led to other technologies (ceramics and metallurgy, among others). The tangible world could be altered into the immaterial when solids became smoke, and fire - like life itself - grows and spreads as long as it is fed. The solidly palpable made immaterial by fire suggested a spiritual world apart from what is available to the senses: religion. Fire made things disappear, where to? Some worshipped fire, some used it to purify; all used it to live by. Pyrotechnology yielded hard, brittle and, especially, non-corrosive ceramics. These heat-resistant containers were waterproof and could extend food's edible "shelf-life" without air-drying and before the discovery of salting. Ceramic containers allowed controlled fermentation, which boosts the nutritive value of foods and, most importantly, ceramics allowed the preparation of stews; the importance of this advance cannot be over-stressed. Stewing, which softens foods, made some of our species biologically dependent on technology for the first time [5]. Those with poor or worn teeth no longer needed to die of malnutrition. The esthetics of this technological transformation are expressed in the range of preferences that cooking works on its available materials. And we all eat; we all partake of this technology and all have strong preferences and opinions, regardless of expertise. Cooking is probably the most invisible of primordial technological advances, being submerged in aesthetics, culture, tradition, habit and, most recently, the hype of agri-business and food companies. The true science of food preparation concentrates many separate spheres of inquiry and joins cooking in the ranks of other advanced sub-specialties, like the craft of medicine - which is not itself a science but which relies on many fields of research [6]. It is commonplace to assert (usually with false modesty) that medicine is an art but it is just as true to assert that cooking is applied technology. In this sense, a wonderful, even essential, one-volume summary of the dependence of cooking procedures upon the physio-chemical nature of each food - and therefore how the appropriate treatment of each food arose from the practical knowledge of evolutionary experimentation - can be found in the magisterial **On Food and Cooking** by Harold McGee [7]. But this book is neither a history nor a personal critique, though McGee allows himself an occasional droll aside.

The artistry of cooking was never better essayed than by the late eighteenth-century philosopher of eating, Jean Anthelme Brillat-Savarin, in **The Physiology of Taste** [8]. His observations help reconstruct an approximate idea of early-modern food, how it was served, and, only incidentally, the chef's technological resources. Since then, various recollections in the food trade recount what it is like to master the techniques of food-preparation and to live by that knowledge and vocation [9]. The technical corpus leads from food preparation to the corollaries of presentation: the restaurant [10]. From this sort of literature arose the popularizers; some, like the pioneer James Beard, were American prophets in a near wilderness whose words and ideas were incomprehensible to the masses but who (like a culinary John the Baptist) made possible the jaunty and learned

preaching of the academy-trained Julia Child. Upon this base of acceptance, the highly practiced professionals - like the Franco-American Jacques Pepin, a real cross-cultural ambassador for the popular acceptance of gastronomy - advanced the developing "science of food." A few globalists made possible a synthesizing of cultural traditions (aesthetic preferences) and the hard products of chemistry and physics. Without these teachers, there would be no significant modern literature on cookery in the English language outside of professional dietetics, as there would be no audience for multi-volume sets like *The Cambridge Complete World History of Food.*

The touchstone for modern cooking derived from the French model remains the recently up-dated *Larousse Gastronomique*, a practical, handy and accessible how-to book that actually, with witty self-consciousness, enculturates a traditional technology every bit as custom-bound as the etiquette performed before a resplendent tribal chieftain [11]. It is an inadvertent work of anthropology and a deliberate essay in applied technology. As a reference work, it directly descends from Apicius' first-century cookbook, the earliest surviving collection of recipes that also, incidentally, indicates the state of food technology at about the time Pompeii was buried [12]. Significantly, the 1200-page *Larousse* bills itself as a culinary encyclopedia, which is accurate, in a limited way, but it is not a history, as Cambridge claims to be. The Cambridge volume has some stiff competition.

Barbara Ketcham Wheaton's amiable volume, *Savoring the Past*, historically surveys the social and technological dynamics that shaped cooking from the middle ages to the French Revolution, from an ancient approach to food preparation to the birth of modern cookery and the creation of the restaurant - an establishment that did not exist before that time [13]. A compact survey of the historical development of cooking, Reay Tannahill's *Food in History*, is a fine one-volume celebration [14], while food's cultural resonance - its ever-dilating exchange with mythology and society (derived from technology and history) - can be sampled in Margaret Visser's *Much Depends on Dinner* [15]. Into a banquet of publications on food and cooking sailed the grand vessel deceptively named *The Cambridge Complete World History of Food*; it is neither complete nor does it balance the world's cooking traditions (which determine what is food) nor is it a proper history, but it is gloriously invaluable nonetheless. The wealth of knowledge contained here, however arranged, is inspiring. Hundreds of food plant species are assigned summary descriptions, and each of these cultivated or wild flora represents a technological breakthrough, a genetic adaptation to circumstance.

Implicit here is the distinction between food and cooking. While the latter is more obviously a technology using implements, the former is the original bio-tech in which the implements disappear in the final product. Consider learning that the four edible species of Asian tropical taro - each now completely dependent on humans for their reproduction, and thus every bit as artificial a form of life as anything cooked up in a DNA lab - may have been the earliest domesticated plant foods; that tidbit changes the tilt of human geography away from the northern hemisphere. Humans and taro are now interdependent. These pages glitter with such insights. Cooking and food are inseparable, although the processes of arriving at each are different. Each food item has a story to tell and it is worth disentangling one from the other.

Despite its alluring title, promising a narrative, this immense

two-volume set is not really a narrative record at all. If it were, the section on "The Question of Paleolithic Nutrition and Modern Health" would not be on page 1704 in the second volume, but integrated near the beginning. While this arresting article is subtitled "From the End to the Beginning" and thus hints at a circle being closed, since everything we know of paleolithic diet is inferential - including butchering marks on the bones of supposed game animals, in a history this study should have been front-loaded to lead the other essays. In short, the articles in the immensely useful study could have been dealt out in a more strictly chronological order and produced a more densely told history, or something more nearly like a history. The fault is not the many authors' responsibility.

The whole two-volume work is an under-edited mine in which history's raw materials are carefully presented in innumerable choice articles by diverse specialists. The pieces are not reconciled and are curiously arranged - they are a garden in profusion, each article its own species with its own logic and order, the totality a rich jumble. The daunting chore of organizing this material into something vaguely narrative was a job the editors shirked, relegating ordering the loosely quilted fabric to benighted indexers who had to make some sense of all this material. And so they did - no book is more in need of reading from the indices. Without the table of contents and the thorough indexing as guide, the perplexed and fascinated reader would stumble, lost, through unknown continents of information. Odd, in such an ambitious venture, but the index is the consistently most useful part of this whole project, though it is neither scholarly nor as readable as the articles. Without an encyclopedia's alphabetic format - like Craig Claiborne's grandly titled but superficial and skimpy *New York Times Food Encyclopedia* - and without a consistent historical thread, the *Cambridge Complete World History's* deficiencies will almost certainly glare, imperfections that might have been hidden within an easily accessed organization [16].

Inconsistency is the watchword here, as every author apparently set his/her own standards about what to include. Some articles are historical and illustrated; most are unillustrated. A discussion of the cereal grain and green vegetable amaranth is unillustrated, although the plant is not easily visualized, while an article on watermelons, an easily visualized fruit, features several photographs that illustrate things as mundane as the appearance of a Japanese watermelon hothouse (looking exactly as you would expect). And while amaranth is described in depth, the other South American grain of current interest, quinoa, must be located through the index, like Ethiopian tef, a grain of equal antiquity and interest. You will find nothing on the domestication of cavi (Guinea Pigs) as a food source. The two illustrations of yaks are so unrepresentative that if a reader did not know the appearance of this animal it would be impossible to accurately visualize it from the representations. Did no one oversee quality control of the images? Finally, lest the reader suppose I cavil unfairly, a caption in an article on turkeys (p. 582) reads "Only two domestic animals greeted the first Europeans to visit the southwestern pueblos. They were the dog and the turkey;" this below a picture of . . . a dog and a turkey. Surely visual resources could have been better invested.

The wildly uneven and irregular nature of the pieces in the *Cambridge History* differ in word-length, range of focus and historical depth, type and extent of supporting materials and just about every other variable. In short, a real history of food

- an idea inseparable from a history of cooking as technology - can and should still be written, and most of the necessary materials are already in this book. None of this carping, however, detracts from the necessity to reckon with this monumental (in size and content) effort to summarize what is known. The book is essential to consult for an overview of this basic technology by which, over thousands of generations of hominids' (erectus-neanderthal-sapiens) unremitting experimentation, the world has been adapted so that the planet's carrying power has zoomed for today's staggering human population. What the sum of these innumerable essays convey is a converging realization. For better or worse, we live in the age of the globalization of crops. Sustained into a future, this homogenizing legacy will distinguish the maturity of our species as a planetary entity, truly out of Eden and consciously in charge. And one of the first of the deliberate systematics is the entire globe as a pattern of agriculture(s). Compared to this highly structured organization, the glamour of aviation, biotech, electronics, etc. will only play supporting roles. Without food nothing else matters.

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1. Kenneth F. Kiple and Kriemhild Cone Ornelas, eds. *The Cambridge Complete World History of Food* (Cambridge, UK: Cambridge Univ. Press, 2000).
2. To be honest about it, so do people, as enjoined by Psalms 34:8 - "O taste and see that the Lord is good."
3. Retted flax fibers and even the continuous strand of silk suggested function and technology. A great intellectual leap envisioned a use for twisted fibers before weaving. Spinning, then plying and braiding, produced very strong, flexible and sometimes durable strands. Today, "string theory" is alluring to physicists, but real string was an amazing technological advance and, however it began, with vines or retted stalks, it continues with carbon nanotubes.
4. Also, with more bodily energy available for something other than maintaining internal temperature, some marginal illnesses might not bloom into life-threatening disease.
5. Raw foods need strong jaws for ripping and chewing. Only the vigorous with healthy teeth and digestion survive, even if they only share in the hunt and are not themselves hunters. The tastier fibers of fired (broiled) meats are broken down so that softened foods can nourish those with weaker teeth and jaws (e.g. the aged or infirm). With broiling, meat could nourish those who, formerly, would not have been able to survive on a diet of raw meat. In a fireproof ceramic container, stewed foods are easier to chew and digest than the merely broiled. Even those without teeth, the truly aged, could be nourished into dotage. The community that hunted and made pots and cooked and wove fiber could maintain those who could make none of these contributions. Ceramics extended human lifespan and the aged wisdom of venerable toothless survivors could accumulate useful information and experience for a younger generation. Cooking in ceramics vastly dilated the range of cultural resources and memory. Since the introduction of fire and ceramics, the human jaw has in fact been shrinking at a measurable percentage (hence the problem of where to put "wisdom teeth" when the increasingly gracile jaw has no room for these big grinders). In that far-distant era of the

first ceramic technology, humans and their inventions became inter-dependent on the course of future evolution. We have been androids for at least eight or nine thousand years - a condition of machine dependence only intensified by the widespread use of surgical (caesarian) delivery. Technology skews who lives through birthing and thereby drastically alters the gene pool toward androids who are further dependent on technological intervention for their reproduction.

6. The medical doctor, like the chef, is a clinician - intuitive, creative, making use of technical developments, few of which are locally concocted. Only the exceptional practitioner in each field is distinguished with a named syndrome or dish.

7. Harold McGee, **On Food and Cooking** (New York: Charles Scribner and Sons, 1984).

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9. A prime example of this genre is Pierre Franey's **A Chef's Tale** (New York: Knopf, 1994).

10. See, for example, George Lang, **Nobody Knows the Truffles I've Seen** (New York: Knopf, 1998).

11. **Larousse Gastronomique**, ed. Jennifer Harvey Lang (New York: Crown, 1988).

12. M. Gabius Apicius, **Cookery and Dining in Imperial Rome**, ed. and trans. Joseph Dommers Vehling (New York: Dover, 1977).

13. Barbara Ketcham Wheaton, **Savoring the Past: The French Kitchen and Table from 1300 to 1789** (University of Pennsylvania Press, 1983).

14. Reay Tannahill, **Food in History** (New York: Crown, 1988).

15. Margaret Visser, **Much Depends on Dinner** (Toronto: McClelland and Stewart, 1986).

16. Craig Claiborne, **The New York Times Food Encyclopedia** (New York: Times Books, 1985).

ISAST NEWS

< Leonardo Call for Papers on the Cultural Roots of Globalization >

The editors of **Leonardo** are seeking papers about the cultural roots (artistic and scientific) of globalization. Possible topics include, but are not limited to, art and science that involves:

* Planet Earth as artistic material

- * Creolization (transnational cultural relationships)
- * Global climate (sensorial experience of the climate as possible corrective of global thinking)
- * Migrations (mobility in general)
- * Geography in a globalized world (places, cities, continents, world regions, approaches to space and time in general)
- * Transportation in a globalized world (travel poetry today in a world with different means of transportation)
- * Internet and tele-technologies in their planetary dimensions
- * Net Art, telematic art and planetary issues
- * Overview Effect (e.g. use and consequences of GPS and satellite technologies)

Guest Editors:

Julien Knebusch
 Annick Bureauud
 Roger Malina

A Leonardo Working Group for the project includes:

Roger F. Malina
 Annick Bureauud
 Herve Fischer
 Jacques Arnould
 Bernardo Cinquetti
 Julien Knebusch.

Material already published online as part of the project can be found at <<http://www.olats.org>> (projet singulier Fondements Culturels de la Mondialisation).

Interested authors should contact guest editor Julien Knebusch with proposals at <julien_knebusch@yahoo.fr>.

Please note: *Leonardo* features articles written by artists about their own work, but we are also seeking articles by theorists, historians and other scholars addressing how the work of artists and scientists has interacted with trends towards globalization.

For authors' Editorial Guidelines, see:
 <<http://mitpress.mit.edu/e-journals/Leonardo/isast/journal/editorial/edguides.html>>.

.....

< New books by Clifford Pickover >

Leonardo Board Member Dr. Cliff Pickover recently published four science-fiction books in a Neoreality Series that explores strange realities. The titles are *Liquid Earth,* *The Lobotomy Club,* *Sushi Never Sleeps,* and *Egg Drop Soup.* More information can be found at his web site:
 <<http://sprott.physics.wisc.edu/pickover/neoreality.html>>.

ANNOUNCEMENTS

< Announcement and Call for Entries: Light Art Exhibition - Rays of Light >

Chicago, IL - Lightology, a leading U.S. designer and distributor of contemporary lighting, is pleased to announce Rays of Light, an exhibit of art works using light as an expressive medium. The show will take place in a specially designed exhibit hall at the company showroom building, located in Chicago's River North gallery district. The controlled conditions of the separate, dedicated exhibition space are ideal for exhibiting art using light. The curators therefore seek the best in stimulating and provocative artworks from the U.S. and abroad for this event. Artists are invited to submit finished light art works for this exhibition, which will open 15 November, 2002 and close 31 December.

Rays of Light is timed to coincide with the International Association of Lighting Designers (IALD) conference. All attending IALD members will have invitations to visit the Lightology showroom and a special viewing of the Rays of Light exhibition. Following this preview, the exhibition will be opened to the public, offering visitors a rare look at a provocative and stimulating art form.

The deadline for artist proposals is 20 September, 2002. Details and more information about Lightology can be found at <www.Lightology.com>.

Questions can be directed to the show curators:

Kasia Kay, <kkay@lightology.com>, tel: 1-773-883-6111 (x264);

fax: 1-773-883-6121

Louis M. Brill, <lmb Brill@earthlink.net>,

tel/fax: 1-415-664-0694

David Parker, <dparker@lightology.com>,

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< Statement on Spectroscopic Imaging in Art Conservation: A New Tool for Materials Investigations >

Michael Attas,^{a*} Edward Cloutis, Catherine Collins,^b Douglas Goltz, Claudine Majzels, James R. Mansfield,^a and Henry H. Mantscha

Centre for Scientific and Curatorial Analysis of Painting
Elements (C-SCAPE) University of Winnipeg, 515 Portage Avenue,
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[Figure goes here in the Artist's Statement] [Caption: "Drawing

as it appears to the eye (left), and enhanced using spectroscopic imaging and principal-components analysis to highlight differences among near-infrared spectra of materials (right). Charcoal lines are coded red.”]

The remote-sensing technique of spectroscopic imaging has been adapted to non-destructive examination of works of art [1]. The technique allows the art materials to be distinguished by their composition, and underdrawings revealed [2]. Our initial results indicate that, even over limited wavelength ranges and with relatively coarse spectral resolution, a number of pigments can be distinguished on the basis of variations in their near-infrared reflectance spectra. Non-destructive identification of pigments can be used to address issues of attribution, age dating, and conservation. Since the technique produces images, it also provides information on the distribution of the pigment types in the work being examined. By acquiring an image at each of dozens of wavelengths spaced at 10-nanometer intervals through an extended spectral range (650-1040 nm), we can build up what is known as a 3-dimensional spectroscopic imaging data cube. An additional advantage of this technique is that it can be performed off-site using portable instrumentation, and under relatively benign lighting conditions. The equipment it utilizes is specialized but relatively inexpensive.

The technique has been applied to the examination of a fifteenth-century drawing, *Untitled (The Holy Trinity)*, in the collection of The Winnipeg Art Gallery. Software adapted from the remote-sensing image-processing field has been used to successfully map the areas of different brown and black pigments across the drawing. Multivariate image analysis [3] produced a set of principal-component (PC) images highlighting different materials aspects of the drawing. A color composite image produced from the PC images provided a direct visualization of the compositional characteristics of the work (see figure). The images produced are easily interpreted, and the information obtained is directly usable by conservators, art historians, and curators alike. Features of the underdrawing have been exposed, and its material tentatively identified as charcoal, by comparison with reference data. Identification of the other pigments awaits the creation of a more appropriate database of near-IR pigment spectra.

Based on the success of our preliminary work [4,5,6], the collaboration between our institutions (University of Winnipeg, Winnipeg Art Gallery, and Institute for Biodiagnostics of the National Research Council of Canada) has been formalized as C-SCAPE, the Centre for Scientific and Curatorial Analysis of Painting Elements. With federal, provincial, corporate, and private funding, C-SCAPE is purchasing dedicated instrumentation for infrared spectroscopic imaging, as well as other equipment for chemical and computer analysis of artworks. The research program being drawn up includes the following components: building a spectral library of historical pigments and other art materials, based on collections held elsewhere and on preparation of known media types according to traditional recipes; collecting more data from known media types including acquiring spectra and spectroscopic images of them to correlating spectral properties with media, by analyzing works whose media are already known; investigating multivariate computer techniques for the analysis and visualization of spectroscopic IR image sets; and analyzing works in other collections from the same period for corroboration of our results. The collaboration is also open to extending the application of these techniques to other types of works of art

such as textiles, ethnographic specimens, pottery, stone, etc. Infrared spectroscopic imaging could also prove useful in document and forgery analysis, as well as in attributions of works of art.

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