ΑΛΘ = Φ

Composer/Researcher

Dimitri Voudouris

Composition

ΑΛΘ=Φ

Text to speech synthesis with Computer Processing for a 24 Speaker robotic ensemble with designed space for performance.

Performance Space

ΘΩΡΑΞ

Duration

25min29sec

Composed

2005-2008

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figure 10 shows the connections of the speakers how they follow a central route into the space via neurodes of various weight and strength.

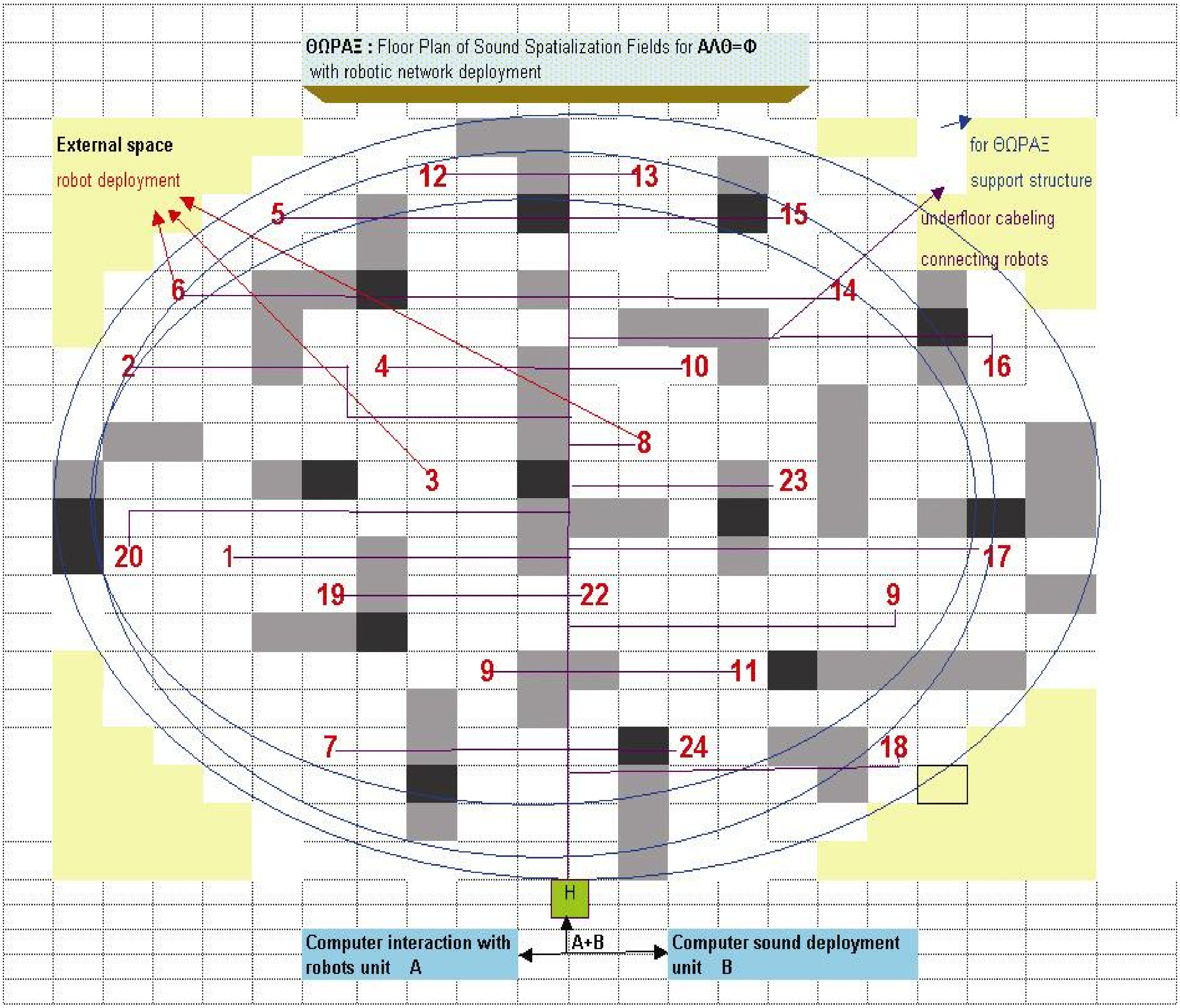
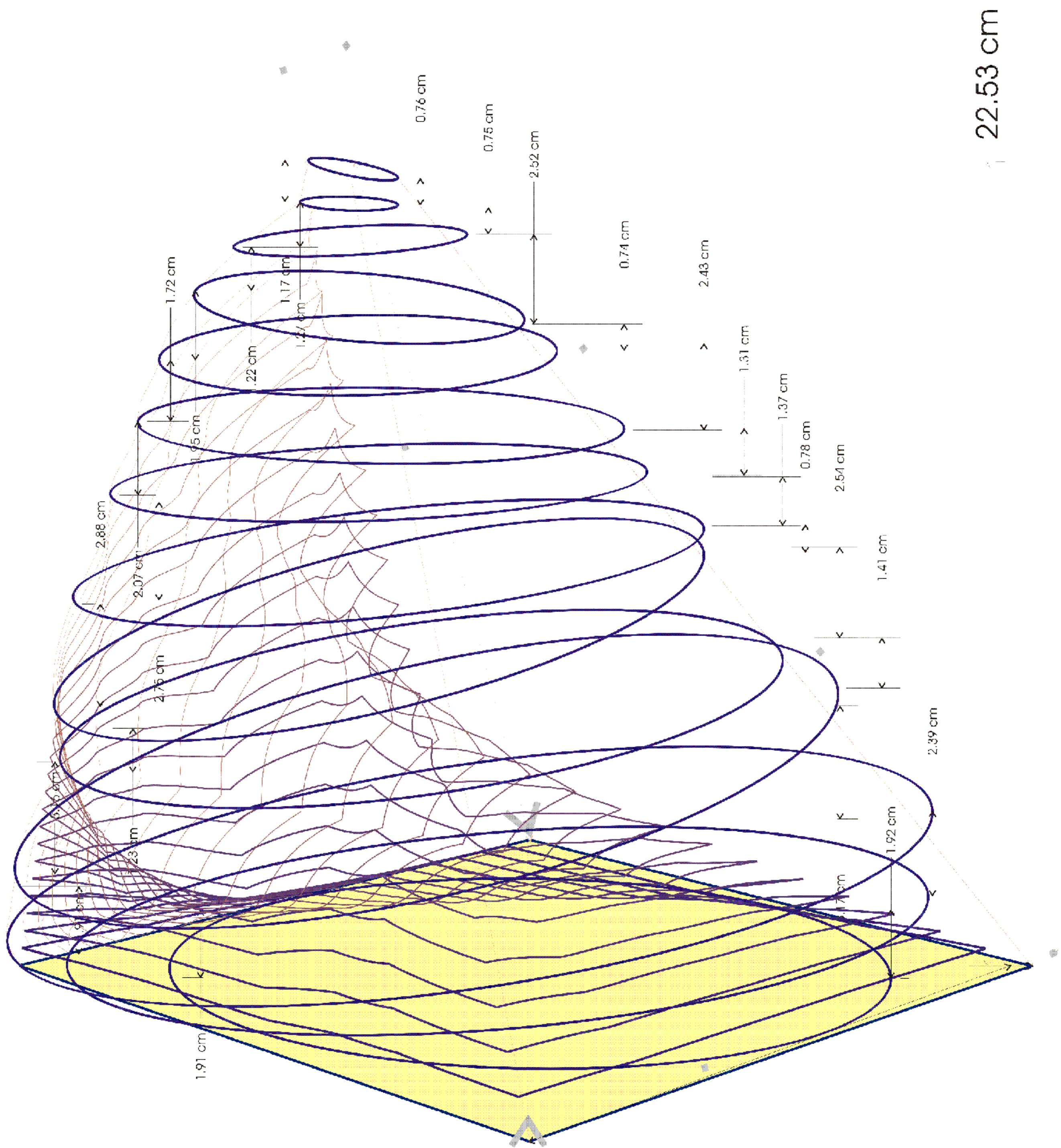


Figure 10

At Unit B is a sound engineer and at Unit A is a computer engineer + robot technician. Signals from the behavioural characteristics of the robots are received and pass this information to the computer engineer who's system then decides to up/lower the volume and to exercise manouvre possibilities for each of the robots the information is passed on to the sound engineer who releases the sound spectrum.



The 14 Ring structure of ΘΩΡΑΞ together with speculative sound performance ***Figure 11***

11 --- Robotic ensemble

a --- Structure and Specifications

Vibration Sensor: ***Figure 12***

Seismic, low frequency, ceramic flexural ICP accel, 10 V/g, 0.03 to 500 Hz, top exit, 2-pin conn.
Broadband Resolution: (1 to 10000 Hz) 0.5 μg (5.0 μm/s²)
Electrical Connector: 2-Pin MIL-C-5015
Electrical Connection Position: Top
Weight: 22 oz (624 gm)

Acoustic Pressure Sensor: ***Figure 13***

Measurement Range: (± 5 V output) 3.33 psi (181 dB)
Sensitivity:(±15%)1500mV/psi(217.5mV/kPa)
Low Frequency Response:(-5%)5Hz
Resonant Frequency:>=13kHz
Electrical Connector: Integral Cable

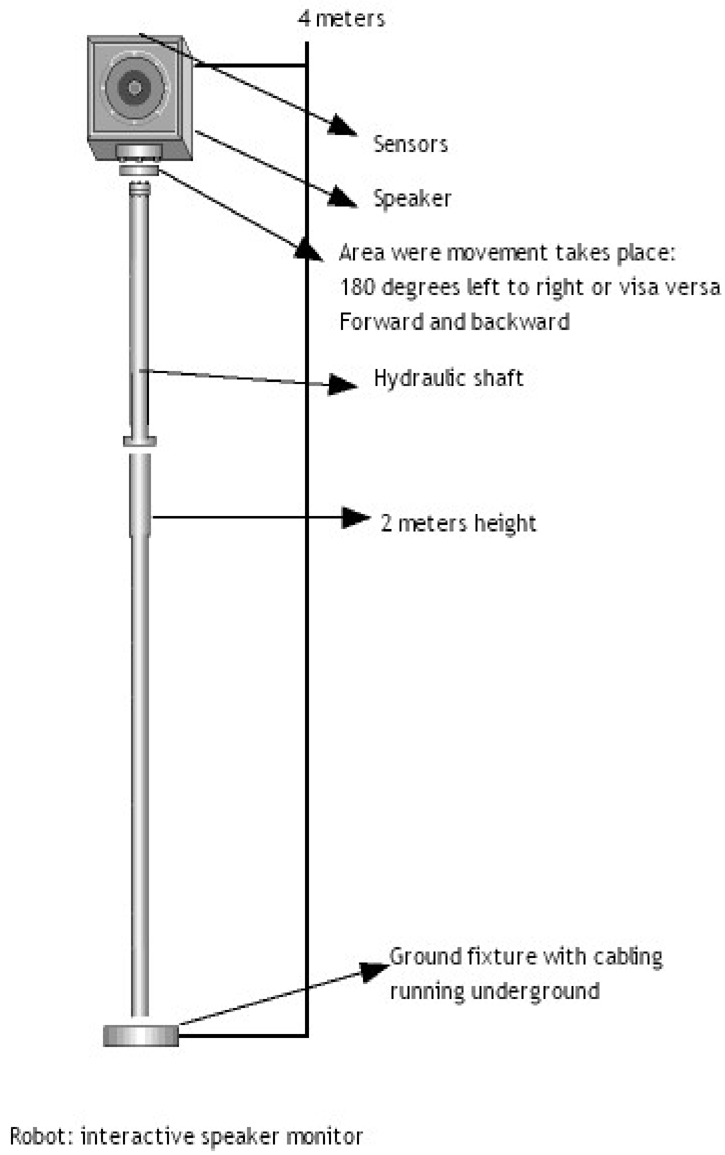


Figure 14

1. Vibration and Acoustic Pressure Sensors: which can detect the ground noise and adjust sound volume accordingly (each speaker can function as an independent unit).
2. The speaker head can rotate at 180 degrees on its axis.
3. The speaker head can move forward and backward at 90 degrees.
4. Via hydraulic action the speaker can collapse to half its original size in height.

12 --- Sound Projection

A sound projectionist is required, who is completely familiar with the score who has ample experience with mixing electronic music. The sound projectionist chooses the collaborators of the sound equipment company and inspects, ahead of time, the performance venue. At that time, it must be arranged that no listener is to enter the performance space before the performance and to enter the control booth were the multi-track equipment is situated. The sound projectionist decides all details about the sound projection, organises the necessary rehearsals with the equipment and directs the technical installation [tests that the speakers are performing correctly].

In addition to two sound technicians, he needs a musical assistant who checks the acoustics of all the positions in ΘΩΡΑΞ and to establish how clearly the sound directionality can be heard through out the space.

It is his responsibility that the listener hears a balanced whole.

a --- Frequency spectrum

Sound spectrum is one of the determinants of the timbre or quality of a sound or note. It is the relative strength of pitches called harmonics and various frequencies usually above the fundamental frequency. Care was taken to take all above into consideration during the sound construction of ΑΛΘ = Φ.

b --- Sound elasticity, density and velocity of transmission

Sound waves travel through any medium to a velocity that is controlled by the medium. Varying the frequency and intensity of the sound waves will not affect the speed of propagation. The elasticity and density of a medium are the two basic physical properties that govern the velocity of sound through the medium.

Elasticity is the ability of a strained body to recover its shape after deformation, as from a vibration or compression. The measure of elasticity of a body is the force it exerts to return to its original shape.

The *density* of a medium or substance is the mass per unit volume of the medium or substance. Raising the temperature of the medium versus inside and outside (which decreases its density) has the effect of increasing the velocity of sound through the medium.

The velocity of sound in an elastic medium is expressed by the formula:

$$v = \sqrt{\frac{E}{d}}$$

Even though solids such as steel and glass are far denser than air, their elasticity's are so much greater that the velocities of sound in them are 15 times greater than the velocity of sound in air. Using elasticity as a rough indication of the speed of sound in a given medium, we can state as a general rule that *sound travels faster in harder materials* such as steel [the metal rings in the construction of ΘΩΡΑΞ], *slower in liquids, and slowest in gases*. Density has the opposite effect on the velocity of sound, that is, with other factors constant, a denser material (such as lead) passes sound slower.

At a given temperature and atmospheric pressure, all sound waves travel in air at the same speed. Thus the velocity that sound will travel through air at 0°C is 1,087 feet per second. But for practical purposes, the speed of sound in air may be considered as 1,100 feet per second.

Figure 15 - Comparison of Velocity of Sound in Various Mediums

MEDIUM	**TEMPERATURE**	**VELOCITY**
	°C	(FT/SEC)
AIR	0	1,087
AIR	20	1,127
CARBON DIOXIDE	0	8,56
HYDROGEN	0	4,219
STEEL	0	16,410
STEEL	20	16,850

Elasticity is involved whenever atoms vibrate.A sound wave consists of energy that pushes atoms closer together momentarily. The energy moves through the atoms, causing the region of compression to move forward. Behind it, the atoms spring further apart, as a result of the restoring force.The speed with which sound travels through a substance depends in part on the strength of the forces between atoms of the substance. Strongly bound atoms readily affect one another, transferring the "push" due to the sound wave from each atom to its neighbor. Therefore, the stronger the bonding force, the faster sound travels through an object.

c --- Rubber Elasticity

Rubber bands are made from polymers, but the chains are crosslinked to provide a network. The amorphous phase is also said to be rubbery, constrained by the surrounding crystals and so cannot be said to be liquid-like. For the rubber bands, it is the crosslinks that determine the properties. The crosslinks provide a 'memory'. When the network is stretched, entropic forces come into play, which favour retraction, returning the network to its original unstretched/equilibrium state.

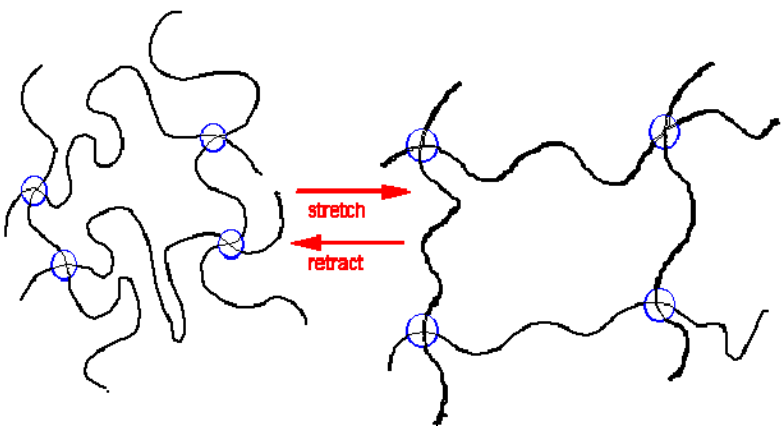


Figure 16

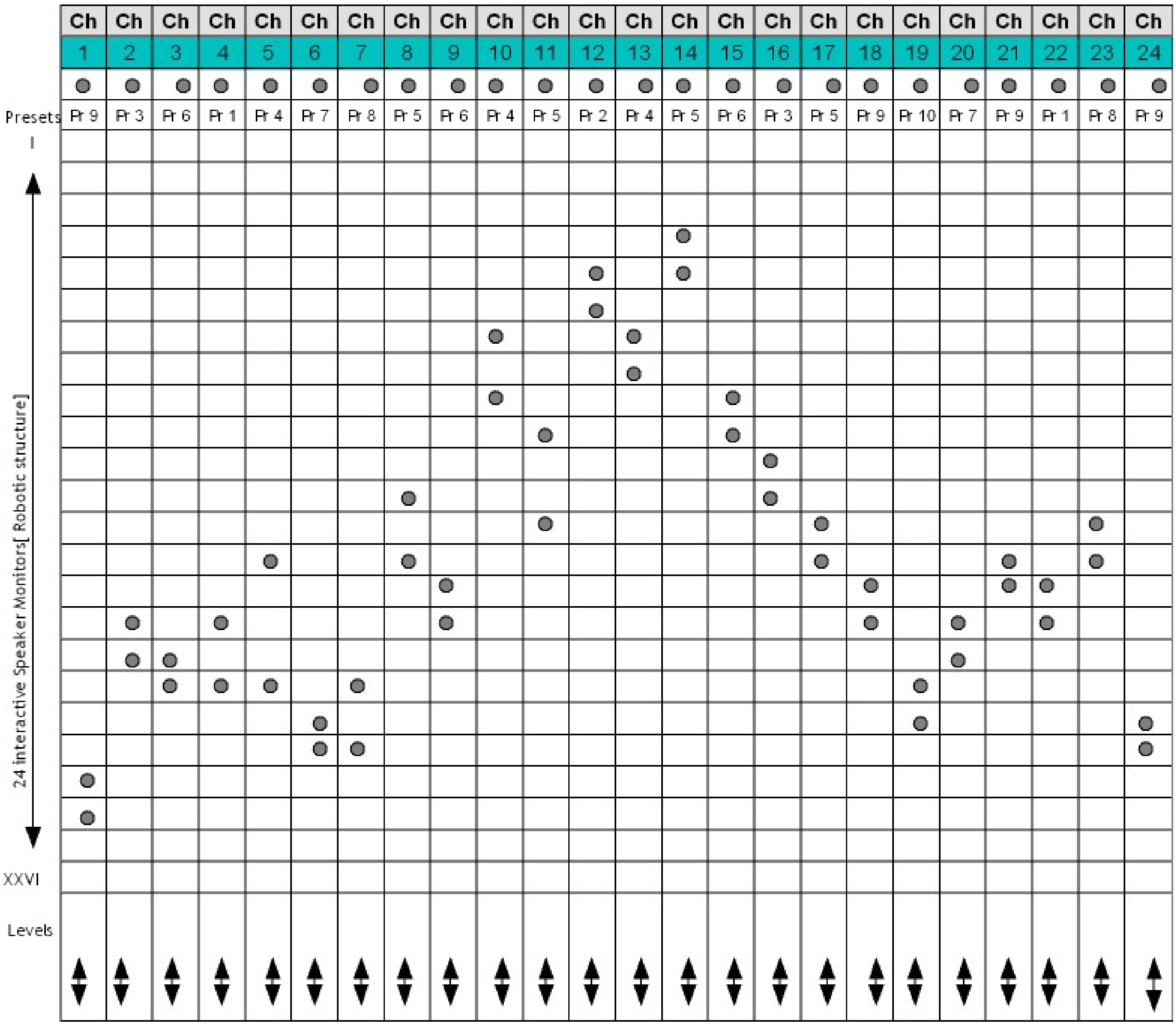
Loss of entropy upon stretching means that there is a retractive force for recovery when external stress is removed. This is why a rubber band returns to its original shape.

Network elasticity

However each chain does not deform individually but is part of a network. This means that for entropic elasticity (unlike enthalpic) the modulus increases with temperature and the material gets stiffer rather than softer. As crosslink density goes up, modulus goes up: a highly crosslinked rubber is stiffer than a lightly crosslinked one.

d --- Sound mixing console

Sound Mixer: Mackie T24, 24 channel Digital Mixer *Figure 17*



Sound Mixing Console for live performance-*Figure 18*

e --- Execution of ΑΛΘ = Φ

- Each speaker would identify its position in the space and send a signal back to the robot engineer.
- During the performance each speaker would analyse the situation in a 0.5 metre radius and decide whether it is important to increase or decrease volume by negotiating with the computer.
- Information regarding volume and manoeuvring of the robots is passed to the sound engineer who is responsible for producing the sound spectrum.
- The music in ΑΛΘ = Φ should be played loud.
- The sound direction could be altered by either up or down, left or right movement taken by each speaker.
- The sensors play a vital role in producing the final product.

13 --- Lighting Technician

Special lighting is necessary to illuminate the space and create a cellular appearance in ΘΩΡΑΞ the lightining technician also needs an assistant. He/she will be seated next to the sound engineer in the control booth.

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