Strategic road mapping for Europe's creative industries: the eu cre-am project

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ABSTRACT: The authors present a novel paradigm for roadmapping creative sectors in Europe based on three key successively integrated phases that implement *mindsets*, *techniques* and *technology*. In the first instance this roadmapping paradigm is piloted for identifying weak and strong signals as well as trends in the sector of Architecture based on aggregated opinions from leading Architects. Further versions of the process and software will separately explore the current state and ideal evolved future state of the Architecture sector. The roadmapping methodology will also be applied to the other creative sectors comprising the project including Media and Epublishing, Gaming, Design and Art. The roadmapping methodology has been created for the CRe-AM project[1], a European Union FP7 funded project that aims to bridge communities of creators with communities of technology providers and innovators, in a collective roadmapping effort to streamline, coordinate and amplify collaborative work. The focus of the project is developing and mainstreaming new Information and Communication Technologies (ICT) and tools by addressing the needs of different sectors of the creative industries.

1. INTRODUCTION

The Creativity Research Adaptive Roadmap Project (Project Acronym: CRe-AM) is a 2 years EU-funded project. CRe-AM is part of the 2013 Work Programme on ICT, being one of the projects selected under the first Call of Objective 8.1: Technologies and scientific foundations in the field of Creativity.

The CRe-AM project requires a roadmapping process that can identify and predict emerging weak and strong signals as well as trends in the Europe wide creative sectors beginning with a representative mindset, process and predictive software implementation tested on data gathered from experts giving their opinions about the state of the Architecture sector in Europe. This roadmapping methodology will be expanded in its application and re-purposed for the other creative sectors including Art, Gaming, Design, Media and E-Publishing.

GATHERING EXPERT OPINIONS

Leading experts in the Architecture sector were interviewed to gather their opinions of the current state of the discipline as well as their perception of the near future and areas needing resource investment. They were asked to offer views and predictions based on the following enquiry:

CURRENT SITUATION
1. What current technologies and tools fulfil your needs in your practice?
2. What technologies do you see emerging in the next 5-10 years?
3. Could you identify any strengths and weaknesses?
FUTURE SITUATION
4. Do you think there are additional technologies or tools needed, or that you would wish for?
5. If these were available what would you be creating?
6. Can you see any strengths and weakness involved?
7. What do you recommend to fill the gap between creators and technology providers

Interview transcripts were analysed for the significance given to specific techniques and technologies used and a numerical score was assigned for each reference. The numerical scores were placed on a

single matrix to track emergent signals and trends and colour coded to suggest where strengths of opinion lay amongst industry professionals. The matrix of opinion relating to each interview was then combined with those from other experts to generate a matrix of collective opinion. The collective matrix was analysed and emerging signals and trends were determined using a three part roadmapping process.

2. MAIN ASPECTS: ROADMAPPING COMPONENTS

The roadmapping paradigm was constructed from three existing roadmapping approaches:

(i) An Emerging Paradigm Model[2] that explores evolution of knowledge and practice and associated technology through clearly defined novel (a) *Mindsets* (b) *Techniques* or Practices to implement that Mindset and lastly (c) *Technology* to refine and scale up the use and dissemination of the Techniques.

(ii) A *Signals Matrix* that visually reveals emerging weak and strong signals as well as trends. This is a table/grid that places Techniques currently utilised in the respective sector weighted numerically by how much they partner with Technologies the sector employs for its operations. The distribution of relationships between Techniques and Technologies infers the current Mindsets that sector professionals are likely to be subscribing to that influences curricula in academic institutions, strategy for sales and development of products and services for commercial organisations as well as Public Services that need to be created, sustained or evolved for local, national or international governmental bodies. The Signals Matrix is based on the Atmascape Matrix used to forecast strong, weak and trend signals in human behaviours of clients undergoing business learning and development[3].

(iii) *Technology Trends Roadmapping*[4] for mapping, immediate, short and long term emergence of sector signals and trends relating to emerging and fading technologies with exploration of their impact on the sector and the resulting consequences for the future of the sector.

[I] EMERGING PARADIGM MODEL

Whenever a shift in thinking, practice or technology happens the established paradigm that oversees each of these aspects of that period in history is likely to shift. The shift can be triggered by any of the three aspects but typically begins with a new way of thinking, perception or conception. This trigger is a shift in the prevailing *mindset* of the paradigm. The shift in mindset influences changes in the *techniques* or practices to implement that mindset. The shift in techniques, practices or methodology results eventually in the emergence or development of new *technology* to refine those practices and scale the adoption of them. The shift can even lead to the decline of existing technologies no longer deemed as effective or attractive. If the technology facilitates the practices in a powerful enough way then a corresponding shift in mindset may ensue beginning a new cycle of evolution in thinking, practice and advancing technology. This process of how a new paradigm emerges is called the *Emerging Paradigm Model.*

As an example, traditional ways of visualising an architectural model used material models which were difficult to adapt or make last minute changes to. With the need to experiment, new ways to visualise using video and graphics, followed by Computer Aided Design were developed. As projects became more complex or needed more realistic modelling more powerful technologies needed developing. In addition the need to fabricate physical models with 3D Printing as well as model existing spaces with 3D scanning evolved. This technology in turn changed the mindset around Architecture workflows. Of course if the needs for rapid modelling were not made clear then iterative techniques using graphics and computing would highlight what was not thought through. Also when techniques were implemented with technologies then soon enough the shortcomings of the techniques would show up after a number of iterations. If the technology itself did not advance techniques or develop new mindsets it would be a sign that the technologies were merely reducing labour and delivery time but not advancing evolution of creativity and refining standards and their enforcement in practice. When the level of belief or derived usefulness in a particular modelling philosophy exceeded a threshold those subscribed to it would typically begin practices around implementing wider adoption

of it into the reality of everyday architectural workflows. With enough practice they would then develop technology to refine or expand that practice as well as scale the number of people introduced to its benefits.

If the modelling mindset was incomplete or lacked soundness then techniques or practices would soon enough reveal these issues. The consequence of practising an incomplete or unsound mindset would be that either people would lose faith in it or the proponents would address the issues to keep people's faith. If the issues were not addressed and proclaimed as doctrine and then dogma would establish itself. With a lack of challenge for the dogma those leading the development of the mindsets, techniques and technology standards would sustain a system that lacked empowerment and engaging ways of modelling. When the mindset is sound but the practices that implement it are not then any effective, aligned technology based on those practices that scales or refines them will soon enough reveal ineffective practices.

The Emerging Paradigm Model is used as a basis for roadmapping the creative sectors in Europe by determining mindsets from interviews with sector experts. Experts are asked to share what techniques and technologies they are currently utilising together and what weights of importance they feel those affinities have. The weights can be numerically represented and then analysed to forecast emerging weak and strong signals as well as trends. This is done using a *Signals Matrix*.

[II] SIGNALS MATRIX

In Architecture a building has to have strong foundations to support what will be built upon them. Weak foundations can make the building lean or subside to one side possibly leading to eventual structural failure and even collapse. The strengths of the building materials as well as the forces acting on them such as gravity or friction would determine which parts of the infrastructure were weak, strong or were showing tendencies to move in particular directions.

This principle is based on and dervived from a similar roadmapping model used to map psychological development in business mentoring practices. The *Atmascape* online psychometric, a previous paradigm with its own effective mindset, technique and technology constructed a roadmapping software and process for the psychological space of human behaviours in mentoring business executives. It can metaphorically be translated for use in roadmapping the Creative sectors. Atmascape uses the architectural principle to determine in which way a person's behaviour would lean towards based on the forces operating in their life and the resources that currently support them. The model relies on exploring a hierarchy of needs a person is trying to meet and how they are meeting them by applying another hierarchy of emotional and social intelligences. The way of collating forces and movement is similar to the way forces and trends need to be tracked in the Creative Sectors. In the Atmascape tool the person completes a questionnaire in which they are asked to record a numerical weight to the competency with which they are meeting a need with a given intelligence. This is what was done when interviewing experts about the current and future situation in Architecture. Because the two axes of needs and intelligences in the Atmascape tool are each hierarchical the matrix of scores behaves like an architectural structure that can be analysed for weak, strong and trending forces that can be used to determine the person's current and emerging mindset and actions. The same algorithm can be adapted to identify strong and weak signals as well as trends in a creative sector such as Architecture, except we are treating the sector like the person mapped in the original Atmascape roadmapping tool.

The same principle and algorithms can be used to place a hierarchy of techniques against a hierarchy of technologies related to the creative sectors in Europe. Experts from the sectors were interviewed and asked to record a numerical weight against techniques and technologies they see working together. The scores are then analysed for determining weak and strong signals as well as emerging sector trends.

Interviews, carried out in 2015, with experts from the Architecture sector were analysed and the weights of importance they had qualitatively emphasised for how strongly they were using certain techniques with certain technologies were converted into numerical weights. The range of techniques

were ordered into a hierarchy of increasing scale and complexity. An example of the initial hierarchy of techniques that experts referenced was compiled and is given below.

Modelling → Visualisation → Production → CPD → Communication → Collaboration → Convergence

If we consider Visualisation then it is something that clearly depends on Modelling techniques. At the same time it contributes to Production practices. A strong Modelling field would provide supportive development for Visualisation. However rapid development or investment in Visualisation while modelling was not evolved could lead to excessive pressure to advance modelling. If not addressed the lack of refinement in modelling would create an inertia that held back development in Visualisation. Similarly Collaboration is underpinned by a foundation of effective communication. Collaboration when coordinated effectively can contribute to professionals working together towards convergence of standards relating to mindsets, techniques and technologies.

Similarly the range of technologies were ordered into a hierarchy of increasingly complex technologies. An example of the initial hierarchy of technologies that experts referenced was compiled and is given below.

CAD → BIM → 3D Printing → 3D Scanning → Virtual Reality → Robotics

In the technology hierarchy BIM would not be possible without a strong foundation in CAD technologies. From a time perspective CAD and BIM are more used in current practice whereas Robotics is more likely to be utilised in the future. Virtual Reality is heavily dependent on CAD and modelling associated with 3D scanning contributes to it. Better virtual reality modelling of real spaces will be dependent on better 3D scanning of physical spaces. If Virtual Reality is rapidly being adopted but 3D scanning is not being evolved or utilised effectively then production of Virtual Reality scenes will be limited to those produced in 3D CAD and will not be able to reproduce live spatial orientations or physical features such as textures or lighting.

Note that both technique and technology hierarchies may change in their ordering based on ongoing industry opinions and dialogue. Each technique in the hierarchy of techniques influenced the one above it and was influenced by the one below it. Similarly each technology in the technology hierarchy influenced the use of those technologies ahead of it while being influenced by the technologies before it. Together the hierarchy of techniques and hierarchy of technologies were placed alongside one another as axes of a matrix in which every cell was related influentially to its neighbours. This matrix is the Signals Matrix (Table 1).

Convergence	38	30	25	25	24	22
Collaboration	77	64	59	57	63	55
Communication	80	66	59	59	67	57
CPD	46	36	34	34	33	31
Production	40	35	34	30	37	29
Visualisation	44	37	29	25	38	20
Modelling	59	47	37	39	47	32
Techniques ↑ Technologies →	**CAD**	**BIM**	**3D Printing**	**3D Scanning**	**Virtual Reality**	**Robotics**

Table 1. Signals Matrix (Collective Results).

A Signals Matrix can be used to numerically represent an expert's opinions of their sector. It shows a hierarchy of techniques in rows linked with hierarchy of technologies in columns. The weight an expert in the sector places on a technique being allied to a given technology is placed as a number in the corresponding cell where the technique the row is in crosses with the column the technology is in. Results from experts could be collated to get an overall picture of the sector as has been done with the data set recorded in the Signal Matrix. The matrix shown is representative of the current state of the Architecture sector according to a group of architects interviewed in 2015. It suggests there is a strong focus on addressing Communication needs around CAD technologies. However there seems little focus currently on Convergence of 3D Scanning technologies (Although underlying trends may change that). When colour coded according to average numerical weight the matrix can be used to see zones of strong and weak affinities.

PRESSURE MATRIX

The matrix shows strengths of association but does not necessarily show emerging weak signals, strong signals or trends. For that the net forces influencing each cell relating to a pairing of a technique and a technology must be calculated by taking into account the relative differences between the weight in the cell with the scores from surrounding cells. This will lead to the *pressure* or *support* each cell is experiencing from its neighbours being determined. When these pressures are compared to the original weights a normalised figure of pressure/support can be obtained and used to determine strong and weak signals, and where there are clusters of these, trends.

Consider BIM that is used with Visualisation with a strength of 37. Also 3D printing uses Visualisation only with a strength of 29. Because BIM is lower in the hierarchy of technology it supports or underpins 3D Printing so if BIM is not strong then 3D Printing will be undermined in its support. Fortunately BIM scores 37 in Visualisation, a larger score than the 29 in 3D printing - implying a strong foundation for 3D printing. There is a difference of +8 between 3D Printing Visualisation and BIM Visualisation -indicating a positive support for 3D Printing from BIM. Below the cell the weights of 47, 37 and 39 support the foundations which add +18, +8 and +10 support. This is a total of +44 support. However note the scores ahead and above of 25, 35, 34 and 30. These place pressure on the cell of +4,-6,-5 and -1 respectively -a total of -8. The total of support and pressure comes to +44-8=+36 (highlighted in the Pressure Matrix table). So overall this area is supported and, if it were amongst the highest scoring areas of support on the matrix, would be considered a strong signal.

When these support and pressure measures are calculated for all cells this results in the Signals Matrix being transformed into a matrix of numbers reflecting spread of pressure and support, a *Pressure Matrix*. The cells with the least pressure or the most support in the Pressure Matrix are typically the indicators of strong signals in the sector. Areas with the most pressure or least support are areas that are currently in a state of decay. Cells surrounded by areas of higher support are indicators of segments that are advancing yet are held back from greater advance by an area that has yet to be supported, an indicator of a weak signal. A prototype for this was done using a simple spreadsheet and from the Signals Matrix the Pressure Matrix was derived (Table 2). The previous calculation of +36 is seen in the 3D Printing/Visualisation cell.

Convergence	73	123	110	105	106	76
Collaboration	91	130	111	107	114	86
Communication	-45	-63	-69	-86	-75	-44
CPD	-61	-84	-83	-83	-84	-56
Production	4	0	-8	-12	-14	2
Visualisation	38	49	**36**	13	27	31
Modelling	49	53	28	15	65	21
Techniques ↑ *Technologies →*	**CAD**	**BIM**	**3D Printing**	**3D Scanning**	**Virtual Reality**	**Robotics**

Table 2. Pressure Matrix

These original strengths will never have a value of zero in the collective matrix as there will always have been one person mentioning a technique or technology and their use together. As can be seen in the example Pressure Matrix, BIM and Collaboration are strongly associated with one another whereas Continuing Professional Development (CPD) for Virtual Reality is not supported well. However Collaboration in Virtual Reality is underpinned by Communications on Virtual Reality so unless Communication is cultivated in Virtual Reality then Collaboration in Virtual Reality is likely to undermined. This represents an opportunity for businesses and educational providers who can provide training to improve Communication practices around Virtual Reality to address support deficits in Collaboration that may be imminent.

TRENDS MATRIX

A caveat with these pressure scores is that they are not adjusted or normalised relative to the original scores. For these figures to be normalised they must be compared to the original strengths in the Collective Signal Matrix and the pressure figures in the Pressure Matrix must be divided by the original strengths in the Signal Matrix. This will provide a normalised *Trends Matrix* (Table 3).

Convergence	1.9	4.1	4.4	4.2	4.4	3.5
Collaboration	1.2	2.0	1.9	1.9	1.8	1.6
Communication	-0.6	-1.0	-1.2	-1.5	-1.1	-0.8
CPD	-1.3	-2.3	-2.4	-2.4	-2.5	-1.8
Production	0.1	0.0	-0.2	-0.4	-0.4	0.1
Visualisation	0.9	1.3	1.2	0.5	0.7	1.6
Modelling	0.8	1.1	0.8	0.4	1.4	0.7
Techniques ↑ *Technologies →*	**CAD**	**BIM**	**3D Printing**	**3D Scanning**	**Virtual Reality**	**Robotics**

Table 3. Trends Matrix Simulation

The Normalised Trend Value = Pressure Matrix Value / Signals Matrix Value. Examples of Normalised Trend calculations in cells shown based on values from the lower left corner of the Pressure Matrix that are shown in the lower left corner of the Normalised Trends Matrix are:

0.8 = 49/59
1.1 = 53/47
0.9 = 38/44
1.3 = 49/37

Within the Trend Matrix a trend can be seen easily by simply observing where clusters of colour are centred, strong in scores or low. In the calculated example there are a lot of positive scores centered on Convergence suggesting a trend in that area. This is particularly strong around 3D printing suggesting that Convergence of standards and practices is increasingly explored around 3D Printing technologies, an indicator of a Strong Signal. CPD shows a row that is mostly low scores again suggested a declining or weakening trend in CPD. This CPD trend is centred around 3D Scanning suggesting if CPD is not provided for 3D Scanning there could be negative effects on uptake and use of 3D Scanning. Where a low score is surrounded by relatively higher scores that technique/technology pairing is important to those areas but is not being currently supported and ongoing lack of support for it may undermine the dependent areas. This is an example of a Weak Signal. If someone where to go and address this weakness they could capitalise on delivering a service or product few are implementing or delivering. An obvious example in the given Trends Matrix is the score of -2.5 relating to CPD in Virtual Reality that underpins the stronger Communication areas above it. Anybody creating a product, training or service or in this area would be able to take advantage of a ready market where many people may already be frustrated or irritated by the lack of offerings. This would in effect allow whoever addresses the issue a chance to be disruptive and lead the way in solutions people are hungry for.

CENTRE OF TRENDS MATRIX AND NORMALISED TREND MATRIX

The problem with the Trends Matrix is that it is difficult to see what technique/technology is at its centre. This can be calculated by simply adding the score in each cell with all the scores immediately around that cell and placing that in the corresponding cell of a new matrix. The scores can be normalised by dividing all values by the absolute (positive) value of the biggest number in the matrix. The results of finding the 'centre of gravity' of each trend, with scores rounded to the nearest integer are shown in the Centre of Trends Matrix (Table 4).

Convergence	9	16	18	19	17	11
Collaboration	8	13	15	15	14	9
Communication	-2	-4	-5	-6	-5	-3
CPD	-5	-9	-11	-12	-11	-7
Production	-1	-3	-5	-6	-5	-2
Visualisation	4	6	5	4	4	4
Modelling	4	6	5	5	5	4
Techniques ↑ *Technologies →*	**CAD**	**BIM**	**3D Printing**	**3D Scanning**	**Virtual Reality**	**Robotics**

Table 4. Centre of Trends Matrix

Dividing all numbers by the largest absolute value of 19 and then multiplying by 10 to give a range from 0 to 10 and rounding to the nearest integer gives the final, Normalised Trends Matrix (Table 5).

Convergence	5	8	10	10	9	5
Collaboration	4	6	8	8	7	4
Communication	-1	-2	-4	-4	-4	-2
CPD	-2	-4	-6	-6	-6	-3
Production	-1	-1	-2	-3	-3	-1
Visualisation	2	4	3	3	3	2
Modelling	1	2	2	2	2	2
Techniques ↑ *Technologies →*	**CAD**	**BIM**	**3D Printing**	**3D Scanning**	**Virtual Reality**	**Robotics**

Table 5. Normalised Trends Matrix

It is clear that in this real data set that Convergence around 3D Printing and Scanning has the largest normalised values so these must be at the centre of trends and strong signals in neighbouring areas. Note also CPD in these areas being on the strongest downward trend. When an area is positively promoted yet is not being provisioned for the inevitable result will be an industry wide adoption problem.

If there are many areas with the maximum value then the scores can simply be added again until one area stood out. Areas with low scores surrounded by higher scores are indication of Weak Signals. In the example not only is the CPD around 3D Scanning at the heart of some trends it is surrounded by relatively higher scores so it is an example of a Weak Signal.

Areas with the highest positive scores are likely to be engaged with in the immediate future. Lower positive scores relate to areas that are either likely to be less supported in the near future or may have support increase for them in the near future. The lowest scores are most likely to be addressed in the far future if left unattended. This may not be what is desired - the industry may see weak areas but may feel that because they are critical to other areas they may need to be supported sooner rather than later.

The original signals matrix has been turned into an online web form to gather or enter numerical weights related to an interview or for an expert to directly enter their weights of importance on technique/technology relationships. The data gathered is added to a cumulative database from which a live Signals Matrix can be generated as well as the derived Pressure Matrix and Normalised Trend Matrix.

[III] TECHNOLOGY TRENDS ROADMAPPING

Portraying trends in the current arena, near future as well as those likely to be responded to in the far future based on the Normalised Trends Matrix is best illustrated and outlined using *Technology Trends Roadmapping* charts adapted from '10 Roadmap Tools' by Martin Suntinger of the website radiantminds.com. These charts were added to the online platform so recommendations or notifications of emerging weak and strong signals as well as emerging trends could be given to industry, academic and public sector subscribers for them to respond to shifting state of the sector.

THREE HORIZONS MODEL

An example roadmapping chart that uses the Trends Matrix data as a base for depiction of trends is the Three Horizons model. The model looks at three time horizons. It presents technology and practice but

also presents viable future options. The strongest scoring areas can be allocated to the Current Arena part of the chart. Intermediate scores can be allocated to the middle, near future section and low scoring, downward trending areas that need Resource Investment are listed for the foreseeable future. An example of the Trend matrix data being laid out in this way using the real data in the previous tables is shown in Figure 1.

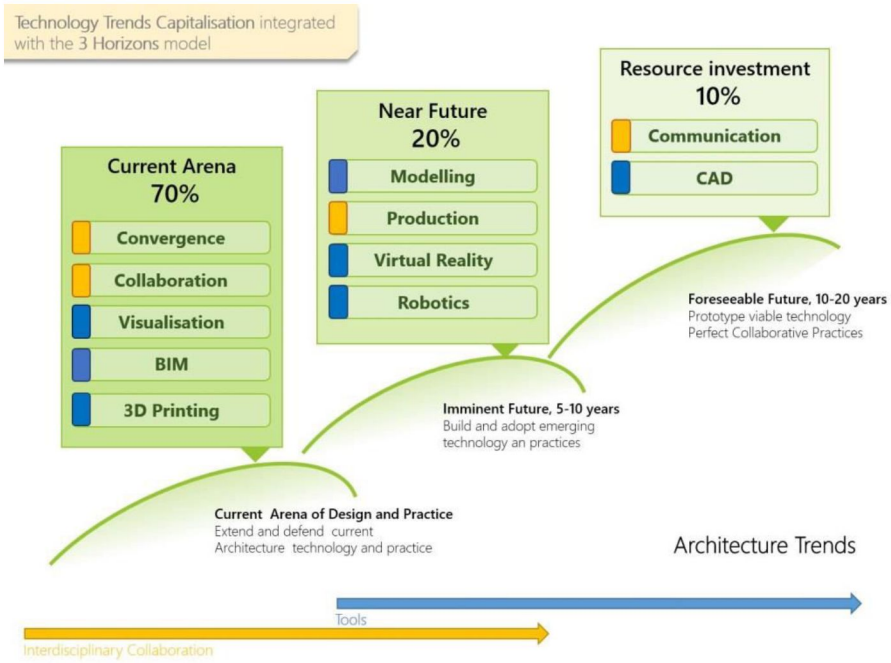

Figure 1. Three Horizons Roadmapping based on real expert opinions numerically represented in the Normalised Trends Matrix data.

This diagram clearly shows which areas are the current focus of interest for Architects, what is being deferred for attention to the near future and what areas are likely to be focused much later in time either because they are not working well or are not an immediate priority.

CONCLUSIONS

The Cre-AM Roadmapping Methodology was reviewed by Vana Kamtsiou of Brunel University. She is an international expert in Roadmapping strategy and investigated how the roadmap differed from what the standard S-shape roadmap has to offer. According to Vana the Cr-eAM roadmaps enable the user to:

(a) View what is being undermined as well as what is being promoted.

(b) Assess if the scale of change is significant in proportion to the way the respective creative industry currently practices.

(c) Identify the current centre of gravity for the industry at the current time

d) Resize datasets for higher fidelity forecasting

e) Exploring ‘what if?' scenarios and simulations

f) The maths that determines trends for a roadmap can be explored in a simple excel-like spreadsheet

(g) A roadmap's building blocks are the weights of importance industry experts place on specific Technologies being used together with specific Techniques.

A strong positive of the model is that it provides a cross impact analysis with other technologies which are needed to be co-developed.

The Signals Matrix used combines opinions of the Current and Future state of the Architecture into a single table to predict genuine emerging strong and weak signals as well as trends. Future work will record the numerical weights of opinions into separate matrices for Current State as well as Future State opinions of where the sector might progress or evolve to. This would allow the Current and ideal Future states to be compared with one another as well as with the emergent Signals Matrix.

The Signals Matrix includes facilities to modify scores for factors besides those used for the technique/technology axes. These factors usually relate to influential mindsets, for instance the impact of ethics in a sector such as Gaming. Attitudes towards a technology independent of a technique or vice versa as well as attitudes relating to a sector as a whole are usually mindsets that contribute multiplicative or dividing influence on associated areas of the Signals Matrix.

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