AtomSwarm: A Framework for Swarm Improvisation

Daniel Jones

Lansdown Centre for Electronic Arts, Middlesex University, London EN4 8HT, UK
`daniel@jones.org.uk`

Abstract. This paper introduces AtomSwarm, a framework for sound-based performance using swarm dynamics. The classical ruleset for flocking simulations is augmented with genetically-encoded behaviours, hormonal flows, and viral 'memes', creating a complex sonic ecosystem that is capable of temporal adaptation and self-regulation. The architecture and sound design methodologies are summarised here, with critical reference to its biomimetic design process, sonic spatialisation and self-organising capabilities. It is finally suggested that the system's life-likeness is a product of its relational complexity, creating empathic engagement purely through abstract formal structures.

1 Introduction

It is well-established that there are compelling parallels between the complex behaviours demonstrated by swarms of social animals and those found within the realm of free musical improvisation [1,2]: simple, local interactions spontaneously give rise to complex global forms, with no a priori organisational principles, creating aesthetic structures that cannot easily be reduced to the sum of their parts. In support of these ideas, the author's research at the Lansdown Centre for Electronic Arts has revolved around situating swarms of simulated agents in the context of live musical performance, as active and reactive software agents.

The outcome of this research is AtomSwarm [3], a framework for sound-based composition and performance. AtomSwarm expresses the dynamics of a swarm both visually and as a spatialised sonic ecology, with each agent corresponding to a genetically-determined synthesis graph, whose parameters are modified based on its movements and interactions. It can be used as an independent generative system, developing and evolving through its internal resource regulation and temporal cycles, or as a complex interactive instrument, 'played' in an improvisatory fashion by modulating the rules that govern the system's interactions.

From the ground up, AtomSwarm's architecture and design has been conducted with biomimetics in mind; both the swarming engine and sound design draw extensively on biology, biochemistry and evolutionary theory. The drive behind the system's development, however, is essentially aesthetic, and certain contributions and abstractions have been made in order to develop the anthromorphic qualities of a performance. A consequence of this is that the system

M. Giacobini et al. (Eds.): EvoWorkshops 2008, LNCS 4974, pp. 423–432, 2008.

architecture features a degree of complexity that is at odds with classical alife objectives[1], seen here as a contingent sacrifice for expressive richness and behavioural familiarity.

In this paper, we first review the system's architecture and design methodologies (Sections 2 and 3). We then position and assess AtomSwarm along three axes: as a spatiotemporal environment (Section 4); as a generative, interactive instrument (Section 5); and as a self-organising ecosystem (Section 6). We conclude with an anectodal account of the ability of a symbolic system to induce an empathic response in an audience.

2 Swarming Engine

The core of AtomSwarm's infrastructure is its object-orientated swarming framework, developed entirely using Processing[2] [5]. Working from the basis of Craig Reynolds' Boid algorithm [6], the engine is extended in complexity by introducing a number of artificial hormones ($h_x \in [-1..1]$) to each agent. Each virtual hormone's behaviours are modelled on the qualities of one or more actual chemical hormones or neurotransmitters, and is modulated by certain interactions and cycles analogous to its counterpart. In turn, it then affects the ruleset for local interactions that each agent follows as it traverses the swarm space, by modifying the strength and threshold values of each rule.

Table 1. Types of artificial hormone

Name	*Modelled on*	*Function*
h_t	Testosterone	Increases with age and crowdedness; decreases upon giving birth. Causes an increase in the likelihood of reproduction.
h_a	Adrenaline	Increases with overcrowding; decreases as a result of internal regulation over time. Causes a greater rate and variance of movement.
h_s	Serotonin	Increases during 'day' cycles; decreases during 'night' cycles, and as a result of hunger. Causes a greater social attraction towards other agents.
h_m	Melatonin	Increases during 'night' cycles; decreases during 'day' cycles. Decreases rate of movement.
h_l	Leptin	Increases upon eating 'food' deposits; decreases steadily at all other times. Signifies how well-fed an agent is, and causes downwards regulation of h_s when depleted, and greater attraction to food deposits.

In addition, each agent has a static *genome*, comprised of a series of floating-point values $g_x \in [0..1]$. These encode various qualities of the agent's behaviour, and remain invariant over time, though individual genes can be overwritten by viral infection (described in Section 6). The full set of genes is summarised in Table 2.

---

[1] See Christopher Langton's edict in the inaugural workshop on Artificial Life that its systems are expressed using "*simple* rather than *complex* specifications" (original emphasis) [4].

[2] Processing is a graphically-orientated extension of Java, incorporating a programming language and standalone IDE.

Table 2. Types of gene

Name	*Name*	*Function*
g_{col}	Colour	The hue of colour used to depict the agent.
g_{age}	Age	The rate at which the agent 'ages'.
g_{int}	Introspection	The degree to which the agent is attracted to social groups, or otherwise.
g_{perc}	Perception	The range at which the agent can perceive and respond to its peers.
g_{son_x}	Sonic parameters	The sonic behaviours exhibited by the agent, described in the following section.
g_{cyc_x}	Hormone cycles	The strength or speed of each hormonal cycle; for example, g_{cyc_s} determines the amount that the agent's h_s level increases during a 'day' cycle.
g_{up_x}	Hormone uptakes	The quantitative increase in hormone level experienced when uptake occurs; for example, g_{up_a} determines the degree of h_a increase following a collision with another agent.

The g_{cyc_x} and g_{up_x} gene sets, determining hormonal cycles and sensitivities, are critical to the ecosystem's diversity and evolution. For example, as a consequence of their effects, a particular agent may be prone to sudden increases in h_a levels, resulting in it 'fleeing' an overcrowded area and locating new food deposits. Given the presence of of agents containing suitable genetic traits, the swarm is thereby able to respond appropriately to a wide range of states.

Thus, in distinction to the time-invariant behaviour of the original Boid algorithm, there are now a number of feedback mechanisms in place: the genotype of an agent determines its hormonal fluctuations; the genotype and hormone levels co-determine its response to each of the set of physical rules (cohesion, separation, etc); and events caused by following these rules (eating, colliding, becoming overcrowded) feed back to modulate hormone levels. The interactions between these three planes of codification quickly become very complex, and result in diverse and shifting collective behaviours over time. Moreover, they create the ability for the ecosystem to adapt and self-regulate its population, as outlined in Section 6.

The size of the population is also subject to continuous fluctuations due to the processes of reproduction and death. The agents are asexual, and give birth to a single offspring after their h_t level reaches a fixed threshold. The genome of the offspring is a duplicate of its parent's, subject to minor variance (wherein each gene g_x is altered by up to ± 0.1) and a degree of genetic mutation (with a probability of 0.05, a gene may be replaced with a uniformly random value $X \in [0..1]$). The offspring's behaviour is therefore usually similar to that of its parent, but may occasionally exhibit radical alterations, opening up the possibility of advantageous anomalies.

Deaths can be caused by hormone imbalances, representing starvation, depression and metabolic overload, or simply by old age, determined relative to the g_{age} gene.

The system additionally incorporates the concept of 'food', an arbitrary resource placed in scattered collections at uniformly random intervals, whose presence introduces a constraint on the swarm's collective resource levels; and 'day' and 'night' periods, which cycle over the course of a few minutes, reflecting the length of a typical performance. These constructs serve to modulate the swarm's hormonal levels over time, in a fashion analogous to natural metabolic systems, and thus structure the sonic form into subtly-defined movements of tempo and intensity.

3 Sound Synthesis and Mappings

The sound generation components of AtomSwarm are handled by SuperCollider's powerful synthesis engine, communicating with the swarming process via Open Sound Control. As the system's design requires fine-grained control over the musical output from the ground up, sonic behaviours are also codified extensively in the swarming engine itself.

At the sound design stage, a palette of 'generator' and 'processor' synthesis modules was defined, each of which is comprised of a number of SuperCollider's primitive DSP units and accepts up to two arbitrary parameters ($x_a, x_b \in [0..1]$). Each agent is then assigned one generator and one processor unit, determined by its genetic content, which are instantiated on the server and combined in serial. This compound graph provides it with an identifiable sonic signature – or to use the language adopted by Dennis Smalley, its "physiognomy" [7].

Alongside its synthesis graph, each agent's genome encodes a 'trigger' mode and threshold, which together determine the point at which the synth is instructed to generate output. This may be, for example, upon collision with another agent, or when the agent reaches a velocity of X pixels per second, where X is genetically specified.

For continuous sonic modulation, the genome also determines a fixed mapping from the agent's movements to a given property of its synthesis graph; for example, its velocity (normalised to [0..1]) may be mapped to the generator's x_a parameter, which, for some generator units, is then assigned to its amplitude. In a more complex case, the relative-shift parameter, reflecting the rate at which the agent is moving towards or away from a peer, could be assigned to the frequency parameter of an oscillator. This creates an approximation of the Doppler effect, exemplified by the familiar drop in pitch of a passing ambulance siren. In testing, this was found to also give a convincing approximation of the pitch oscillations of a swarm of buzzing bees.

AtomSwarm is orientated towards the composition of textural and quasi-rhythmic forms, often making use of repetitive cycles of short, non-tuned sound objects. The single pitched synthesis class is a pure sine wave, with an amplitude envelope for gradual onset and release. Combined with the potential combinatorical complexity of a genetically-selected processor unit and motion mapping, even this can give rise to a diverse range of output.

3.1 Biomimetics in Sound Design

The sound design for the synthesis components was a broadly biomimetic process. An earlier incarnation of the framework used sound recordings of a number of natural phenomena: human bodily functions, cicada calls, and metallic, drip-like impulses. The transition to pure synthesis was made by observing the spectral qualities of these classes of sound, and translating them into functions of basic oscillators and signal processing units. Each generator component thus has a distinct morphological identity, texturally modified by its processor, but retaining sufficient qualities to be identifiable as being from the same source.

Why was this approach taken? Rather than simply using the ordered structures of motion for composition within an existing framework, like the melody-orientated generative composition of Blackwell's early research [8], a conscious decision was made to evoke the qualities of an ecosystem "as it could be" [4] – supporting the existing visual and conceptual narratives, and suggesting immersion within a possible, quasi-biological world. The intention was that, even without the visual depiction of the ecosystem, the sonic design alone would suggest that the source of the sound is organic in nature. With the addition of heavily synthetic processor units, this reference is warped and distended to suggest a bio-technological hybrid.

4 Spatiotemporality

AtomSwarm's agents are located within a continuous 2-dimensional space, bounded by the limits of the visual display. Early prototypes used n-dimensional vectors, following Blackwell's swarm composition research [9] which frequently uses up to 7 spatial dimensions to compelling effect.

However, in the case of AtomSwarm's sonic expression, we are less interested in positional data, instead focusing on the overall dynamics of the swarm's motion and its status as a continually generating ecosystem. Furthermore, as we are not working with the traditional axes of pitch/amplitude/duration, we have no need to capture this number of positional values in parallel; we have a sufficiently wide combinatorical space of timbral qualities to be content with one motion mapping per agent, which quickly results in complex sonic interactions even with a relatively small swarm. Even this one mapping may not be positional, instead taking values from velocity or relative movements. In this way, we hope to express a greater range of the dynamics of the swarm. A crowded, fast-moving group may be expressed by heavy layers of high-frequency ticks, a series of sine waves undergoing rapidly fluctuating Doppler shifts, or by frequent percussive pulses given off by collisions between agents.

The most prominent use of the swarm space, however, is in its identification with the space surrounding the viewer. The single agent present from the very start of a performance is known as the 'Listener', visually identifiable by its red outer ring. Effectively, the viewer hears the swarm's motions from the perspective of the Listener, using vector-amplitude panning [10] for simulated sound source positioning on an arbitrary number of output speakers. On a 2-dimensional multichannel speaker set, sound events to the left of the Listener are heard to the left of the viewer; events displayed above the Listener are heard straight ahead. As the Listener moves around the world, therefore, the viewer's soundscape shifts accordingly.

This is further supported by a global reverberation unit, whose reflection parameters are adjusted according to the Listener's mean distance from its peers to simulate the reverberant qualities of distant sounds within a large space. Though this technique lacks precision, it serves to support the notions of distance and proximity, both important criteria for the faithful sonification of a distributed population.

These methods encourage the viewer to identify with an agent inside the space, shifting them from a position outside of the system to one immersed within it. Indeed, 'immersivity' is intended to be key to the experience of a performance, reinforcing empathic engagement with the spectator. These ideas are a continuation of the drive to realize a possible space "as it could be". Yet, though this space is rendered perceptible around the audience, the system's digital manifestation indelibly marks the experience with the grain of non-reality.

5 Performance Interface and Human Intervention

In the context of a live performance, AtomSwarm is projected onto a screen visible to the audience, with audio distributed via a multi-channel speaker system. Control over the environment is limited to a basic MIDI interface, through which the human 'conductor' is able to create and destroy agents, add food deposits, and manipulate the weightings of the physical rules governing the swarm's movements. Thus, the only control mechanism is wholly indirect, with no scope for determining its sonic behaviours, nor even manipulating the individual agents themselves[3]. Three layers of interactions serve to mediate the conductor's influence over the soundscape: between the rule weightings and the swarm's hormone levels; between the relative positions of each of the agents; and between each agent's motion dynamics and the sonic mappings described by its genome. Through these layers of mediation, it is often the case that that attempts at influencing the system go unheeded; increasing the 'Cohesion' rule, for example, may be ignored entirely by a swarm made up of highly introverted agents.

As far as modulating the current behaviour is concerned, therefore, the conductor's role is limited by constraints imposed within the system. A constant tension emerges between order and chaos, with the human input in continual threat of being outweighed by the balance of internal forces. This is the same "dynamic network of relations" as described by Lev Manovich [11], in which current trends are vulnerable to being swept away by amplified oscillations towards a new structural equilibrium. The resultant experience is almost game-like, in that the aesthetic 'fitness' of the collective sonic output may be at odds with the fitness criteria of its constitutive agents. For example, a clustered group may be generating a rich, compelling timbre, but this cannot be sustained if its collision rate is too high (wherein h_t overload will kill many of the agents), or hunger

---

[3] It is for these reasons that the term 'conductor' has been adopted: as in an orchestra or choir, the conductor maintains real-time control over the unified ensemble, gesturally influencing its flow and dynamics en masse.

levels rise to the point at which the agents ignore the 'cohesion' rule and depart to seek food.

An alternative approach to performance is to allow the ecosystem to develop and regulate itself independently, and engage in total autopoiesis. In the absence of human intervention to supervise its growth, the swarm will still engage in self-regulating behaviour as a consequence of its hormonal requirements, limited resource supplies and aging processes. Evolutionary narratives unfold according to the interconnected rulesets that determine the genome-hormone-ruleset interactions; spectators can select whether to engage on a macroscopic scale, with the synchronised movement and sonification of the swarm as a whole, or on a microscopic scale, in the interactions of individual agents.

6 Self-organization and Emergence in AtomSwarm

The flows of resources within AtomSwarm are carefully balanced to ensure that interactions occur at appropriate levels and rates, so that, for example, a population will not normally die of starvation within a few seconds. As a consequence of this equilibrium, it is now demonstrably capable of exhibiting a range of non-trivial self-organising behaviours, many of which were not anticipated when these interactions were first implemented.

On one level of resource flow, each agent attempts to maintain an internal homeostasis: as a hormone quantity is amassed or depleted, its rule-following behaviours will be slowly weighted towards those actions that will assist its regulation (eating, reproducing, seeking isolation). Above this, on the macro-scale of the swarm as a whole, a "homeorhesis" [12] occurs, or the *regulation of flow* of resources between agents, with only a limited quantity of food deposits available. If the population grows too large, insufficient food supplies result in downwards regulation due to deaths from starvation. If it shrinks, food is abundant and the population is free to increase. Yet, this is no guarantee of survival: agents which are excessively sociable risk death from the h_t overload caused by excessive collisions; a nomadic tendency may be useful for finding isolated deposits of food, but can result in h_s depletion and a lack of h_t, and thus the inability to reproduce.

Another emergent surprise, and one which genuinely instilled the rewarding, unexpected sensation of the "something extra" emphasised by Whitelaw [13] in his cross-section of a-life art, is the swarm's ability to effectively discover food deposits. Each deposit comprises of up to 10 food particles, each of which is sufficient to satiate an agent's hunger for a short period. In one case, a fairly tight-knit swarm was located far away from any food resources. One nomadically-disposed agent was moving separately from this cluster, with sufficient random motion to quickly encounter a food deposit. After consuming a particle, it lingered near the deposit. The remainder, following the rule of cohesion to the swarm's centre of mass, gradually moved across the space to join the nomad, and in doing so discovered and consumed the food deposit.

This food-finding ability through nomadic exploration is clearly not something that was programmed into the individual actions of the agents. It is purely the result of a circular feedback loop between the ecosystem's internal states, via positive feedback through the regulation processes of the individual agents. Yet it is manifest as an adaptive and peculiarly intelligent-seeming behaviour. Despite our awareness that this is simply the result of a set of interactions taking place within a wholly deterministic machine, it is difficult to avoid anthropomorphizing this on-screen behaviour and taking pleasure in its lifelike form.

6.1 Sonic Self-organisation

Because each agent's sonic behaviours are encoded in its genome, which is passed down to child agents and selected through generations of fitness-driven evolution, a significant degree of sonic ordering can be perceived through focusing on the auditory representation of the environment. The sonic spatialisation, described in detail shortly, gives a richly accurate sense of movement and change from within the swarm's frame of reference. Given an agent with a distinctive sound signature, we can hear the result of its reproduction through the sudden introduction of a similar-sounding signature. Population growth is accompanied by an increase in the density and spectral depth of the output.

This is supplemented by the presence of viral *memes*[4], a recent evolution to the AtomSwarm framework itself. An agent will very occasionally develop a temporary meme corresponding to one of its sonic synthesis chromosomes, which can then infect nearby agents through collisions, with statistical probability based on the meme's arbitrary 'strength' rating. An infected agent will adopt this same single genetic value, permanently overwriting the value from its existing genome, and so its sound signature will immediately be transformed to resemble that of the infector. If the population's density is sufficiently high, a strong meme can spread between the agents extremely rapidly, and so the sonic landscape may suddenly switch to a chorus of unified chirping.

Is this sonic self-organisation? Insofar as the sonic terrain frequently orders itself into spectral unison, from a chaotic starting point, then it could certainly be classed as such. Moreover, consider the fact that the population of the swarm is bounded by the limited availability of resources. As the production of sound objects is directly proportional to the swarm's population size, this same bound is placed upon the sonic density; a period of high activity (expressed by high amplitude levels across the spectrum) cannot be sustained.

However, one of the critical principles for non-trivial[5] self-organisation is that of positive feedback: a circular interaction between components that proceeds to amplify a change [15]. In the example of the ant colony, this is manifest in the increase in pheromone trails after locating food. As further ants proceed to follow the pheromone gradient and arrive at the food deposit, the trail is strengthened, amplifying the feedback loop.

---

[4] Taken from the terminology of Richard Dawkins [14].

[5] Francis Heylighen draws a continuum between simple and complex instances of self-organisation; certain traits "will only be exhibited by the more complex systems, distinguishing for example an ecosystem from a mere process of crystallization" [15].

Through the interaction of metabolic systems within AtomSwarm, this class of feedback occurs at several points, such as in the example described in the previous section wherein the swarm can discover food deposits based on its shifting centre of mass. Though these interactions do have a direct result on the sonic output, this cannot be classed as *sonic* self-organisation for the fundamental reason that the this feedback *does not occur in the same frame of reference* as the relations that constitute the plane of sound generation. For true sonic self-organisation to occur, changes in sound synthesis must be reinforced and amplified based on properties of the sound itself. The distribution of sonic artefacts via memes can be modestly viewed as an organisational process, but not one that is linked to an evaluatory procedure based on auditory criteria.

In fact, no richly meaningful form of sonic self-organisation can place without an internal concept of ‘fitness’ in the same frame of reference. This immediately poses the old problem of creating an objective assessment of essentially aesthetic criteria. Given that whether something ‘sounds good’ is an inherently subjective judgement, how can a symbolic system provide positive or negative feedback on its current auditory state?

It is out of the scope of this paper to review methods of evaluating sound-based fitness. In a similar context, however, Blackwell and Young provide an elegant solution by placing ‘attractors’ in the swarm space, whose locations are determined by the attributes of a musical source that is analysed in real-time (such as pitch, amplitude, and duration). As agents swarm towards these attractors, their output – which is parametrised along the same axes – tends towards being relationally similar to the input. Assuming the musical source is a human musician, this swarming can then be positively reinforced by playing more notes in a similar vein, or negatively reinforced by modulating playing style – say, by switching to a different pitch register.

A similar procedure could here be adopted based on timbral analysis of a sound source. However, due to the heterogeneity of each agent’s sonic behaviours, no universal parametrisation of timbral qualities is possible. It is one of the future research directions of this project to consider how the output of audio analysis might result in environmental modifications of other types.

7 Conclusion: Swarming and Complexity

AtomSwarm, like any complex dynamical system, is fundamentally a staging ground for a continuous parallel flux of interactions, between forces, agents and resources. Convoluted feedback loops arise between the multiple planes of interaction (human input, rules, hormones and genomes), with sufficient complexity to evoke the organic (in)stability of a natural ecosystem.

It is only in virtue of this complexity that the system becomes open to the types of anthromorphism that are frequently demonstrated when an audience encounters AtomSwarm’s digital population. Though this is clearly a symbolic ecology – which its sparse, geometrical rendering does little to dispel – whose behaviours are generated by a set of deterministic algorithms, it consistently induces a significant empathic response in audiences. One public performance was concluded with two agents seemingly engaged in a form of dance, pursuing each other in swooping curves. This was left to continue until, eventually, one reached its natural lifespan and died, disappearing from the display. In recognition of the situation, an audible sigh of loss emanated from the auditorium.

This willingness to emotionally engage with a symbolic community, whose resemblance to a living system is limited to its relational structures, is an indicator that concepts are being applied beyond those intrinsic to an abstract generative system. Using the terms of Mitchell Whitelaw [16], a “system story” is being imposed through the the viewer’s imaginative faculties, perceiving the underlying biological origins of the system from its formal isomorphism. The spectator takes joy in this familiar-yet-strange image of “life as it could be” [4].

References

1. Blackwell, T., Young, M.: Swarm Granulator. In: Raidl, G.R., Cagnoni, S., Branke, J., Corne, D.W., Drechsler, R., Jin, Y., Johnson, C.G., Machado, P., Marchiori, E., Rothlauf, F., Smith, G.D., Squillero, G. (eds.) EvoWorkshops 2004. LNCS, vol. 3005, pp. 399–408. Springer, Heidelberg (2004)
2. Borgo, D.: Sync or Swarm: Musical improvisation and the complex dynamics of group creativity. In: Futatsugi, K., Jouannaud, J.P., Meseguer, J. (eds.) Algebra, Meaning and Computation: Essays dedicated to Joseph A. Goguen on the Occasion of His 65th Birthday, pp. 1–24. Springer, New York (2006)
3. Jones, D.: AtomSwarm (2007), `http://www.erase.net/projects/atomswarm`
4. Langton, C.: Artificial life. In: Langton, C. (ed.) Artificial Life: The proceedings of an interdisciplinary workshop of the synthesis and simulation. Santa Fe Institute Studies in the Sciences of Complexity, vol. 6, pp. 1–44. Addison-Wesley, Reading (1989)
5. Reas, C., Fry, B.: Processing (2007), `http://www.processing.org/`
6. Reynolds, C.: Flocks, herds, and schools: A distributed behavioral model. ACM SIGGRAPH Computer Graphics 21(4), 25–34 (1987)
7. Smalley, D.: Defining timbre – refining timbre. Contemporary Music Review 10(2), 35–48 (1994)
8. Blackwell, T.: Swarm music: Improvised music with multi-swarms. In: Proceedings of the 2003 AISB Symposium on Artificial Intelligence and Creativity in Arts and Science, pp. 41–49 (2003)
9. Blackwell, T., Young, M.: Self-organised Music. Organised Sound 9(2), 137–150 (2004)
10. Pulkki, V.: Virtual sound source positioning using vector base amplitude panning. Journal of the Audio Engineering Society 45(6), 456–466 (1997)
11. Manovich, L.: Abstraction and Complexity (2004)
12. Hasdell, P.: Artificial ecologies: Second nature emergent phenomena in constructed digital - natural assemblages. Leonardo Electronic Almanac 14(7–8) (2006)
13. Whitelaw, M.: Metacreation. MIT Press, Cambridge (2004)
14. Dawkins, R.: The Selfish Gene. Oxford University Press, Oxford (1990)
15. Heylighen, F.: The science of self-organization and adaptivity. The Encyclopedia of Life Support Systems (2003)
16. Whitelaw, M.: System stories and model worlds: A critical approach to generative art. In: Goriunova, O. (ed.) Readme 100: Temporary Software Art Factory, pp. 135–154. Books on Demand GMBH, Norderstedt (2005)