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THE DNA OF DESIGN AND DESIGN SIGNATURE: A PERSPECTIVE IN MOTORCYCLE DESIGN

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ABSTRACT
Designers have to frequently face the two terms: the DNA of design and design signature, though no scientific definitions for these two terms are available. This study attempts to formulate a scientific definition for these two terms, differentiate between these terms which are frequently used interchangeably, and explore a mathematical framework. Since the author is a practicing motorcycle designer, this mathematical code has been formulated in context of motorcycle design, but the concepts and methodology can be adopted for design in general. Finally, in context of motorcycles, DNA codes have been calculated for various makers and the results observed, by and large match with the general perceptions. At the same time, limitations faced by practicing designers in devising code have also been discussed.

Keywords: DNA, design signature, design process

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1 INTRODUCTION

DNA of design and design signatures are very commonly used jargons in the realm of design. All cars from BMW are recognizable by their front grill which is supposed to be their design signature. But the important question is-is this DNA of design an abstract thing like soul or a scientific entity? Looking at the characteristics of the biological term DNA and juxtaposing it against the world of artifacts-engineering, cultural or otherwise - DNA of design appears to be a set of characteristics defining the products of a creator and making the creator instantly recognizable. Primarily, design is a process of wordless conversation, which the designer conducts with the user on one hand and the artifact itself on the other. Essentially, any conversation involves language and language, as Derrida says, is a complex artifacts itself which needs to be deconstructed for its social, cultural and psychological power equations. Now, in context of motorcycle design, this deconstruction involves decoding the language in which the user, the designer and the motorcycle converse with each other sending unspoken, subconscious messages, which are essentially a part of the DNA.

Blijlevens et al [1] concludes in her study that consumers perceive product appearances by identifying appearance attributes to distinguish the attributes of durable products. On the other hand Rompay et al [2] find in their study that incongruence among symbolic meaning connoted through visual elements, thwart impression formation by product and brand. These conclusions lead us to find the elements of brand recognition that form the basis of design signature. Karjalainen [3] suggests that value based design features involve explicit or implicit references and can be consistently used over the product portfolio. This, again, leads to find those value based design features forming the signature in context of a motorcycle.

But the question which has been agitating us is the relationship between 'DNA of design' and 'design signature'. Are they euphemisms for each other or are they mutually exclusive? This paper attempts to- (1) define and differentiate the terms 'DNA' and 'signature', (2) design an objective methodology to codify DNA of a product line in context of motorcycles and (3) verify the methodology to test its applicability. In the end, we have been able to address all three questions.

The DNA can be defined as a code consisting of a set of characteristics, which makes the user of an artifact immediately recognize the creator. Going by the basic characteristics of a signature, it is, first and foremost, a visual entity and a part of the visual design, which, by definition, makes it a sub-set of the DNA. But what are common to both the terms are some characteristics:

1. Both the DNA and the signature are present in all products of a creator or a group of products representing a certain stream, whether it is an artiste or a company.
2. The characteristics, known as DNA or signature, are exclusive to the creator.
3. The characteristics should be user defined and not designer defined i.e. the user should be able to identify and appreciate the characteristics.

Besides these common traits, the distinguishing feature between them is that design signature is essentially a sensorial feature whereas DNA is a set of properties encompassing all aspects. This makes signature an element of DNA. Moreover, as the paper discusses in subsequent pages, DNA can be expressed in terms of a code, whereas the signature has to be expressed in form of a statement.

Though, both the terms the DNA and the signature apply equally to creative art and design of engineering artifacts (in our case, motorcycles), we always believe that the semantic equation for design of engineering artifacts is more complex as the designer not only has to contend with semantic requirements but is also constrained by engineering factors and finally has to be governed by market dynamics. Since market is not a monolithic entity, the designers have to contend with varying tastes, economic profiles, demographics and complex sociological equations. Fortunately, a creative artiste is free from these constraints in most cases (the most noted exception being cinema). Since this case study is for motorcycles, all these complexities have to be factored in the DNA of design, as the motorcycle is one of those rare technological species which is a cultural and engineering object at the same time

Though, the DNA and the signature are a phenomenon common to works of art or commercial artifacts like motorcycle, the attitudes of creators towards their creations vary. Though in field of creative arts, creators are comfortable with signature, boardrooms and design studios for commercial products are sometimes apprehensive. Some common fears and apprehensions are:

1. Design signatures or DNA are a constraint on flexibility and freedom of design.
2. For niche products, DNA is desirable. But for mass products, it is a liability.

Before we examine the truth behind these apprehensions, we can visit some areas of creative expression and verify these apprehensions.

Fine arts: Among European masters –Rembrandt, Van Gogh and Salvador Dali the defining feature of Rembrandt is light and shadow play, while Gogh is easily recognized by his flow lines. Dali's signature speaks through the surrealistic images in high value primary colors.

Fig 1: Van Gogh, Note the flow lines.

Fig 2: Rembrandt, Note the light and shadow play.

Ramkinker Baij and Michelangelo, two sculptors separated by three centuries and a continental divide, belong to different cultural milieus. But the common trait with both of them is their strong signatures. Michelangelo's work can easily be recognized by the minute detailing of human anatomy- be it David's muscles and genitals or the ribs of Jesus in 'Pieta'. Ramkinker's signature is abstract but figurative style apparently in mud or cement.

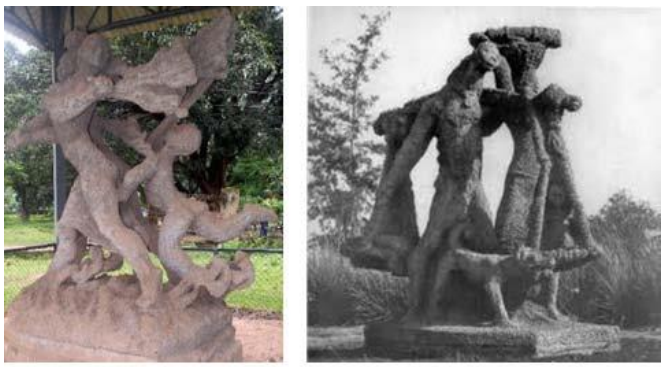

Fig 3: Ramkinker Baij, Note the figurative style in mud.

Fig 4: Michelangelo, Note the minute detailing of anatomy

Literature: Signatures are prominently available in literature as well. In fact the impact a writer generates is directly linked to his signature. Hemingway has his hard metallic style which stands out in all his works whereas Shakespeare's signature is the internal conflict of the tragic hero beset with ambition and guilt of betrayal. Rushdie's imprint can be seen in his innovative vocabulary and phraseology. The point here is that all the writers discussed above have travelled a huge range in their journey, still maintaining their distinct signature.

Cinema: Scorsese and Coppola have very clear stylistic signature of narration. Throughout his cinematic journey from "Mean Streets" to "Gangs of New York", Scorsese has his signature style- macho posturing, bloody violence, catholic guilt, redemption and gritty locales, whereas Coppola has his sense of design in all his frames. Though both use the cinematic frame to create an epic like imagery, the selection of dominant colors by both is unique to both and creates the difference.

These examples essentially prove the point that DNA or signature does not inhibit the diversity of scope and the designer can always exercise his freedom of diversity maintaining his own signature or DNA. Another apprehension that DNA becomes a liability for mass product companies does not pass the test of reality. We will see later that mass product companies like Honda maintain different DNAs for different product lines and are able to maintain diversity while protecting the DNA.

2 DNA OF DESIGN

Pythagoras suggests-"the whole thing is a number", suggesting that every truth can be expressed in terms of mathematics. The problem we have with us is to express the DNA of design in terms of numbers in form of a code. Here, before devising the code, we have to consider two issues. The basic problem with this code is that it has to be both general for all engineering artifacts and at the same time specific to the artifact, which in our case is motorcycle. Before coming to specifics, let us revisit some generalities. In general, there are three kinds of interactions between an engineering artifact and the user- sensual, experiential and performance. The problem is to specify and quantify these interactions and this is where the specifics of a motorcycle enter the scene. What we intend to do here is to define the construction of the DNA code, find a method to quantify the code and finally to discuss each of the specific elements and to quantify those elements from the users perspective, so that they can be fitted into the code.

Norman [4] classifies the emotions generated by a design as visceral, experiential and reflective emotions. Krippendorf [5] classifies the meanings attached to an object as meanings in use, meanings in language and meanings in ecology. All these classifications lead us to two basic types of codes to define how a user interacts with a motorcycle- sensual (see, hear, touch, smell) and experiential (quality of riding experience). But besides these two codes, we cannot avoid the third type of code i.e. engineering. After all, the user is a rational being and his opinion about a machine is not completely insulated from the engineering of the machine. We definitely get influenced by the technology used in motorcycle (engine technology, type of brakes, cushions etc). This gives us the outlines of the DNA code i.e. SEE (sensual, experiential and engineering). We define this framework with the following matrix.

Though, the elements in the matrix are self-explanatory, they need to be broken into recognisable and quantifiable characteristics. For example, the element 'form' is not one single characteristic but a combination of many. Adding to the complexity is the fact that a motorcycle, unlike a car, is not a

visually monolithic form and the the overall form is the aggregate of forms of various parts. In short, the form of a motorcycle is dictated by many factors. The dominant one is the body styling type followed by forms of various components. Similarly, other elements can also be broken into sub-elements or characteristics in form following version of the same matrix.

Table-1: The DNA matrix for motorcycles

S (Sensual)	Form	Colour	Dynamism, Unity, Balance	Sound
E (Experiential)	Performance	Ergonomics	Driveability	Sensing Efforts
E (Engineering)	Architecture	Output	Feature	Ruggedness

Table-2: The detailed DNA matrix for motorcycles

Body Style, Fuel Tank Seat Head Light/Visor Wheel Graphics	Hue, Value, Chroma Logo Graphics	Dynamism, Unity, Balance	Loudness, Sharpness Fluctuation
Speed Acceleration	Ergonomic triangle,	Vibration, cushioning, braking, Steering geometry, Wheel base, Rn	Gear shifting effort, Switching effort, throttling, clutching and braking effort
Cylinder arrngement Frame Cushions and brakes	Torque Power	Special features	Tolerancing, Rust resistance Design life

To express this matrix in form of a code needs a detailed framework so that the code describes the exclusivities of a motorcycle in a unique way. The tables in the appendix provide this framework and the codified matrix will look like the following.

xxxxxx/0	xxxxxx xxxxxx /0	xxxx/0	xxx/0
xxx/0	xxxxxx/0	xxxxxx/0	xxxx/0
xxxxxx/0	xx/0	x/0	xxx/0

It must be emphasized here that each ‘x’ represents the exclusivity of a motorcycle relating to the property represented by the location of that ‘x’ as denoted by the appendix table. If the motorcycle has no exclusivity relating to the property, it will be denoted by a ‘0’. It also means that if a set of properties becomes an exclusive combination, it can be expressed as a DNA code. For example, the DNA of ‘Goldwin’ and CBR lines of Honda motorcycles can be respectively expressed as:

CGLLJ	0	LHHL	0
HHH	LL00LL	0000H0	0
P00000	0	0	0
EEMKF	0	HLMH	0
0	0	0	0
0	HH	0	0

Many elements in this matrix are simple to identify and quantify. But many of them are easier to define but complex to quantify or classify and need a scientific rather than a conceptual basis for doing so. The sensorial aspects like form, color, branding, unity, dynamism and sound have been objectively classified in the appendix, where each property can be denoted by a set of letters. Similarly experiential aspects like performance, ride feeling, sensing efforts etc have been described in terms of objective and quantitative parameters and can be represented by a code. Similarly engineering parameters like architecture and output are easy to codify. Problem arises, when we try to codify engineering ruggedness as it is not possible to collect confidential data. So it needs extensive testing. As for features, any feature introduced by one manufacturer is adopted tomorrow by all. So we have assumed the binary code to be 0. (By the very definition of assumption, there is a chance that this assumption may be wrong). True, it is not possible to create an exhaustive list of parameters. But this tool can always be updated, if need arises.

3 THE DESIGN SIGNATURE

As we have discussed, the signature is a single sensorial aspect making the whole work of a creator identifiable with him as in the case of Michelangelo or Scorsese. So, the signature has to be a statement like 'a distinct exhaust noise' for Harley.

4 RESULT

The purpose of the exercise was to try to find the DNAs of prominent motorcycle manufacturers. The main roadblock to this effort was non-availability of design data. The brochures for the bikes specify the key parameters on engineering architecture and output. A huge portion of data was collected by analysis of visual data, measurement and testing. For example form, color, branding, unity, dynamism, balance and ergonomics is based on analysis and calculation. Similarly, performance, sensing effort and ride feeling is based on testing the bikes. The cell relating to ruggedness needs confidential data, which is difficult to obtain, Even without this confidential data, we could find important DNAs.

Table-3: DNA codes for motorcycles

Company	DNA Code				Details
Hero (Formerly Hero Honda)	0	0H/H0000 0 0 0000	HL/H	0	Color-High value and high saturation.High unity for single cylinder commuter bikes (2-3) and dynamism consistent with character (I for loww cc and 3 for above 150 cc sporty bikes)
	0	0	0	0	
	0	0	0	0	
Bajaj	0	0	0	0	
	0	0	0	0	
	0	0	0	0	
TVS	0	0	0	0	
	0	0	0	0	
	0	0	0	0	
Yamaha	0	0	0	0	Link type rr suspension
	0	0	0	0	
	000D00	0	0	0	
Royal Enfield	AAA0A0	000060 EEECE0	0000H0	000H	Minimalist bare construction for single cylinder engine with single surface fuel tank, spoke wheel and round head light.The gun logo and unique color , location and shape combination for branding.High vertical imbalance for single cylinder engine.High fluctuation sound for a single cylinder engine. Highest torque for a single cylinder engine at lowest torque.
	0	0	0	0	
	0	0H	0	0	
Ducati	0	000 999 H/H0000 900 0 0 0000	000HH	0	Red-black-white body color combination without stripes and with red colored frame.High vertical imbalance with high horizontal imbalance.Trellis frame with single side swingarm and L-twin engine arrangement
	0	0	0	0	
	00H00B	0	0	0	
Harley Davidson	AAA0A0	000000 00000D	0	000H	Multi-cylinder ngine bare construction, single surface fuel tank, large wide tyres and round head light. Logo at head light centre. Unique fluctuation pattern.High θ1 and low θ2. Large rake angle with high Rn.Belt final drive and V-twin engine arrangement.Very high torque at lowest rpm
	0	HL0000	000HHH	0	
	I/J000C	HL	0	0	

Fig-5: Bikes from Ducati (left: Note the black, white and red color combination, high visual imbalance and trellis frame), Harley Davidson (Middle: Note the bare construction, single surface fuel tank and large rake) and Hero Honda (right: Note the high value high chroma colors and high unity)

5 CONCLUSIONS AND DISCUSSION

Encompassing the whole gamut of motorcycle design into a single matrix necessitates some simplification, assumptions and generalizations and this study is not an exception. Moreover any study of motorcycle DNA cannot be complete without access to confidential data of manufacturers. Despite these constraints and limitations, as we can see, the DNA code represents the manufacturer's basic traits fairly well. Moreover, some observations provide very good clues. For example, it is easier for niche companies like Harley Davidson, Ducati and Royal Enfield to maintain a strong DNA code. Mainstream companies producing whole range of bikes like Yamaha and Bajaj find it difficult to maintain a strong DNA covering all motorcycles. I for one personally believe that this should not be the case because DNAs are not so much about specification but the correlation between specifications. One case in point is Hero Motocorp, which despite being a mainstream company has been able to maintain its DNA for color scheme, unity and dynamism. Moreover, instead of a company DNA, these manufacturers maintain DNA for product-lines, as we have seen in case of Honda. On the other hand, it is easier to maintain a common signature like Harley having its signature exhaust sound.

An unfortunate part of this study has been its inability to decode the design ruggedness. This has two important aspects. Design ruggedness is a product of hard engineering parameters like choice of materials, surface and heat treatments, dimensional relationships like fits, clearances and kinematics, safety factors and tolerances. All this makes the data needed for decoding ruggedness to be very huge- too huge to put in a small matrix. More importantly, as we have already discussed, all this data is confidential and so is impossible to compare. Still this provides an important insight for manufacturers and practicing designers. Design ruggedness is an area, where the manufacturer can define their own DNA and maintain throughout their range of products without affecting the diversity.

There is one more revelation about the DNA which has not been covered. DNAs can proliferate and travel across companies. In this age of international acquisitions, mergers and joint ventures, this has become a very frequent phenomenon. Honda, having joint ventures in India and Brazil can have similar products with similar architecture and ruggedness code. After the joint ventures expire (as as been the case with Honda in India), the two companies can share the same DNA. Moreover, as the motorcycle design gets diversified into many categories and niche segmentations like off-roaders and café-racers, the same makers are developing multiple DNAs and signatures. This becomes essential to overcome the difficulty faced by mainstream manufacturers as they diversify.

Finally we come to the basic question, where we started- the relationship between design signature and design DNA. By now, we have a very clear idea about the basic traits of both. The design signature is about the cognitive aspect of a bike like an iconic logo or a specific color scheme. Whereas, DNA is he

basic trait of the building blocks- the intrinsic character of design. Important to note here is the fact that despite this distinction, the signature remains a subset of the DNA. This makes the relationship intriguing and interesting like the two rail lines- always separate but always together.

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APPENNDIX

DNA Codes

Form

	1	2	3	4	5
	Body Style	**Fuel Tank**	**Seat**	**Front Facia**	**Wheels**
A	Minimalist Bare Essentials	Single side surface with slow curvature	Single Straight	Only round head light	Small narrow tyres with spoke
B	Stylish extension of A with rear cowl and visor	Single side surface with fast curvature	Single inclined	Only rectangular head light	B. Big narrow tyres with spoke
C	Fuel Tank , side cover and rear cowl in unified flow	Mild negative space with sharp character lines	Single curved	Only trapezoidal head light	Big wide tyres with spoke
D	Multi cylinder bare engine with bare frame	Mild negative space with generous character lines	Straight +mild curve	Round head light + visor	Small wide tyres with spoke
E	Full cowl body	Deep negative space with sharp character lines	Inclined +mild curve	Rectangular head light + visor	Small narrow tyreswith cast rim
F		Deep negative space with generous character lines	Straight + deep curve	Trapezoidal head light + visor	Big narrow tyres with cast rim
G		Positive curves with sharp character lines	Inclined + deep curve	Round head light + visor and windshield	Big wide tyres with cast rim
J			Mild step (Straight +straight)	Rectangular head light + visor and windshield	Small wide tyres with cast rim
K			Mild step (Straight +Inclined)	Trapezoidal head light + visor and windshield	
L			Steep step (Straight +straight)	Twin head light with visor and wind shield	
M			Steep step (Straight +Inclined)		
N			Single seater		

Color

	Hue	**Value, Chroma**	**Body Texture**	**Engine Texture**	**Stripe Style**	**Stripe color**
	R (0-9),G(0-9), B(0-9)	L/M/H, L/M/H	A. Glossy	A. Glossy	1. No sripe	R (0-9),G(0-9), B(0-9)
			B. Plain	B. Plain	2. Unified	
				C.Rough	3. Linear	
					4. Spiral	
					5.Random	
					6.Theme	

Branding

	Product Name		Company Name		Logo	
	Typography	Location/type	Typography	Location/type	Theme	Location
A	San Serif	Fuel Tank, Stripe	San Serif	Fuel Tank, Stripe	Alphabet	Fuel Tank
B	Square Serif	Fuel Tank, Emblem	Square Serif	Fuel Tank, Emblem	Animal	Side Cover
C	Roman Old Style	Side Cover, Stripe	Roman Old Style	Side Cover, Stripe	Any Other	Visor
D	Cursive	Side Cover, Emblem	Cursive	Side Cover, Emblem		Head Light
E	Other	Other	Other	Other		Other

Dynamism, Unity, Balance

	Visual Dynamism	L/H	Unity	Horizontal Imbalance	Vertical Imbalance
L	Low	Low	Low	Low	Low
M	Medium	Medium	Medium	Medium	Medium
H	High	High	High	High	High

Sound

	Loudness	Sharpness	Fluctuation
L	Low	Low	Low
M	Medium	Medium	Medium
H	High	High	High

Performance

	Speed	Acceleration
L	Low	Low
M	Medium	Medium
H	High	High

Ergonomics

	θ_1	θ_2	θ_3	θ_4	h_1	h_2
L	Low	Low	Low	Low	Low	Low
M	Medium	Medium	Medium	Medium	Medium	Medium
H	High	High	High	High	High	High

Drivability

	Ride Feeling			Steering geometry		
	Vibration	Cushioning	Braking	Rake Angle	Wheel Base	R_n
L	Low	Low	Low	Low	Low	Low
M	Medium	Medium	Medium	Medium	Medium	Medium
H	High	High	High	High	High	High

Sensing Effort

	Switches	Pedals	Hand Levers
Effort	1:Worst, 5:Best	1:Worst, 5:Best	1:Worst, 5:Best
Smoothness	1:Worst, 5:Best	1:Worst, 5:Best	1:Worst, 5:Best
Clarity	1:Worst, 5:Best	1:Worst, 5:Best	1:Worst, 5:Best

Engineering Architecture

	Engine					
	Cylinders (CC,No, Arrangement,Cooling)	Spark/Valves	Frame	Suspension	Brakes	Drive/Swingarm
A	<125, 1, Horizontal,A	Single/2	Double Cradle (Fe)	Fr-telescopic, Rr-Hydraulic	Fr-Drum Rr-Drum	Chain-2 side steel
B	<125, 1, Vertical,A	Twin/2	Single Down Tube (Fe)	Fr-telescopic, Rr-GRS	Fr-Disc Rr-Drum	Chain-1 side Al
C	<150, 1, Vertical,A	Single/4	Diamond(Fe)	Fr-telescopic, Rr-Mono	Fr-Disc Rr-Disc	Belt-2 side steel
D	<150, 1, Vertical,L	Double/4	Delta box(Fe)	Fr-telescopic, Rr-Link type	Fr-Dual Disc Rr-Disc	Belt-1 side Al
E	<250, 1, Vertical,A		Trellis (Fe)	Any other	Any other	Belt-2 side Al
F	<500, 1, Vertical,A		Double Cradle (Al)			Any other
G	<500, 2, Vertical,A		Diamond(Al)			
H	<1000, 2, Vertical,A		Trellis (Al)			
I	<1000, 2, Vertical,L		Any other			
J	<1000, 4, V-twin,A					
K	>1000, 2, V-twin,A					
L	>1000, 4, V-twin,A					
M	>1000, 4, V-twin,L					
N	>1000, 4, L-twin,L					

Engineering Output

	Peak Torque/100 cc	Peak torque rpm
L	Low	Low
M	Medium	Medium
H	High	High

Ruggedness

	Tolerancing	Rust Resistance	Design Life
L	Liberal	Low	Low
M	Medium	Medium	Medium
S	Close	High	High