Sonification Of Emotion State In Family-Run Businesses

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Abstract. I report on an application that makes use of auditory display of data that represents an individual's appreciation of his situation in the specific collaborative context of a family owned company. The auditory display is an emotion mapping of the company-family structure, and thereby transmits the emotional impact of possible future scenarios if no intervention takes place. The structural parameters 'family complexity', 'company complexity', 'company structure' and 'structural risk' are mapped to structural aspects of the auditory display that contain sufficient similarity to be readily appreciable with minimal preparation. The result is that the implicit emotional state of the analysis subject – a member of the family – is represented in the audio stream. This facilitates other family members' empathy, because it circumvents subjective semantic interpretations and potential rejection of a purely verbal interpretation of the data. The technique is general and may be applied to other collaborative situations where a self-learning approach is preferred.

1 Introduction

Family-run companies are abundant. They exist in all parts of the world, their size varying from 1-2 employed family members with a close-knit company-family structure, to the biggest companies in the world such as Wal-Mart, Ford, and Ikea that rely on a range of mechanisms to maintain family control while observing good management practice. This means that characteristics of being a family-run company may become a key influential factor in the company's stability, development, and sustainability.
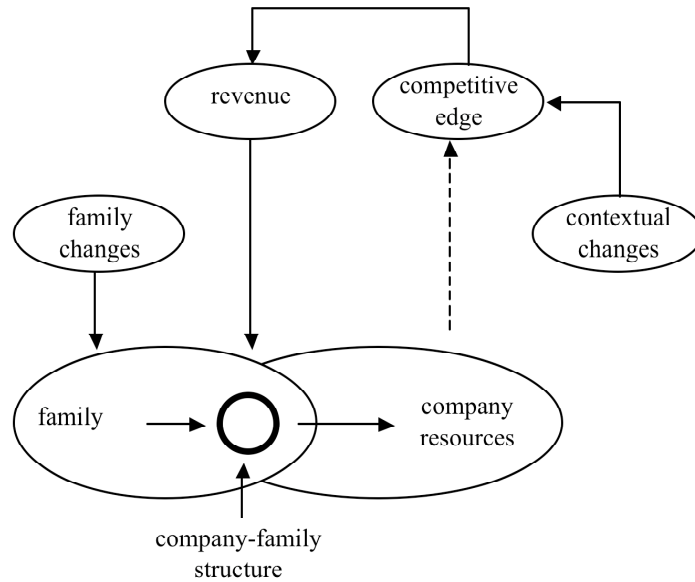
Fig. 1: Competitive loop of a family company, adapted from [2].

Being family run may bring particular conflicts that incur loss of competitive capacity, confusion, and disorder in the company. This happens because behind a company and the family running it is two distinct social systems with different functions, rules, and roles (Fig. 1). Likewise, when family and company interact, there is a tendency that disorder in one is transmitted to the other, where instability in the company may generate problems in the family. This may affect negatively the company's crisis management, and is similar to what happens inside a company, where disorder in financial, operational, commercial, judicial, or human resource sectors will transmit to other sectors.preparation of manuscripts which are to be reproduced by photo-offset requires special care. Papers submitted in a technically unsuitable form will be returned for retyping, or canceled if the volume cannot otherwise be finished on time.

2 Emotion and Risk Management

Since the eighties, a range of instruments has been developed to regulate family-run businesses. Initially, focus was on succession, but later models of family associations and dependencies were developed in order to modify, adapt and execute changes, observing immediate needs and future goals. Recently, attempts have been made to apply principles from corporate governance, but several important factors lie outside the company-family structure, such as relevancy of family relations, degree of family singularity, areas and variables of a family to address when re-structuring, and relations between the family's situation and the company's needs for strategic development.

One of the difficulties in dealing with these aspects is the different nature of a family and a company. The family is the formal owner of the company – and therefore the place where decisions of importance are taken – but family relationships are governed by loyalties, moral dependencies, affect, and rivalry etc., which influence each family member's judgment, understanding, and actions inside the company-family structure. If any major changes in the company need to be decided on in the family, many factors come into play that may have little or nothing at all to do with good company practice. The success of change is often dependent on the family's ability to formalize its relationships and apply appropriate regulating tools. A central issue in family-run businesses consequently becomes how to convey a deep yet immediate and intuitively accessible understanding among the family members of each member's subjective appreciation of the company-family structure's state.

2.1 Structural Risk

Understanding the nature and background of a required change in the company context and determining whether to act upon it, is therefore influenced by a number of personal factors that may be detrimental to the will to act upon them. Often a family-run company is very dependent on the entrepreneurial skills of one person, who may be the founder of the company. This can result in a very top dependent company model, which prevents other family members from participating in a substantial way in important decisions, a problem that becomes very prominent at periods of power transition between generations. When changes are needed, the family needs to arrive at a common understanding of the situation and needs of the company, but also at a mutual understanding of each family member's appreciation of his individual situation. This is required in order to reach sustainable solutions from both family and company perspective.

The company owner needs to know how the different members of the family perceive the company and their own relation with it, particularly the next generation that may become future managers. This perception may be very different among family members, because it depends on occupation, information, interests, and needs.

2.1.1 The SRM rule

The Structural Risk Management rule (SRM rule) was developed by the consulting company Family Business Knowledge, as a derivative of 14 structural relations in the company-family structure. (Fig. 2). Through questionnaires a report is produced that will identify differences of opinion, measure their relative importance, and determine their background. The state of a company-family structure is then exposed in short-form in the SRM rule as a numerical representation.

$$\left[\begin{array}{c} \text{family} \\ \text{complexity} \end{array} + \begin{array}{c} \text{company} \\ \text{complexity} \end{array} \right] - \begin{array}{c} \text{company} \\ \text{structure} \end{array} = \begin{array}{c} \text{structural} \\ \text{risk} \end{array}$$
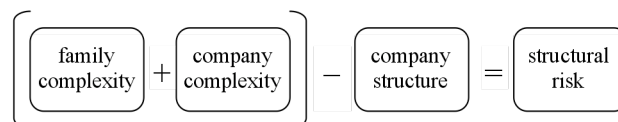
Fig. 2 Structural risk management rule (SRM rule), from [2].

Each parameter has the range 0-100, and the rule exposes the degree of complexity in the family *FC* and in the company *CC*, the relation between them, and the company structure to balance them. Significant structural risk *SR* occurs when the relations between family and company reaches a degree and complexity which the company structure *CS* cannot contain.

The perspective may either be general – the overall balance of the elements is queried – or it may be subjective, seeking to expose the balance as perceived by each family member independently. The latter case is of interest to us here, because a well-designed auditory display can facilitate mutual understanding by avoiding subjective interpretation. Instead, it places all family members inside the same un-verbalized yet highly emotive and communicative framework.

2.1.2 Emotion as a Means for Self-Learning

Individual family members may tend to refuse or question other family members' stated experience when done in verbal form. This can be due to earlier differences from within the family structure, or competitiveness and rivalry in the company-family relation, without relation to the company's internal structure. When a family needs to develop their relations and responsibilities, a general and common way to display relevant data is called for, where the emotional essence of a structural risk state and its underlying elements can be communicated to all family members in a way the facilitates understanding through self-learning.

Self-learning is an insight gained that gives a different interpretation and understanding of reality. It essentially involves comprehending the world by reinterpreting knowledge [1]. It is conducive to self-regulation, which is an efficient means for changing attitude towards persons that were previously seen as adversaries. Auditory display facilitates self-learning because it avoids the step of verbalization, with the connected subjectivity and individual interpretation of meanings. If we can make the listener perceive and mirror in himself the emotional state of another person through emotion-charged auditory display, then we can create the basis for the empathy necessary for a mutual reinterpretation of the present situation.

3 Emotion, Sonification, and Self-Learning

Emotional skills are an essential part of human intelligence; they modulate human communication and are fundamental to human activities [5]. The significance of the emotional aspects in musical content is readily appreciable by scholar and layman alike [6], and emotions can readily be categorized with the valence-activity map [4].

The strength of emotion and the ease with which humans detect basic emotions in music have contributed to establishing sets of detectable expression categories through a limited number of high-level music parameters. Tracking of a reasonable number of basic emotion categories in music is robust, and Camurri and collaborators reported on an abstract space representing emotional content of music [7]. They found that when the content is tied to musical structural cues – or cues in the sound's physi-

cal energy – then the emotions could be synthesized and later successfully recognized by test subjects.

3.1 Auditory Display for Self-Learning

Humans recognize emotion categories by a mirroring capability [8]. Given the right elements in the auditory display, a second-person emotion state can be directly and intuitively understood by musical and non-musical persons alike. This means that the somewhat abstract conclusions in numerical or verbal form of the SRM rule can be represented in sound in such a way that the emotional state of the person questioned is directly present in the auditory display.

Emotion in music is clearly discernable on signal level, but requires a self-interpretation on part of the listener that will depend on context factors difficult to address. The auditory display must therefore take into account the user's perspective, so that it does not convey or suggest any irrelevant secondary information, in particular any issues of musical issues such as style. On the other hand it must make use of music's uncanny ability to transmit emotional content, because it is through emotional impact that the auditory display can go beyond verbal interpretation, and manifest the particular state of a person in the context. Instead of style, a complacency-discomfort continuum (degree of desire to intervene, to change the situation into a comforting one) is attempted in the auditory display of the SRM rule, hereby conveying to the listener the degree of stability of the person it represents.

4 Implementation of the SRM Rule.

From early on it was early clear that the auditory display should have stable states extreme values of SR: a very soothing state when low, and a very discomforting state when high. Interestingly, both states were best represented as very stable states in terms of auditory display, because that would emphasize each state's characteristics the most. In particular, the discomfort of a high SR would be very present when very menacing.

Mainly rhythm and direct auditory icon content (albeit of a musical nature) has been implemented, since no emphasis was to be placed on melodic or harmonic elements. Each element of the SRM rule has been made musically and emotionally unambiguous by tying them to particular structuring aspects of the auditory display, so that they are always independently identifiable.

4.1 Spectral placement of the SRM rule elements

The four elements were placed so that their role in the SRM rule was related to structural elements of the auditory display, and so that they were scalable in both domains. FC and CC were interpreted as one statement of complexity, yet in two different areas: the family and the company. They should therefore display the degree of complexity in similar ways, they should 'lock together' when in balance, and they should

be clearly discernable. Complexity should be stated as stable and calm when at low values, unstable and transient in the middle range, and highly present and pressing when at maximum values. A rhythm pattern was chosen that would provide an inverse rhythm between the two that would overlap and increase in density towards high values of complexity (Fig. 3). The layers *FC1* and *CC* show the extremes, where the crossed notes represent the complexity values at 0. Increasing complexity would bring in the ø-notated notes, up to the point where complexity at 100 would provide two streams of 16th notes.
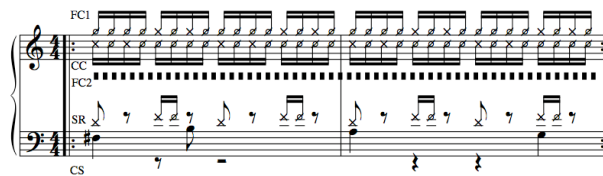

Fig. 3: Distribution of the SRM rule variables, in musical notation.

The uniqueness of having 'family' in the complexity parameter was underscored by the presence of the auditory icon – *FC2* in (Fig. 3) – representing degree of family presence. The amplitude of the auditory icon would increase with complexity, but would not interlock with the rhythm patterns. Instead, it would provide a state-of-presence that would allow for complexity to be displayed by the interlocking rhythms, thereby adding a complementary layer to this information stream.

The supporting structure is implemented in the auditory display as a structuring element of the longest periodicity. It thereby has the capability to sustain very intense auditory constructions (high levels of *CC*, *FC1*, and *FC2*), and still provide a low *SR*. It is equivalent to a bass-line, and is represented in (Fig. 3) as *CS*. It is the only element in the auditory display that has a clear melodic contour, yet it has been kept sufficiently simple to not convey any independent meaning outside its structuring needs. The result is that it conveys comfort when present because it balances the auditory construct, yet influences very much when missing or only sporadic or erratically present. It hereby clearly serves its purpose to display and represent in the auditory display the structuring force that has the capability for cohesion.

The emphasis for *SR* was to provide for a comforting sound on low values that would be able to transform into an auditory icon of alarm qualities tat high values. In fact, the goal was to present it in such a way that the discomfort should take on aspects of urgency, the same urgency for action that a real-world alarm going off would necessitate. A filtered noise source provided for this ability, where a narrow band-pass filter at low values of SR would give a soft, periodic ring, that could then be expanded to cover the major part of the frequency spectrum with bursts of noise at high values of *SR*.

4.2   Periodicity, pulse, and loudness

Having no melodic cues, tempo is defined as stable, so that the affected musical variables would be note density, amplitude, and noisiness applied to a dynamic frequency

range partitioning. Of the well-known mappings between amplitude and emotion, we use 'loud' to represent restlessness and 'soft' to depict tenderness [3]. Noisiness is used to depict danger, and density to depict instability. Increase in note density raises the pulse to double tempo, to further emphasize restlessness.

The periodicity falls into four structural categories: short (0,5-1 sec.), medium (1-2,5 sec.), long (2,5-5 sec.), and undefined (indeterminate length). Periodicity may change in the aspects of the SRM Rule as they change value, and the focus is on the emotional and representational impact in the auditory display.

An important aspect is the use of pulse and loudness. There is a clear doubling of pulse taking place from low to high values of *SR*, which happens because the *FC1*, *FC2*, and *CC* take on subdivisions. This is in itself not perceived on a positive-negative continuum, but more as what it is in itself, namely, an increase of activity in the complexity area. The transition between the extremes contains elements of instability, which aptly suggests that neither of the extreme states is present, yet both possible future developments. The supporting *CS* element is by its nature unaffected by any halving our doubling of the pulse. Instead, it emphasizes its own structure, and thereby its erosion when insufficiently strong to balance the complexity elements. This structural element has, as the only one, a melodic contour. This was very important, in order to clearly define its beginning and end, and how the element may loop and thereby provide an unstoppable, 'eternal' support for the entire audio complex.

aspect	low SR	medium SR	high SR
FC1	low density	unstabile	high density
FC2	distant	present	near
CC	low density	unstable	high density
CS	periodic	a-periodic	erratic
SR	pitch	percussive	noise
overall	low loudness	medium	high loudness

Table 1: Overview of the SRM rule variables' mapping onto the auditory display. Transitions across value ranges are implied.

Increase in loudness is determinant for the perception of anger and aggression, and there is an overall rise in loudness in each of the auditory displays of *FC*, *CC*, and *SR* as they approach higher values.

The mapping is different among the elements, because they would have independent needs for presence and transition at the different possible states of the SRM rule and its auditory display. Furthermore, the auditory display is generative, thereby providing constancy of impact, yet variety of presence (Table 1).

5   Usage

The system is fully implemented and has been used on several occasions (Fig. 4). But proper usage is dependent on minimal orientation in the auditory displays output. The output is not complex as such, and to facilitate familiarity we have implemented a testing phase implemented. This gives a sonic reference to the extremes of each of the four parameters so that the auditory display's sonic space can be established.

5.1   Familiarizing procedure

First, we audio-display the values 0, 50, and 100 for each of the four parameters individually. This step may be repeated at will. Then we test for recognition of simultaneous audio-display with random values 0, 50, or 100, and for random values 0, 33, 67, and 100. The purpose is not so much to have the user be able to identify the exact numerical value, but rather to show in a clear way the extremes of the auditory display, at different resolutions. If the outcome of the verification step is not sufficient – too high error rate in recognition – the audio-display step can be repeated. More tests with increasing resolution has not been implemented, because the users are able to identify the scope of the auditory display with the existing two, albeit in some cases with the need to repeat the verification step.
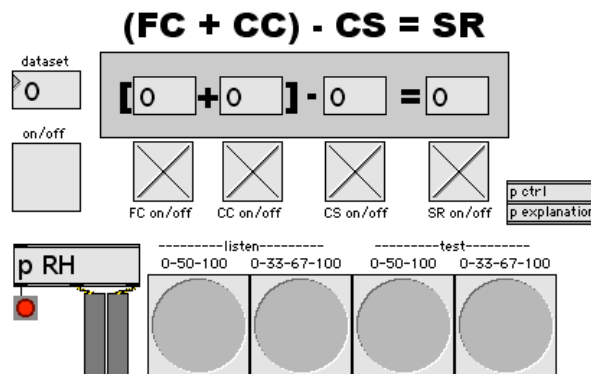

Fig. 4: The application's user interface.

The use of the application is easy and straightforward. The audio output has been optimized for small-speaker output, meaning that it can run on any laptop. The resources needed by the system are very limited, and no external data files are required. Values of the SRM rule can be entered manually, or sets of data can be read in and called up by indexing.

6 Conclusions

It is possible to truthfully convey individual emotional states through auditory display, through proper mapping of structuring elements extracted from a questionnaire onto similar structuring elements of the auditory display. The emotion state implied by the values analyzed for is hereby embedded in the auditory display. When another person perceiving the state is similarly represented, it provides for a potential situation of self-learning. This facilitates the conveying of complex and potentially subjective data to persons in a more secure and practical way, which is useful in a collaborative context where empathy and understanding are central issues.

The use of auditory displays is not common practice. This means that the representation may be conceived as less practically useful and trustworthy. The approach can prove useful in other collaborative situations where conflicts are present.

7 References

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