tors of grammatic sentences, which in turn generated both a phoneme sequence and prosody resembling that of speech, and thus controlled the motor coordinating centers for speech. On the motor side, respiration, laryngeal movements, and articulation were all involved. It was his conclusion that it is impossible to use phonemes for automatic speech recognition and that speech production must take into account the total behavior of the articulatory system. In the Russian language the open-ended syllable sequences appear to offer better prospects for speech recognition than the use of the phoneme sequence. E. E. David (Bell Telephone Laboratories) indicated that research in this country had also demonstrated that phoneme analysis was not adequate for automatic speech recognition. Lawrence J. Fogel (Decision Science, Inc.) pointed out that pattern recognition of musical instruments depends on their percussive nature rather than on their sound, and this distinction may also be important in speech recognition.

Fogel also described his model for simulating Darwinian evolution in fast time, thus permitting the experimenter to simulate 15,000 generations of intelligent machines in a matter of several minutes of computer time. In his view the human operator can be helped most by the design of adaptive transducers for optimally displaying the sensory data of the real world.

Minsky reviewed the development of mechanical hands and arms for amputees which could be computer coupled. Wasserman and Ralph Alter (Massachusetts Institute of Technology) described engineering models of mechanical arms (constructed in their laboratories) which use electromyographic signals from the remaining portion of amputated limbs for control purposes. In order to achieve portability, the computational adjunct to a mechanical arm cannot be too complex and the power pack cannot be too large. Other problem areas mentioned were velocity control during flexion and control of torque. The arm developed by Alter incorporated a Sprague clutch which permitted fixation of the artificial limb without the use of motive power. David commented on the applicability of audio control of prosthetic devices and Remond described an auditory presentation of EEG patterns whose topological organization could be used as the basis for motor control.

The conference was supported by the National Aeronautics and Space Administration and the Office of Naval Research. An edited transcript of the proceedings is scheduled for publication before next year's meeting. The topics of discussion over the next 3 years include communication in social groups, the pathology and therapy of control processes in living systems, and new vistas in biological information processing.

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Ultrasonics

Ultrasonics has many engineering applications (delay lines, mechanical filters, inspectoscopes, thickness gages) and analytical uses. The wide range of physical investigations that can be carried out by ultrasonic wave transmission was brought out at the fifth annual symposium of the Institute of Electrical and Electronics Engineers, Boston, Massachusetts, 1–4 December 1965.

During a general informational session H. E. Edgerton described subbottom exploration with sound pulses and Philip W. Anderson reported on the role of phonons in superconductivity. In discussing the physical significance of third-order elastic constants and their relation to nonlinear processes, R. N. Thurston provided an introduction to a number of papers dealing with nonlinear elastic effects in acoustic wave propagation. Since nonlinear elastic moduli provide the means for interchanging the acoustic energy with the energy of thermal phonons, a knowledge of their values is essential for determining the thermal acoustic losses. In the region for which the product of the angular frequency ω and the thermal relaxation time τ is greater than unity, the direct exchange can be followed. P. G. Klemens showed that for shear waves the loss was proportional to the frequency and to the fourth power of the absolute temperature. For longitudinal waves in the lowest temperature region the increase should be proportional to the ninth power of the temperature, changing to the fourth power at higher temperatures. Experimental results by J. de Klerk indicated agreement with this result in SiO_2, LiF, and CaF_2.

In the region where $\omega\tau < 1$, individual modes cannot be followed, and the interaction is in the nature of a phonon viscosity. Using recently measured third-order moduli for NaCl, KCl, and yttrium iron garnet (from D. E. Eastman) good agreement was found with measured ultrasonic losses according to a formula derived by W. P. Mason.

Electrons can damp acoustic waves by interchange of acoustic energy with electron energy. Dislocations dragged through the crystal are also damped by the "effective" viscosity of these electrons. This effect is the origin of a nonlinear attenuation which is different in the normal state and in the superconducting state (R. W. Shaw and W. P. Mason).

Another major effort was the generation of higher-frequency acoustic waves. The highest frequencies were in the range of 70 gigacycles (70×10^9 cycles), using surface wave excitation in quartz (P. E. Tannenwald and J. B. Thaxter). Cadmium sulfide and zinc oxide thin-film transducers can be put on in the form of layers having half-wavelength frequencies in the high gigacycle range. An alternative method for reaching these high frequencies is by the use of Brillouin scattering of laser beams. This technique was reviewed by G. B. Benedek, and lasers were employed by B. Tell, T. C. Damen, and S. P. S. Porto to investigate Raman active modes in ZnO and CdS. Brillouin scattering was also used by M. G. Cohen and E. I. Gordon to investigate the properties of externally generated sound. Study of thermal phonons in the transmission of heat pulses was described by A. H. Nethercot and R. J. von Gutfeld and by J. M. Andrews and M. W. P. Strandberg.

More conventional transducers, such as ferroelectric antiferroelectric transition transducers, were described by D. Belincourt. J. Bohm, A. W. Warner, and D. B. Frazer reported on GaAs and $LiNbO_3$ piezoelectric transducers. The latter material has very high Q values (above 10^5 at 10^9 cycles) and has a strong electro-optic effect. An ingenious technique for measuring piezoelectric constants of materials with high electrical conductivity is the piezoelectric Hall effect devised by G. Arlt.

Many types of acoustic wave ampli-

fiers were described—acoustic masers (N. S. Shiren) and several forms of cadmium sulfide amplifiers using a high electronic drift velocity and parametric amplification of magnetoelastic waves (R. G. Damon). The effect of acoustic gain upon the electrical impedance and the resonant vibrational modes of CdS plates was described. A. R. Hutson predicted an active crystal resonator based upon these effects and D. L. White and Wen Chung Wang reported experimental observation of stable single mode oscillations in cadmium sulfide plates in the ultrahigh-frequency range.

The many applied uses of ultrasound were noted—ultrasonic inspection, scattering of sound by polycrystalline grains, techniques for measuring solids up to 2800°K, forming of materials under ultrasonic irradiation, transmission of sound in specially shaped solid horns, wave propagation in specially shaped torsional rods, ultrasonic image converters, electroluminescent displays panels, and tunable bandpass filters and ferroelectric devices for use in linear microcircuits.

In a session on the use of ultrasonic energy in basic biology and medicine, W. J. Fry, F. J. Fry, J. H. Holmes, and J. M. Reid discussed therapy at intermediate intensities and the use of high-frequency sound in surgery. The use of ultrasound in supplying pictures of various operations of the body was also described.

The symposium presented an impressive picture of the research uses, practical applications, and future possibilities of ultrasonic processes. This rapidly growing field can be regarded as one of the fundamental methods for physical investigations.

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Yeast Genetics

Sixty-two geneticists from 11 countries met at the University of Washington, 13–15 September 1965. Herschel L. Roman (chairman, Department of Genetics) was the coordinator and chairman of the meeting, which marked the opening of the new Biochemistry-Genetics Building. The conference was dedicated to Professor and Mrs. Carl C. Lindegren, pioneers in the field of yeast genetics, on the occasion of his retirement as director of the Biological Research Laboratory, Southern Illinois University. Eight general areas were discussed: mutation, suppressors, radiation effects, recombination, macro- and micromapping, cytoplasmic inheritance, gene-enzyme relations, and cytology. Except for clarification of the cytology, individuals discussed their work without slides. Discussion centered around unpublished results and emphasized research techniques and methodologies.

Magni (Parma) presented data on new experiments showing that mutations that have a higher reversion rate during meiosis compared to mitosis are associated with additions or deletions of bases, whereas those that revert at the same rate are associated with based-pair substitutions. To assay reversion rates in vegetative yeast Hurst (Brooklyn College) used a replica-plating version of the method of Ryan, in which the number of papillae indicates mutant number and the colony size indicates cell number. Von Borstel (Oak Ridge) discussed the use of the 10 × 10 multicompartmented boxes of de Serres for measuring mutation rates in liquid culture during mitosis and meiosis. Luzzati (Gif, now at Yale) described a technique for studying gene conversion in liquid medium. In principle the technique should also work for leaky mutants. To distinguish original prototrophic revertants from their progeny, the latter are changed to "petites" by growth in the presence of acriflavine, the mother prototrophic cells being unaffected by the acriflavine for a few generations.

A rapid-scanning microscopic method was used by Fogel (Brooklyn College) for detecting and isolating tetrads (originating from heteroallelic diploids) that contain a prototrophic spore. Wilkie (London) described a mutant-enrichment method based on destruction of prototrophs by actidione. He also noted a promising method of selective staining of auxotrophs with magdala red on synthetic complete medium. Pittman (Carbondale) independently has confirmed the usefulness of the actidione technique. Snow (Davis) has used Nystatin for 1000-fold mutant enrichment. De Serres (Oak Ridge) described chemical mutagens used on *Neurospora* which were of interest to yeast geneticists. Of particular interest is the acridine mustard, ICR-170, that seems to specifically induce addition-deletion mutations in *Neurospora*. Magni mentioned that 0.3 to 0.6*M* nitrous acid (*p*H 4.5) generally induces addition-deletion mutations, whereas 0.01 to 0.03*M* nitrous acid (*p*H 4.5) generally induces base-substitution mutations.

Hawthorne (University of Washington) introduced the topic of super-suppressors and their action with a summary of their known properties. He has found at least ten classes which act on overlapping hierarchies of super-suppressible mutants. Super-suppressible mutants generally are neither leaky nor osmotically alterable to wild-type. Super-suppression is essentially dominant, although a few cases of recessive (or semidominant) action of the super-suppressors have been observed. Some super-suppressed mutants grow better than wild-type on the minimal medium. One-third of the mutants induced by ultraviolet radiation are super-suppressible. Manney (Oak Ridge, now at Western Reserve) found that super-suppressible mutants rarely complement, and whenever they do, they exhibit a polarized complementation pattern. Mortimer (Berkeley) confirmed this for similar mutants at two other loci. Gilmore (Berkeley) presented evidence for a series of at least eleven super-suppressor loci, some of which may overlap those in Hawthorne's series. Some of the super-suppressors, when combined in one haploid strain, result in depressed growth. Mortimer reported a case of super-suppression of a non-complementing mutant to a nonfunctional, but complementing, condition. Magni, von Borstel, and Steinberg (Oak Ridge) showed that super-suppressible mutants revert at the same rate during mitosis and meiosis, whereas mutation of super-supressor loci occurs at a higher rate during meiosis. Cox (Oxford) told how cytoplasmic conditions seem to control the expression of some super-suppressors. Data from Leupold (Bern) on super-suppressibility in *Schizosaccharomyces pombe* parallel closely the data presented for *Saccharomyces*.

Manney presented evidence that super-suppressible mutants will make a fragment of the enzyme tryptophan synthetase. When the mutation lies between the A and B portion of the molecule, only the A fragment is made (as measured both by enzymatic activity and molecular weight). Fink (Yale, now at NIH) observed that the only super-suppressible alleles found in the hi_4 operon are noncomplementing or show polarized complementation in the B and C cistrons.