Understanding cooperative sound design through linkographic analysis

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ABSTRACT

Protocol and linkographic analysis are applied to a task of cooperative vocal sketching, proposed in the scope of educational research activites. The understanding of the cognitive behaviors involved in sound creation is aimed at setting the ground for the development of rigorous, designerly evaluation practices tailored to sound design. We show how relevant qualitative and quantitative information about the creative process can be used to inform the assessment and possibly improvement of vocal sketching methods.

1. INTRODUCTION

In the last decade, Sonic Interaction Design (SID) became a widespread label in the academic and artistic domains, to give voice to the plethora of emerging sound design practices and approaches to the culture of the audible, rooted in the synthesis of art, science, and technology. Major efforts have been undertaken by the research community to devise practices, frameworks, methods and tools to channel creative processes within the streams of a proper design discipline, founded at the intersection of interaction design and sound and music computing [1].

However, it must be admitted that despite these many efforts, SID propositions [1] are hardly finding their place in the real-world practice, being mostly confined in the labs and the fictive realms of educational workshops. For example, cooperative processes based on incremental iterations of crafting and evaluation are far from entering the *de facto* workflow of sound practitioners. Instead, projects are mainly carried out individually, the sound designer is left alone, immersed in a multitude of software tools to transform early, highly conceptual ideas in refined realizations.

Design methods, proposed by the academy, fail to breach the professional practice because they are developed in playgrounds which are essentially research-led rather than practice-led. It is not only a concern of magnitude of resources to assess the effectiveness of a design method in a real-world context, it is rather a matter of user research and testing. In fact, despite the general advocacy of a user-centered design, many scholars often fail to take in account designers as end-users of the methods under development [2].

In the last years, we have been collecting several workshop experiences around the themes of basic design and vocal sketching [3, 4], and several processes and activities have been conceived and structured to foster SID pedagogy and training [5, 6, 7]. Despite the optimization of careful pacing and clear learning objectives, we must say that workshop outcomes are often below expectations, in terms of both quality and quantity. The fact is that the proposed methods are mostly assessed qualitatively through observations collected in the lab environment or educational contexts, with the aim of setting points for analysis and future work. We feel that a step forward in the consolidation of SID would benefit from the application of rigorous, designerly evaluation practices. In other words, we attempt to apply established evaluation approaches in the design domain to assess the effectiveness and appropriateness of SID methods and practices.

In this paper, we address the assessment of the creative processes involved in a task of cooperative vocal sketching. A group of six master students in sound and music computing was engaged in sketching the engine sound for a concept car, and producing a sonic overlay out of vocalizations: A video-prototype of the vehicle was produced, by adding the sonic elements as layers of a silenced video of the car motion [2] [4]. The design session was constrained to a maximum duration of sixty minutes.

Protocol and linkographic analyses [8, 9] are the preferred tools to generate a qualitative and quantitative understanding of the design processes, and implicitly of the effectiveness of the use of vocalizations as primary means to support sound design-thinking, when drafting the acoustic appearance and behavior of an artifact.

The present study is part of a broader research aimed at developing a fine-grained understanding of the unfolding of design-thinking in the early conceptual stage of the sound design process. Indeed, the engine sound design task was proposed to six teams, under three different sound production conditions, one condition per pair of groups: 1) vocalizations only; 2) Foley [3] only; 3) sound synthesis and processing only. The objective is to produce comparative analyses of the creative processes under the same condition, and across conditions, in order to assess the effectiveness and appropriateness of approaches and tools.

[1] A comprehensive chart on SID can be found at http://mat.ucsb.edu/240/F/static/notes/Sonic_Interaction_Design.html.

[2] Similarly to the video example available at https://vimeo.com/128886746.

[3] https://en.wikipedia.org/wiki/Foley_(filmmaking).

In Section 2, we briefly introduce protocol analysis as means to study design cognition, then we report about the preliminary study on the early five minutes of the vocal sketching session, aimed at calibrating the coding procedure and the linkographic analysis. In Section 3, we analyze the whole session qualitatively and quantitatively. Then we discuss the findings in the light of possible improvements to the design task.

2. CODING THE SOUND DESIGN PROCESS

In our previous study [10], we tested the application of linkographic analysis methods to cooperative vocal sketching. In particular, we discussed the calibration of the analysis to the early five minutes of the audiovisual recording, and showed how sentences, vocalizations, and gestures by participants can be extracted, coded, and related to each other to extract qualitative and quantitative summaries of design processes. A summary is reported in Section 2.3.

Protocol analysis is an established method to study design cognition. The design process is segmented in *design moves*, that is minimal, sequential semantic units representing increments in thought. Once the protocol is parsed in design moves, a coding scheme is applied in order to categorize the segments. In our study, we developed a coding of elementary design moves by exploiting the Function-Behavior-Structure (FBS) ontology of design, as proposed by Gero [11, 12]. According to this categorization, each design object can be conceptualized in terms of three main ontological categories, that is the Function, the Behavior, and the Structure. This FBS categorization has been developed to model the process of designing as a set of distinctive activities [4] .

2.1 The Function-Behavior-Structure scheme

The FBS generic categorization framework is showed in Figure 1, and represents the design process as valid semantic transitions in a finite-state automaton of design moves.

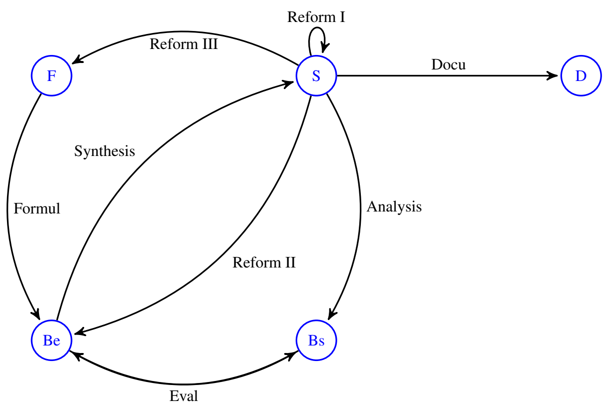

Figure 1. The FBS categorization automaton. The codes represent the states. Arcs are labeled according to the design processes.

[4] See `https://en.wikipedia.org/wiki/Function-Behaviour-Structure_ontology`, for a comprehensive overview.

Design moves are coded according to:

- the **Function (F)**, that is the purpose of the artifact, set by the designer or redefined from **Reform**ulation **III**, as a consequence of the emerging structure (S);
- the **Expected Behavior (Be)**, as **Formul**ation of the function or as **Reform**ulation **II** of the emerging structure (S);
- the **Structural Behavior (Bs)**, as derived from the **Analysis** of artifact configuration, that is the structure (S). **Eval**uation occurs when the expected and structural behaviors are compared against each other;
- the **Structure (S)**, that is the configuration of the elements and their formal relationships, as emerging from the **Synthesis** of the expected behaviors, or from the **Reform**ulation **I** of the revised Structure (S);
- the **Documentation (D)**, represents the set of design descriptions as outcomes of the FBS process.

Hence, we segmented the audiovisual recording of the vocal sketching session, and extracted the relevant verbalizations, vocalizations and gestures. These segments were put in relation and linked with each other using the finite-state automaton in Figure 1. Being this an interpretive activity based on common sense, we analyzed the transcriptions and the coding, individually and together, in order to converge to shared coding procedure and ensure intersubjective verification and consensus around the occurrence of links [10]. The emerging network of links between design moves represents a rich source of information that can be systematized through linkographic analysis [9].

2.2 A linkograph of design moves

The Excel file with the transcriptions and the code labels was imported in LINKOgrapher [5] [13] software to generate the linkograph, and extract general statistics as well as parameters of dynamic models proposed in the literature for design processes [14, 15]. At this stage, absolute temporal information is neglected, as linkographic analysis is only based on a discrete temporal logic.

Figure 2 shows a snapshot example extracted by the linkograph of the whole session. Links emerge as nodes of the reasoning, that can be established as forward or backward, based on their contents. Forelinks denote acts of synthesis. Backlinks reveal evaluation steps in design thinking.

In particular, Figure 2 depicts the reasoning about the aerodynamic component of the braking sound: Participant 5 (P5) formulates the behavior of the braking, accompanied by a sucked woosh vocalization and an iconic gesture illustrating the sound dynamics. Both vocalization and gesture at moves 10 and 11 represent a synthesis of the expected behavior set at move 9. Participant 2 (P2) proposes an alternative formulation of the braking function (set at

[5] `https://sites.google.com/a/linkographer.com/linkographer/`

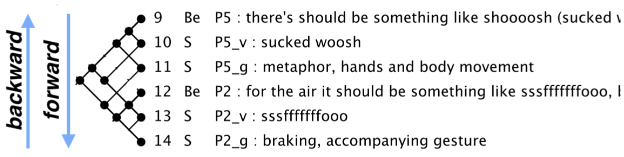

Figure 2. Snapshot of the linkograph for moves 9-14. The number of the move, the participant_type label, that is verbalization, vocalization (_v), gesture (_g), are reported for each transcription.

move 5 by P4 and not displayed in Figure 2), yet the proposed structural vocalization and gesture are both a synthesis of the behavior at move 12, and a reformulation of the vocal and gestural structures at moves 10 and 11.

2.3 Summary of the early five minutes

The early five minutes, corresponding to the segments $1-81$, are highlighted in the blue-framed box in Figure 3, which represents in turn the linkograph of the whole design session. Lapse $1-81$ was isolated by the authors to calibrate the application of linkographic analysis methods, because it encompasses a complete cycle of design process, from the formulation of functions to the production of early documentations.

The application of linkographic analysis to the early five minutes of the design session has been extensively discussed elsewhere [10]. Here, we report only a few points to stress the richness of the information that can be extracted.

In general, this early cycle describes a process progressing smoothly, yet not well-integrated, due to the presence of several nodes with distant links that quickly resolve to documentation steps. The first three purple ellipses highlight three main clusters of links reflecting an intense and in-depth examination of the design problems at hand. Cognitive activity in conception and exploration of ideas is high at the beginning, to fade almost linearly during clarification and resolution, respectively represented by the almost linear progression in the fourth ellipse and the documentation transition.

Table 1 reports the occurrence of different FBS categories for segments $1-81$, as extracted by LINKOgrapher. Structure codes are the most influential elements in

Code	Segments	
F	1	1.2%
Be	14	17.3%
Bs	13	16.0%
S	37	45.7%
D	16	19.8%

Table 1. FBS codes for segments $1-81$.

this session, thus suggesting a tendency to support and confirm the behavioral elements set, as they are. This can be read in terms of functional fixation on the initial ideas, thus impairing the generation of alternative concepts from the iterative inspection of the representations being produced (i.e., the structures).

Figure 4 represents the temporal distribution of codes, computed with a sliding window of 10 segments: Three roughly structured cycles of evaluation can be observed, right after a short and intense step of formulation and synthesis in the early 20 moves.

The analysis of the linkograph unveils an early collaborative process which is mainly focused on searching a shared and steady arrangement and progression, rather than exploring alternative ideas, to the detriment of creative and out-of-the box solutions.

3. THE WHOLE SESSION

Summary: After a brief discussion on the sonic features of the concept car, the group formulates a basic set of car sound behaviors, and namely the ignition, engine idling, engine revs-up, braking. One idea per sound is quickly sketched, based on individual proposals, and a first audio-visual documentation is produced by recording a live collaborative performance on top of the car video. Tasks are divided between participants, and the individual sounds are developed, through iterative sketching and discussion. Finally, the documentations of the single sounds are edited and added to the car video.

3.1 Qualitative analysis of the linkograph

From the combined inspection of the protocol and the linkograph (Figure 3) it is possible to roughly partition the overall session in three macro regions: 1) the early design cycle from segment 1 to 81; 2) a second region spanning the exploration and refinement of the sounds set; 3) a third region encompassing editing and montage of sounds on the video.

The first region shows a relatively higher density of links and inter-links between groups of moves, compared to the other parts, and indicates a rather solid activity leading to the early production of several design descriptions.

Groups of moves that are almost exclusively linked among themselves represent lines of thought focused on a specific design element, while interlinks between these groups can reveal the exploration of divergent thinking, and different viewpoints on the issue at hand [9]. This is not the case, as the connections between the four ellipses rather describe the generation and inspection of concepts which alternate or go in parallel. Figure 5 provides a closup on segments $1-31$, where the presence of several moves with no forelinks can be noticed, denoting propositions which are discarded by the group and no further scrutinized. The only move with no backlinks is at segment 6 and represents a novel proposition.

The substantial absence of moves with no backlinks suggests that the activity is focused on one principal idea only, derived from the function set at move 5 (red dash). In other words, the set of sounds documented at the end of this first cycle are originated from the one main idea.

Nonetheless, the first region is the most active part of the whole session, the working plan is defined and sound behaviors are structured, evaluated, and documented by sketching.

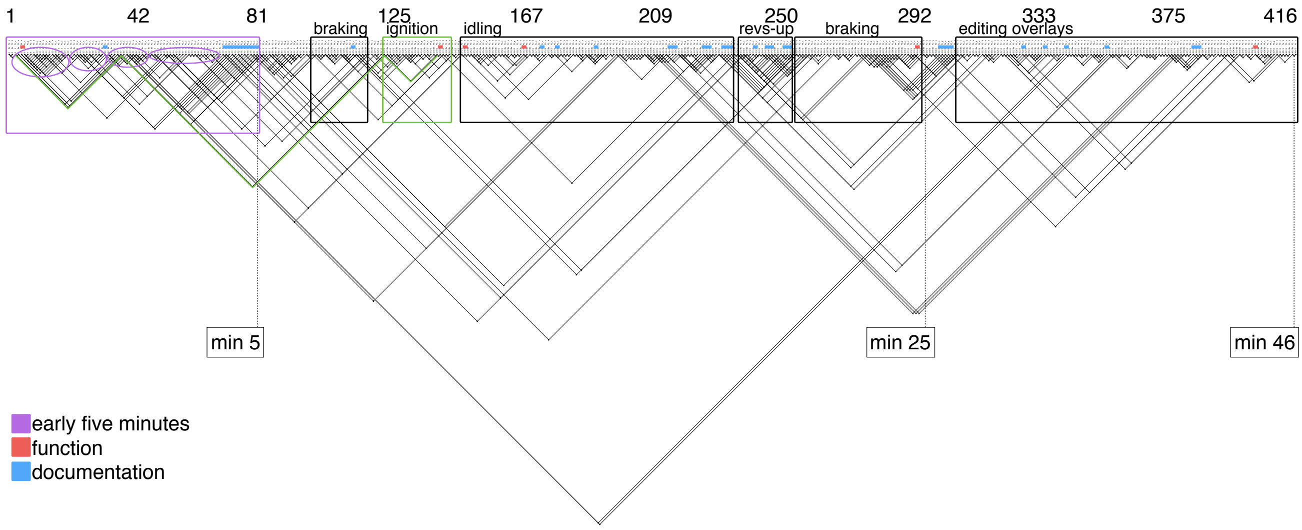

Figure 3. Linkograph for the whole session. 416 segments were retained for coding.

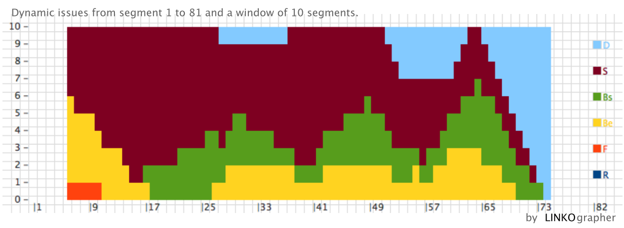

Figure 4. Temporal distribution of codes for segments 1 – 81.

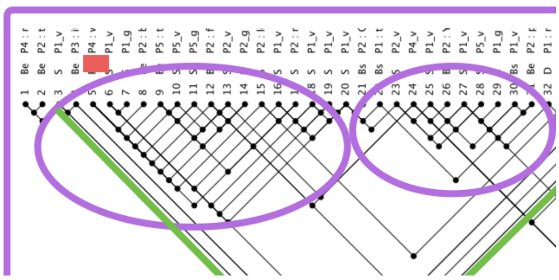

Figure 5. Closeup of the early design steps. Moves with no forelinks denote lines of thought which are no further carried out. Moves with no backlinks represent novel ideas.

Indeed, the second part (spanning segments 100 – 295) essentially represents a refinement step, in which the individual sound behaviors are deepened sequentially, as highlighted by the most distant connections between the first region and the sub-regions of the second part. We can speculate that the group is mostly focused on improving the quality of their sketches, that is practicing and exploring the vocal articulation of the fixated sound concepts.

The rather long extension of the number of moves for the idling sound refinement may be read in terms of a high complexity of the element at hand. However, from the closeup in Figure 6 it is possible to isolate several *sawtooths*, sequences of at least four linked moves, ending with no forelinks. This means that the idling sound process is mainly proceeding linearly with a poor engagement in the synthesis process. Propositions are built one upon another, without a widen investigation. It can be noticed how only the last two documentations out of the six produced are actually forwarded in the process.

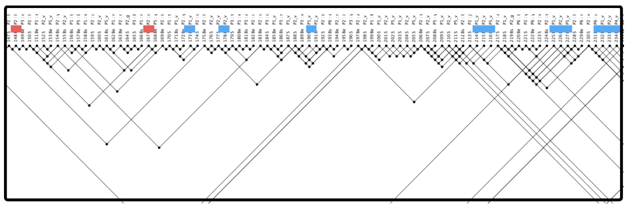

Figure 6. Closeup of the idling-sound design section. Sawtooths are linear sequences of moves and are an indicator of low engagement in synthesis processes.

Of interest is the case of the ignition sound design-thinking process, whose unfolding is highlighted in green. The trajectory clearly shows how this proposed sound function received basically no examination at all, and left aside until move 122. As shown in Figure 7, the design process progresses through dead-end linear sequences of moves to a point in which the function (red dash) is reformulated. However this reformulation does not lead to a new FBS cycle, and the ignition sound process is abandoned at move 145. The specific sound for the car ignition is discarded, yet the function is retained and assimilated in the idling sound process, as it can be inferred in Figure 3, by the move right after the red dash linked with the next to last documentation (blue dash) of the idling region.

The third macro region in Figure 3 encompasses the editing and montage operations towards the prototyping step. At this stage, the sound elements produced so far undergo a process of evaluation in context. In some cases, the group preferred to discard the most recent documentations and recovered the early sound structures. These are well-exemplified by the connections towards this region,

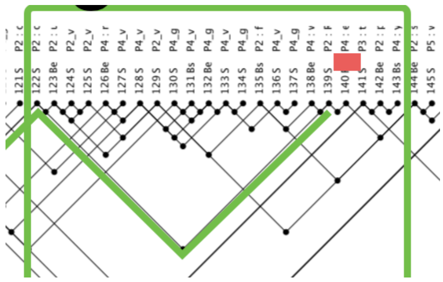

Figure 7. Closeup of the ignition-sound design section.

with the highest link span. In other words, the editing step reflects the evaluation and reconsideration of the previous design cycles.

Although absolute time intervals are not taken into account in linkographic analysis, the relative durations of the processes in the three main regions are worth noticing. Five minutes are devoted to conception and exploration stages (i.e., first region), twenty minutes are allocated to clarification and refinement activities, and other twenty minutes to the resolution stage. Only a small time was actually used by the group to understand and address the design task.

This can be interpreted as 1) difficulty or scarce inclination to exploit divergent thinking; 2) limited mastery in sound sketching, and therefore pressure to accomplish the task; 3) inadequacy of the software tool (i.e., the simple video editor) in affording sound sketching without sparing attention on the production process (indeed, sound editing and audiovisual syncing were mostly postponed to the end of session).

Finally, Table 2 shows the occurrence of verbalizations, vocalizations, and gestures by each participant during the whole session.

	Verbalizations	Vocalizations	Gestures
P1	40	44	7
P2	101	41	8
P3	40	2	0
P4	25	33	12
P5	9	22	5
P6	15	9	3
Total	230 (55,3%)	151 (36,3%)	35 (8,4%)

Table 2. Occurrence of verbalizations, vocalizations and gestures per participant during the sketching session.

In general verbal-thinking is prevalent, however some participants are more prone than others in using vocalizations as means to externalize sound ideas. Gestures have a limited use, mostly in a dual function, 1) as iconic means to signify aspects of sounds that cannot be produced or controlled with the voice, and 2) to physically affect the vocal sound, e.g. a damper effect obtained with the hand on the lips.

Sketching through vocalizations proved to be an effective means in structuring a complex concept in a few minutes. It can be argued that the bottleneck to prolific concept production and creativity is not in the aesthetic limitation of the human voice, but instead in sketching dexterity as opposed to the proficiency of " vocal rendering".

3.2 Quantitative description of the session

The qualitative analysis can be supported by statistics generated in LINKOgrapher. Some general statistics are reported, to give a clue about segments and links:

- Number of segments: 416 were retained for coding;
- Number of links: 674. The link index is of 1.62 per segment. The link index is an indicator of productivity in terms of linking activity;
- Average segment length: 7.35s, computed on non-empty segments;
- The occurrence of different FBS categories is reported in Table 3.

Code	Segment	
F	7	1.7%
Be	96	23.1%
Bs	60	14.4%
S	202	48.6%
D	51	12.3%

Table 3. FBS codes in the whole session.

The occurrence of FBS codes for the whole session is in continuity with the statistics extracted for the analysis of the early five minutes, reported in Table 1. However the slightly different percentages tell us that the overall session is essentially less effective and integrated if compared with the early five minutes.

The increase of the expected behaviors (Be) and structures (S) to the detriment of the structural behaviors (Bs) essentially signifies an increase of synthesis transitions and reformulations involving the structure or the expected behaviors. However these cycles are not the result of an iterative process of evaluation, they rather unfold through addition in a linear progression, as visually inspected in the linkograph. In fact, being evaluation associated to transitions between Be and Bs, the decrease of Bs codes results in less opportunities of analysis and evaluation.

3.2.1 Semantic processes

Relevant statistics are also found considering the semantics of the transitions between the FBS states. In particular, $A \rightarrow B$ is a valid semantic transition if A is a segment linked back by B in the linkograph [16]. The design processes (arcs of the finite automaton) are derived from such transitions, and their occurrences are reported in table 4.

Analysis and evaluation are effectively marginal compared to the combination of synthesis and reformulation I (i.e., reconsideration of the structural elements). Taken together, the design processes affecting the structure take the 50% of all valid semantic transitions. The direct effect of

Process	Occurrence	Percentage
Formulation	11	1.9%
Synthesis	106	17.9%
Analysis	68	11.5%
Evaluation	67	11.3%
Documentation	65	11.0%
Reformulation I	192	32.4%
Reformulation II	75	12.6%
Reformulation III	9	1.5%

Table 4. Occurrence of design processes.

this imbalance is scarce productivity in terms of documentations. This analysis suggests that, despite the effort and the engagement, the team suffered from lack of knowledge and attitude to evaluation and critical thought. Mastery of vocal production is certainly another important issue, as stressed by the large percentage of reformulations I.

3.2.2 First-order Markov model

LINKOgrapher also returns the transition probabilities of codes across links. It is a prediction of the probability of design issues coming after each other. Empirical probabilities of code-to-code transitions are computed, based on the association of the FBS states and processes with the segments representing the design moves, and constitute a first-order Markov model [16]. The transition probabilities between codes is reported in Table 5.

	F	Be	Bs	S	D
F	0.00	0.58	0.00	0.42	0.00
Be	0.01	0.02	0.17	0.80	0.00
Bs	0.00	0.90	0.06	0.04	0.00
S	0.02	0.18	0.17	0.47	0.16

Table 5. Transition probabilities between FBS codes.

In general, the transition probabilities towards the structure code (S) are the highest, except for $Bs \rightarrow S$. When Bs issues are occurring, the likelihood to be followed by Be and therefore lead to an evaluation process is very high. However, the probability to have a Bs right after a S code is very low, being only the 17%. Remember that $S \rightarrow Bs$ is the valid semantic transition, as illustrated in the scheme in Figure 1, and that evaluation processes can be bidirectional $Be \leftrightarrow Bs$.

The combined reading of $Bs \rightarrow Be$ and $Be \rightarrow Bs$ probabilities stresses that a design progression, as the one found by the group, would lead to a low rate of iterations. In other words, the design issues at hand are not really deepened, and rather resolved as they are. In practice, it is likely to have a design process stuck on one issue, or hopping from one issue to an other. In both cases, the process inefficiency results in a scarce probability of producing documentations.

3.2.3 Entropies

The strength of an idea can be measured quantitatively by using entropy [15], and this is a measure that can contribute to give a clear picture of the productivity of the sketching session.

To use the information-theoretic concept of entropy, every link between two segments is considered as an event, which does or does not occur. In the measurement of dynamic entropy only the structure of the linkograph is considered, ignoring the codes. For the reported LINKOgrapher computations over the whole session, we used a sliding window of forty-two segment. This means that, given a segment, the software checks for the presence or absence of a link with other segments not farther than forty-two positions away.

Figure 8 shows the dynamic forelink entropy of the whole session. Forelink entropy gives a measure of the opportunity for new creations or initiations. A low entropy means weak or fixated ideas, respectively due to the occurrence of a too few or too many forelinks. The drop around move 42 corresponds to the third ellipse in Figure 3, and the clarification step in Figure 4. It means that the process is not focused on creation, but rather on evaluation. We can infer that this drop actually represents the most effective evaluation step in the whole session.

The highest peaks around moves 230 and 290 correspond respectively to the last parts of the idling sound region and the second braking iteration in Figure 3.

The segment spanning approximately moves $125 - 150$ represents the ignition sound process. Here, the only peak over the mean value is the link of the segment in which the group decides to include the ignition function in the idling sound.

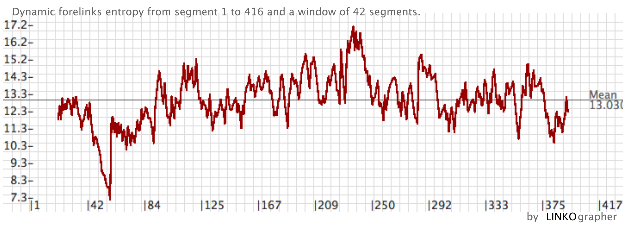

Figure 8. Forelink entropy in time.

The novelty of ideas can be measured also through backlink entropy. If an idea is very novel, it will not have backlinks, and therefore it will have low entropy. The backlink entropy of the session is shown in Figure 9. It is possible to isolate three main iterations starting at moves 1, 84, and 300, and roughly corresponding to the macro-regions, highlighted in the qualitative analysis of the linkograph. Segments $125 - 150$ reflect the ignition sound region, where the apparent novelty is related to the fact that the embrionyc idea, set at the very beginning of the design process, was basically left in the background. The low backlink and average forelink entropies for the set of documentations occurring at segments $300 - 310$ suggest that the novelty mainly arises from an alternative arrangement of the structural elements at hand, as a consequence of one of the few $Bs \leftrightarrow Be$ transitions. That is, the group actually managed to produce design a description when enabled by an iterative evaluation.

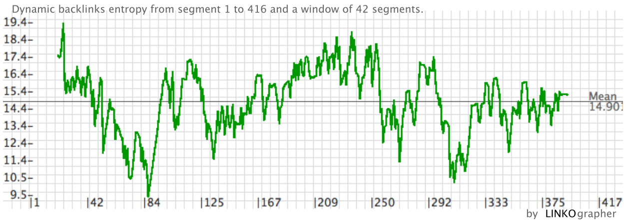

Figure 9. Backlinks entropy in time.

Finally, horizonlink entropy provides a measure of the opportunities for ideas generation based on the horizontal link span between inter-connected moves. This measure takes in account the cohesiveness and the incubation of segments. Low entropy indicates a strong cohesiveness. The graph (Figure 10) provides an overview of the process unfolding based on the distance between inter-connected moves.

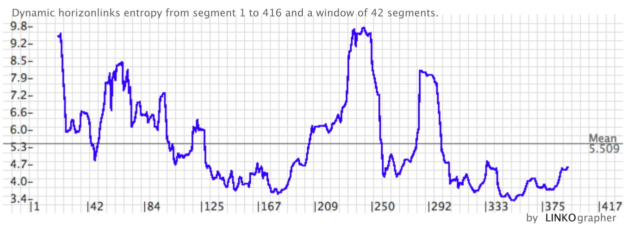

Figure 10. Horizonlinks entropy in time.

From the combined reading of the graphs of entropies, some interesting observations can be drawn regarding the revs-up sound region. As shown in Figure 11, this region is characterized by the highest incubation of segments, and high values of backlink and forelink entropies. Given the high backlinks entropy, the novelty of the ideas does not depend from the formulation of new and original propositions. Rather, the revs-up sound design process is effectively carried out and documented, by transforming and rearranging a few structural sound elements produced farther away.

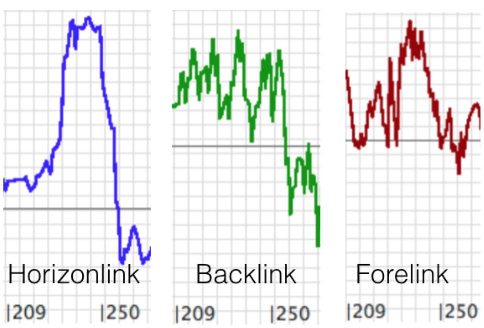

Figure 11. Entropies for the Revs-up sound region.

4. DISCUSSION AND CONCLUSIONS

The informations collected from the linkographic analysis stress several issues deserving a further in-depth analysis. A consideration concerns the critical review of the proposed task, from the viewpoint of its rationale. The proposed assignment is framed in a set of incremental activities aimed at acquiring and developing cognitive abilities and compositional skills in sketching sonic interactions and designs.

The first issue is understanding whether the conception and pacing of the assignment meet their underlying rationale, and whether alternative measures can be undertaken to effectively achieve the objective. For this purpose, protocol analysis and linkographic representations are exploited to develop a fine-grained understanding of the cognitive behaviors and the possible bottlenecks emerging in sound creation processes. Time-constraints, and economy of means are devices that are largely used in design exercises to foster creativity.

The task at hand was conceived around a few requirements: the production of poliphonic sketches in order to promote cooperation, no speech sounds nor onomatopoeia in order to foster the creation and design of non-verbal auditory displays, no Foley nor sound processing in order to encourage the practice of vocal articulation and production. Loose time-constraints are counter-balanced by the requirement of producing at least two alternative designs. In the early formulation of this task, it was required to produce at least five propositions.

The linkographic analysis of this specific team work showed that the group effectively created a self-contained sketch in the early five minutes of the design session. Therefore, a measure to foster effective productivity is to reduce the overall duration of the task, and allocate constrained slots of five minutes to actually produce one sketch. This pacing is similar to the use of speed-dating for design ideas generation and exploration of divergent thinking opportunities [17].

The exploitation of divergent thinking certainly represents a fundamental issue, and preparatory exercises around creative sound associations should be conceived in order to develop design-thinking and imagery. In order to do that, the cognitive activity emerged from the analysis of the revs-up sound process stresses the relevance of learning and mastering mental transformations. That is the ability to shift configurations and relations in the time-frequency domain, as opposed to shifting spatial relations in visual sketching.

As a consequence of focusing on the improvement of dexterity in vocal sketching, it is necessary to develop a practice of vocal articulation tailored to design, as emphasized by the frequent occurrence of structure codes and reformulation I processes across the session.

On the other side, we must not forget the assumption stated in the introduction, that is the effective grounding of methods development in user-centered design. From this viewpoint, we recently run a 48 Hours Sound Design workshop at Chateau La Coste art park and vineyard, in south France. Each of five professional sound designers was invited to work on one of the site-specific art pieces located in the park, and design an accompanying sound signature for the chosen art installation, in 48 hours. Vocal sketching methods and tools, developed in the scope of the EU project SkAT-VG [6] (Sketching Audio Technologies using Vocalizations and Gestures) were the exclusive means available for sound ideas generation and sketching. The documentary of the workshop is available at: `https://vimeo.com/169521601`. We plan to apply protocol and linkographic analysis to sound design processes involving both expert and novice designers.

5. ACKNOWLEDGMENTS

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