Spatial Disorientation in Military Aviation

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What is Spatial Disorientation?

- SD occurs when
  - "the aviator fails to sense correctly the position, motion, or attitude of his aircraft or of himself within the fixed coordinate system provided by the surface of the earth and the gravitational vertical."
- This includes
  - "the erroneous perception of the aviator's own position, motion, or attitude to his aircraft, or of his aircraft relative to another aircraft."

Why do aviators become disoriented?

…and other misconceptions

Inexperience

Easily overcome by getting on instruments

Night Vision Devices (NVDs)

Vision-related

Rarely Occurs

IMC

Low time in cockpit

Previous Mishap Research

Gillingham, K.K. (1992). The spatial disorientation problem in the United States Air Force. *Journal of Vestibular Research, 2*: 297 - 306.

	Total	Operations related	SD related	LSA related	SD/LSA related
Mishaps	633	356	81	263	270
Fatalities	795	515	115	425	437
Cost (US$)	4,452M	2,558M	539M	2,012M	2,045M

Bellenkes, A. et al. (1992). Spatial disorientation in Naval aviation mishaps: A review of class A incidents from 1980 - 1989. *Aviation, Space, and Environmental Medicine, 63*: 128 - 131.

	All mishaps	Helo	Prop	Jet
# SD mishaps	33	11	1	21
Fatalities	37	28	0	9
Fatalities/mishap	1.12	2.55	0.00	0.43
Mean flight hours	1458.6	1945.2	1164.0	1266.6

Braithwaite, M.G. et al. (1998). Spatial disorientation in U.S. Army rotary-wing operations. *Aviation, Space, and Environmental Medicine, 69*: 1031 - 1037.

Factor	SD Accidents	Non-SD Accidents
Total number of accidents	299	694
% of all accidents	30.8	69.2
% of class A accidents	36	18
Total cost of accidents	$46.79 million	$49.95 million
Average cost per accident	$1.62 million	$0.74 million
Total lives lost	110	93
Average lives lost per accident	0.38	0.14
Mean height above ground at emer.	65 ft	455 ft
Mean airspeed at time of emergency	28 knots	44 knots

Naval Safety Center: FY90 - FY96

Aircraft	SD	Total aircraft	Fatalities	Cost
All aircraft	58	64	88	$956.93 M
Tacair	32	37	26	$778.57 M
Rotary	23	23	30	$88.02 M
Fixed Wing/ non-ejection	3	4	32	$90.34 M

NAMRL Mishap Research

- **Mishap review**
  - **US Navy and Marine Corps**
  - **Class A flight Mishaps**
  - **Fiscal Years 90 through 98**
    - **392 mishaps (USN-248; USMC-146)**
- **Methods**
  - **Braithwaite et al. SD categorization**

Categorization of the Spatial Disorientation Accident

Category	Definition
1	SD was the "major" component of the accident sequence (all other contributory factors would normally have been overcome without mishap)
2	SD was a "subsidiary" component of the accident sequence (other contributory factors would have led to a mishap in any case, but SD made the accident sequence more difficult to deal with or the outcome more severe)
3	SD was an "incidental" component (SD occurred but did not affect the outcome)
4	SD did not occur
5	The role of SD was unknown

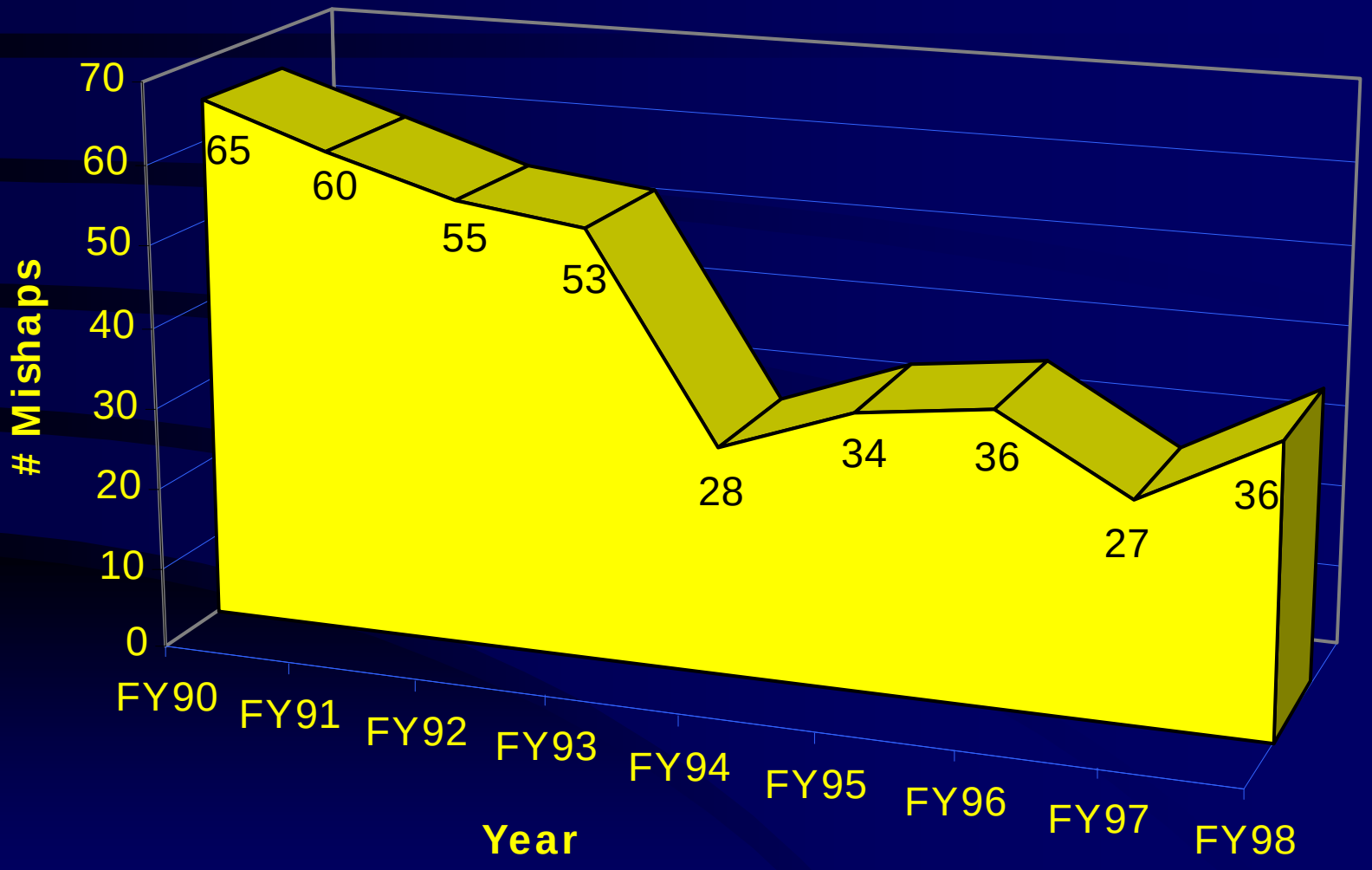
Naval Safety Center Reports: FY90 - FY98

	SD mishaps	Non-SD mishaps
# mishaps	51	341
% of total mishaps	13%	87%
Fatalities	104	267
Fatalities/mishap	2.04	0.78
Mean flight hours	1730.25	1606.78
Mean hours in type	662.8	742.91
NVG's in use	8	22

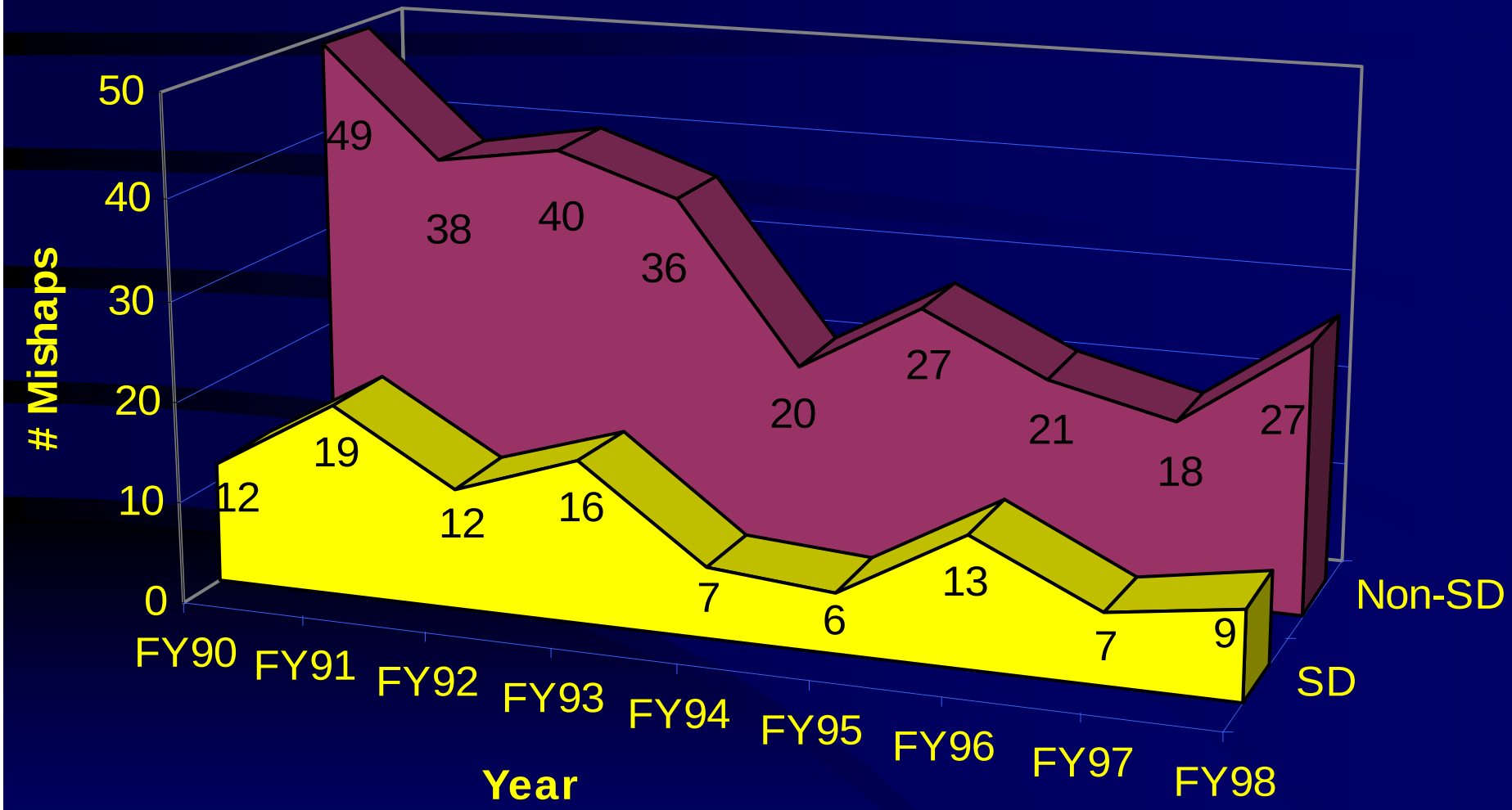
Mishaps (SD & Non-SD) per Year

	Total	USN	USMC
FY90	65	38	27
FY91	60	39	21
FY92	55	38	17
FY93	53	34	19
FY94	28	17	11
FY95	34	21	13
FY96	36	21	15
FY97	27	15	12
FY98	36	25	12

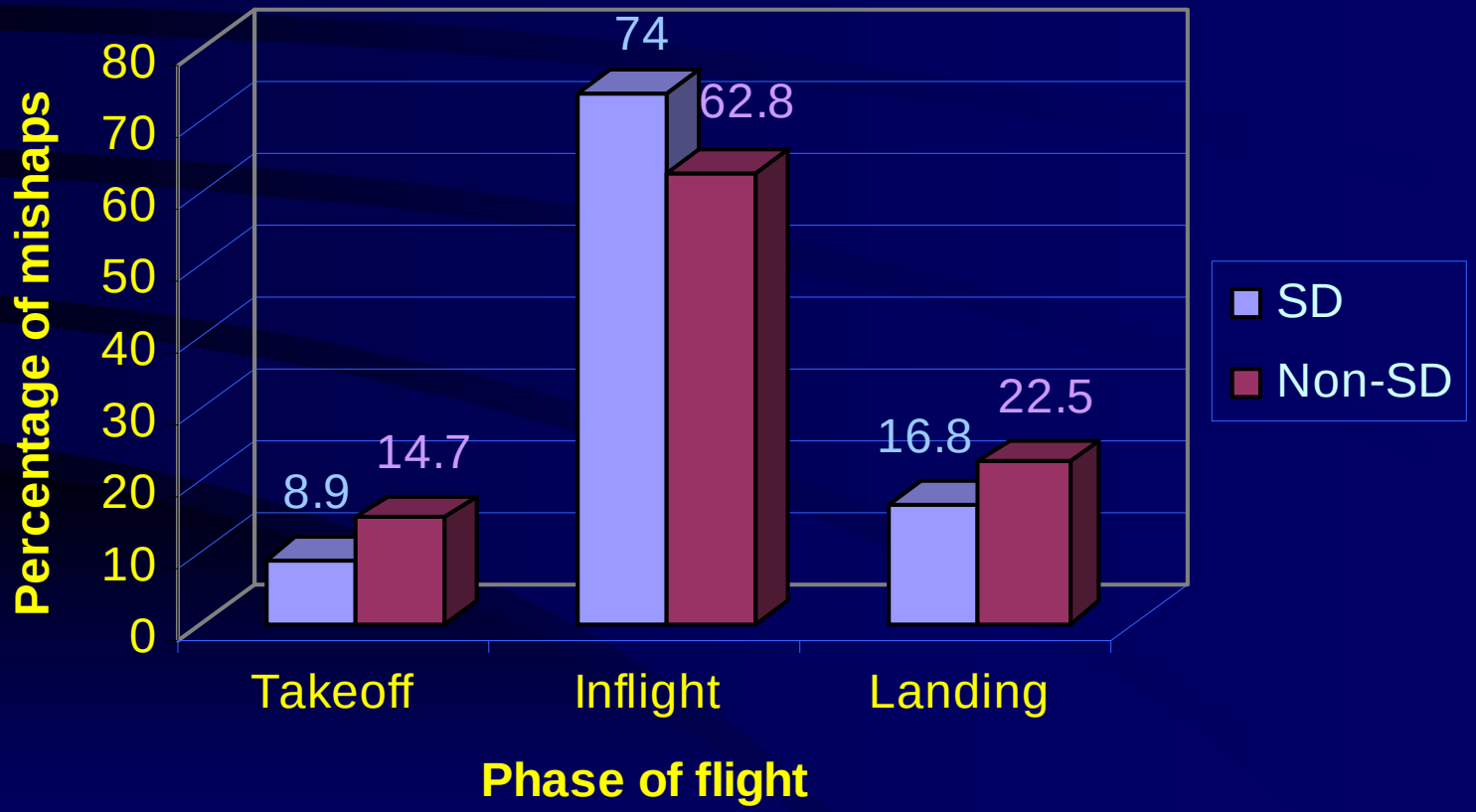
Class A Mishaps: FY90 - FY98



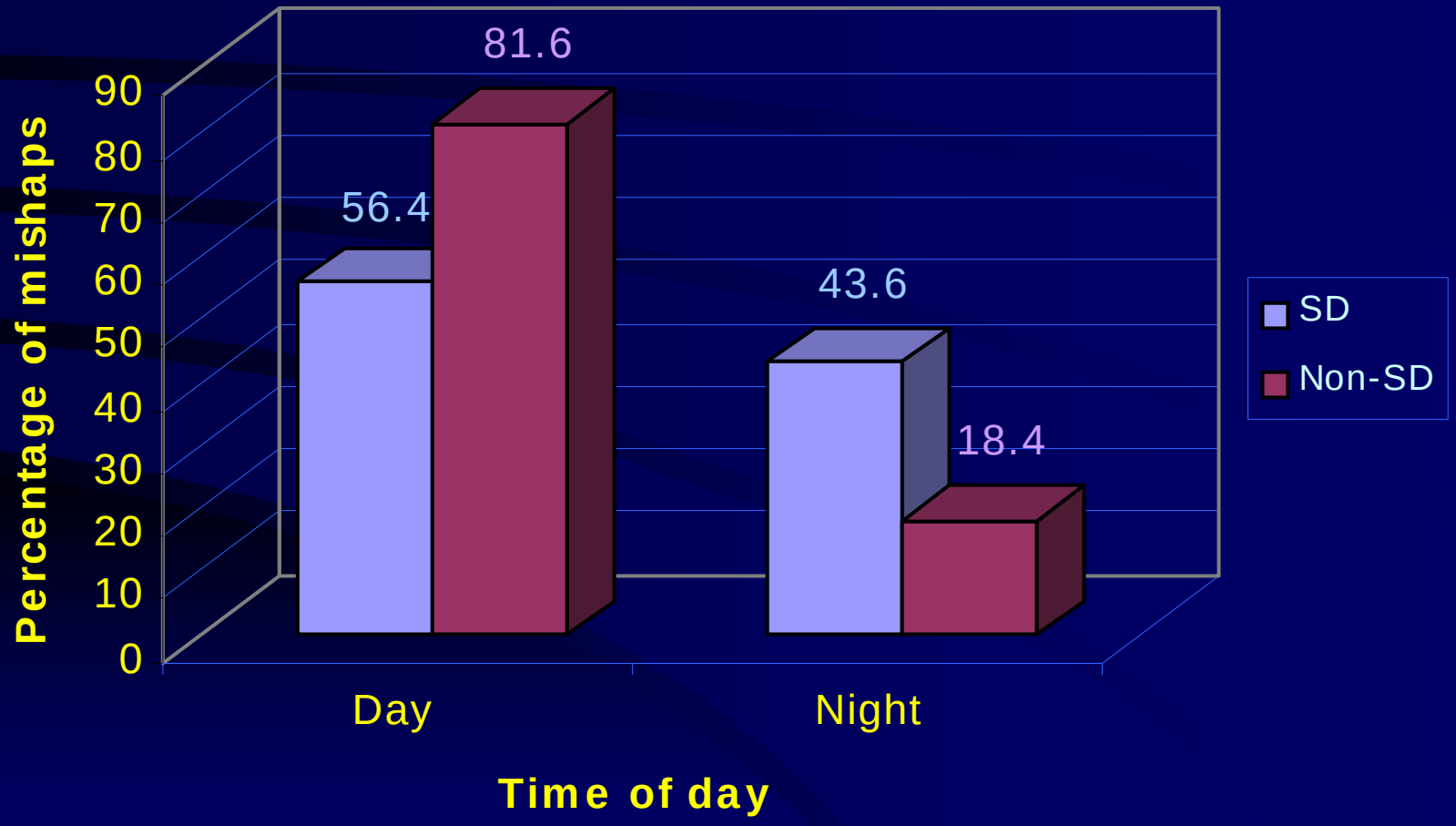
Spatial Disorientation (SD) vs. Non-SD Mishaps



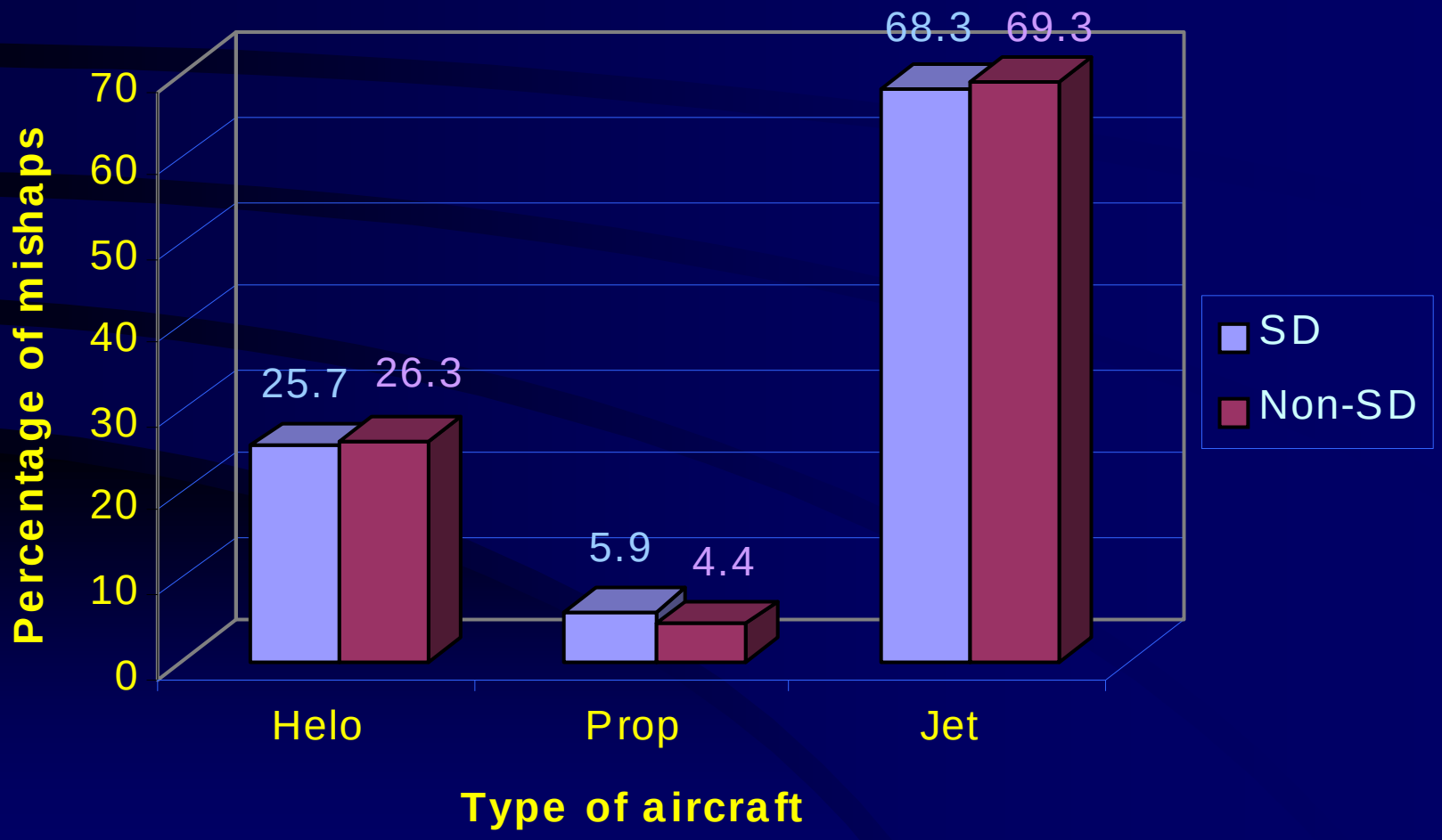
SD vs. Non-SD mishaps: Phase of flight



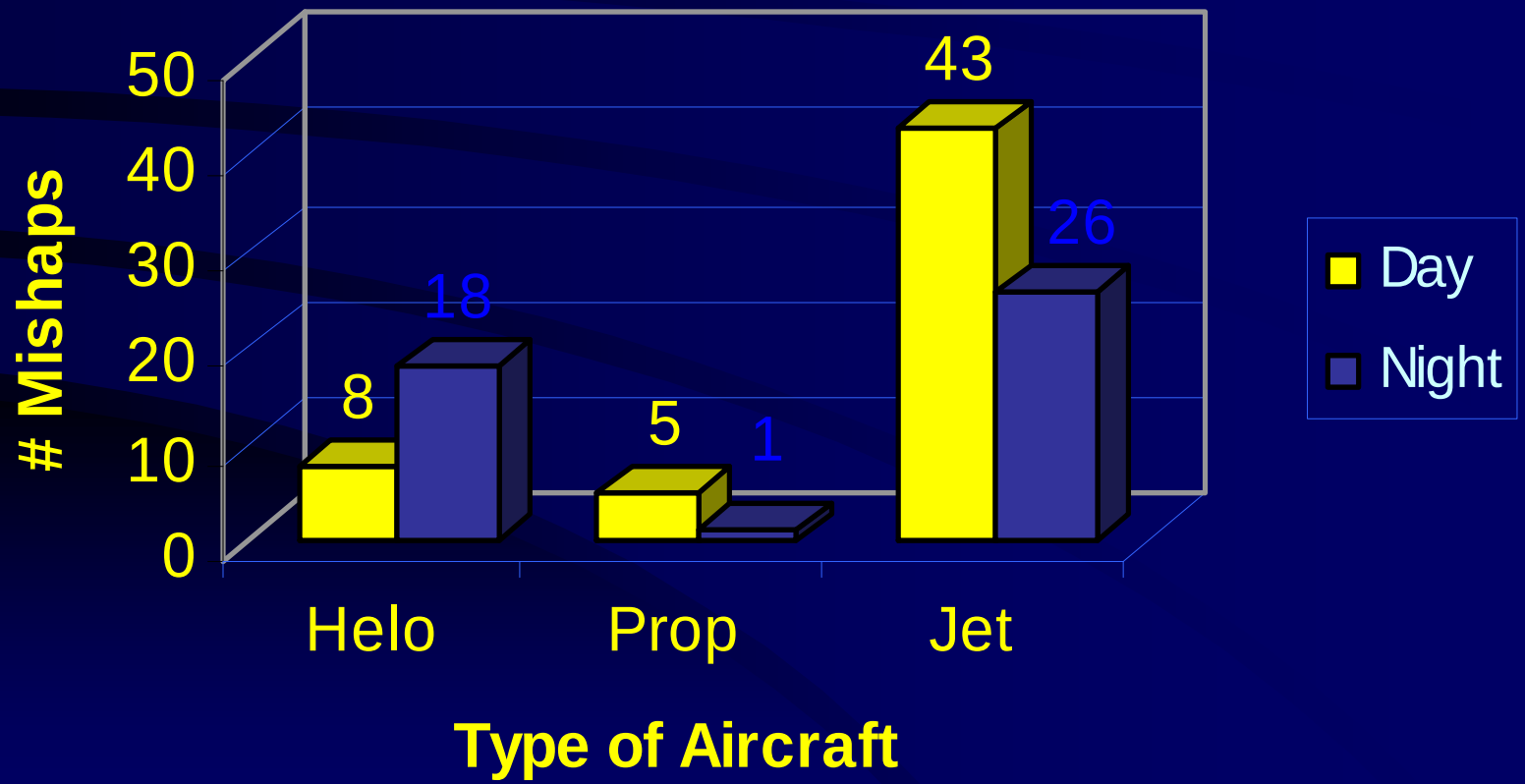
SD vs. Non-SD Mishaps: Time of day



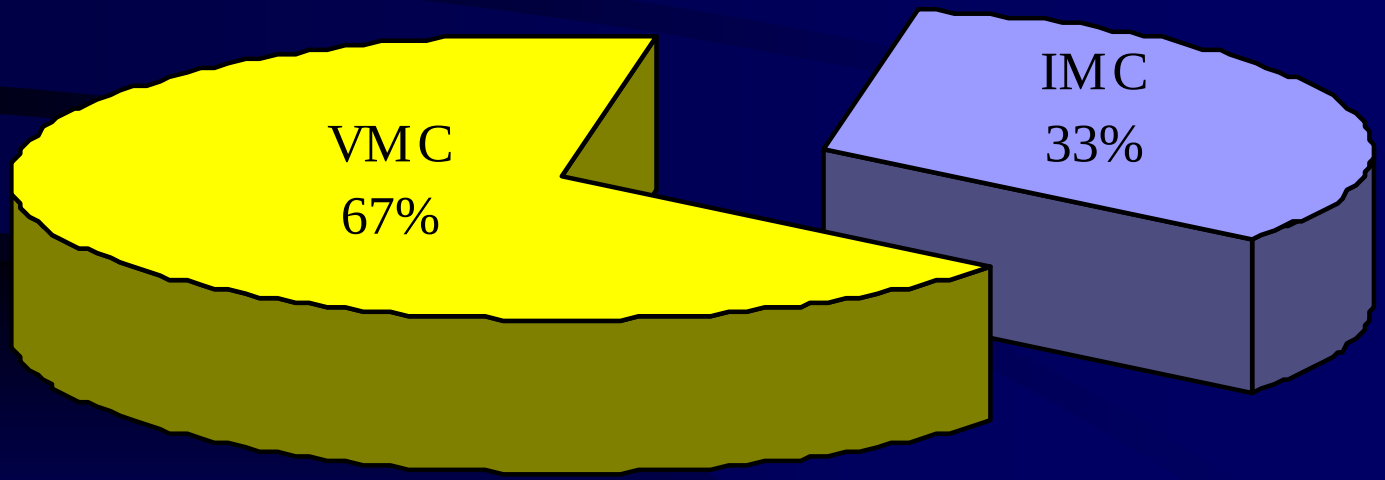
SD vs. Non-SD Mishaps: Type of aircraft



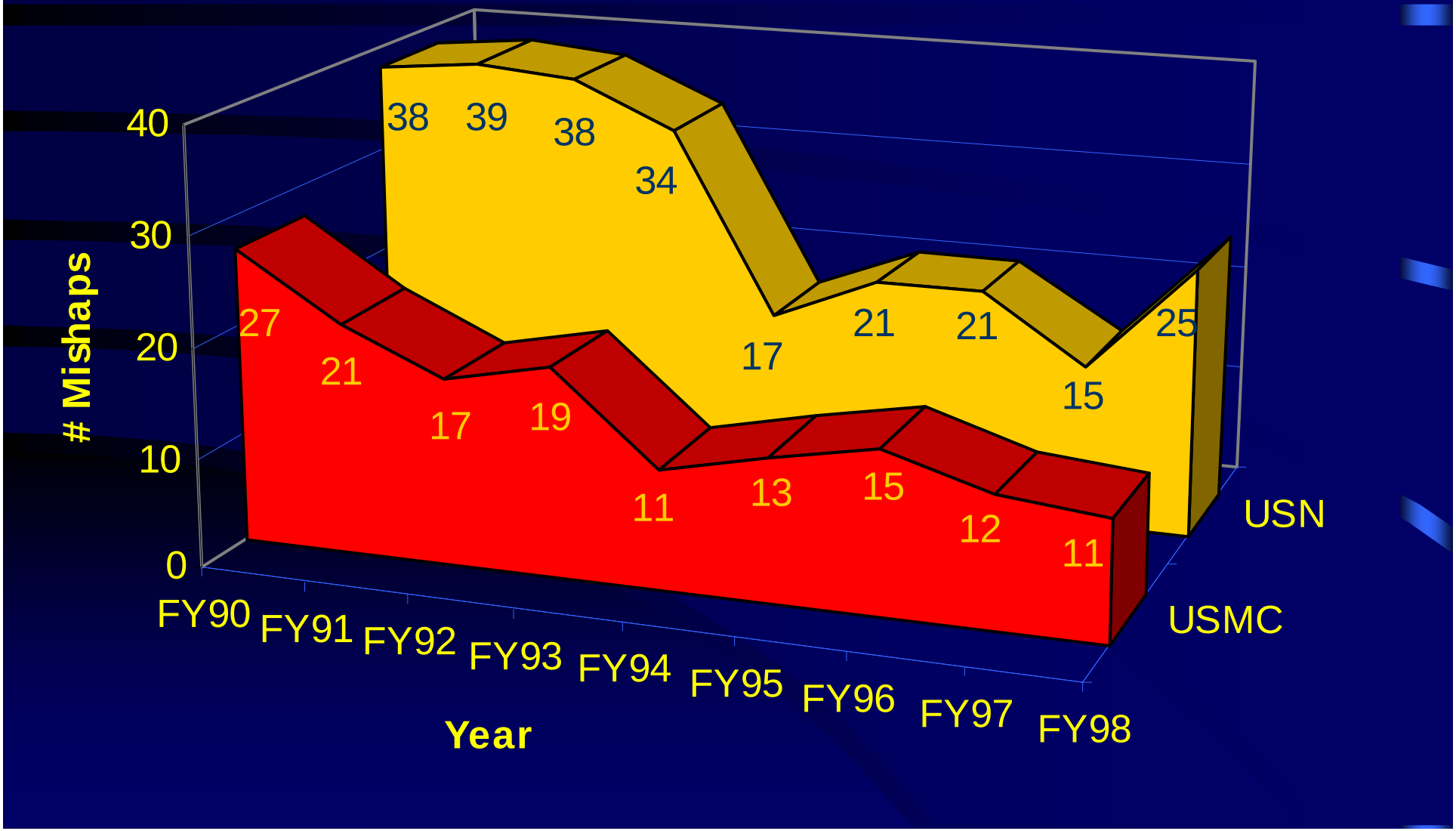
SD mishaps: Aircraft type and time of day



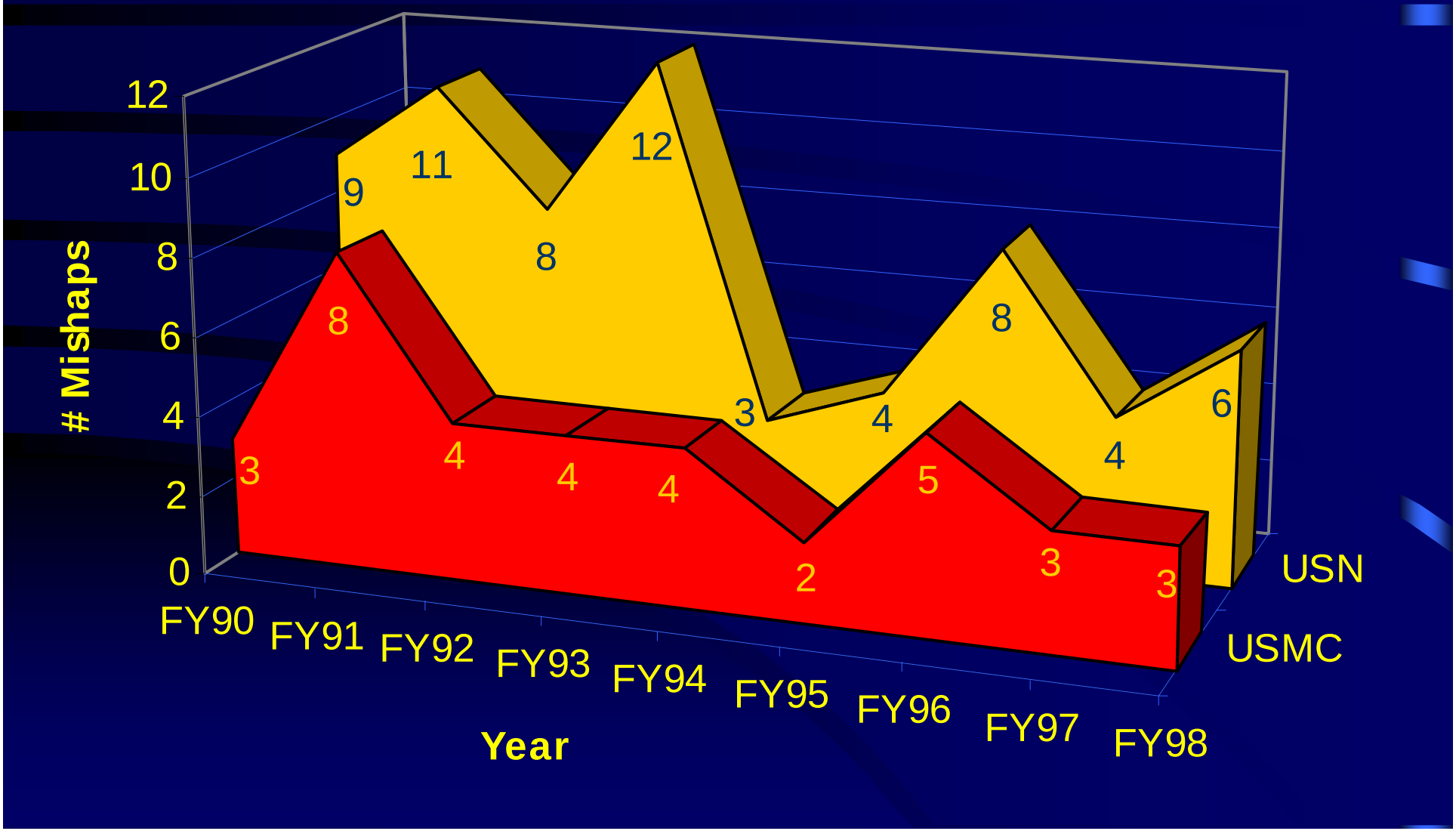
Meteorological Conditions for All SD Mishaps



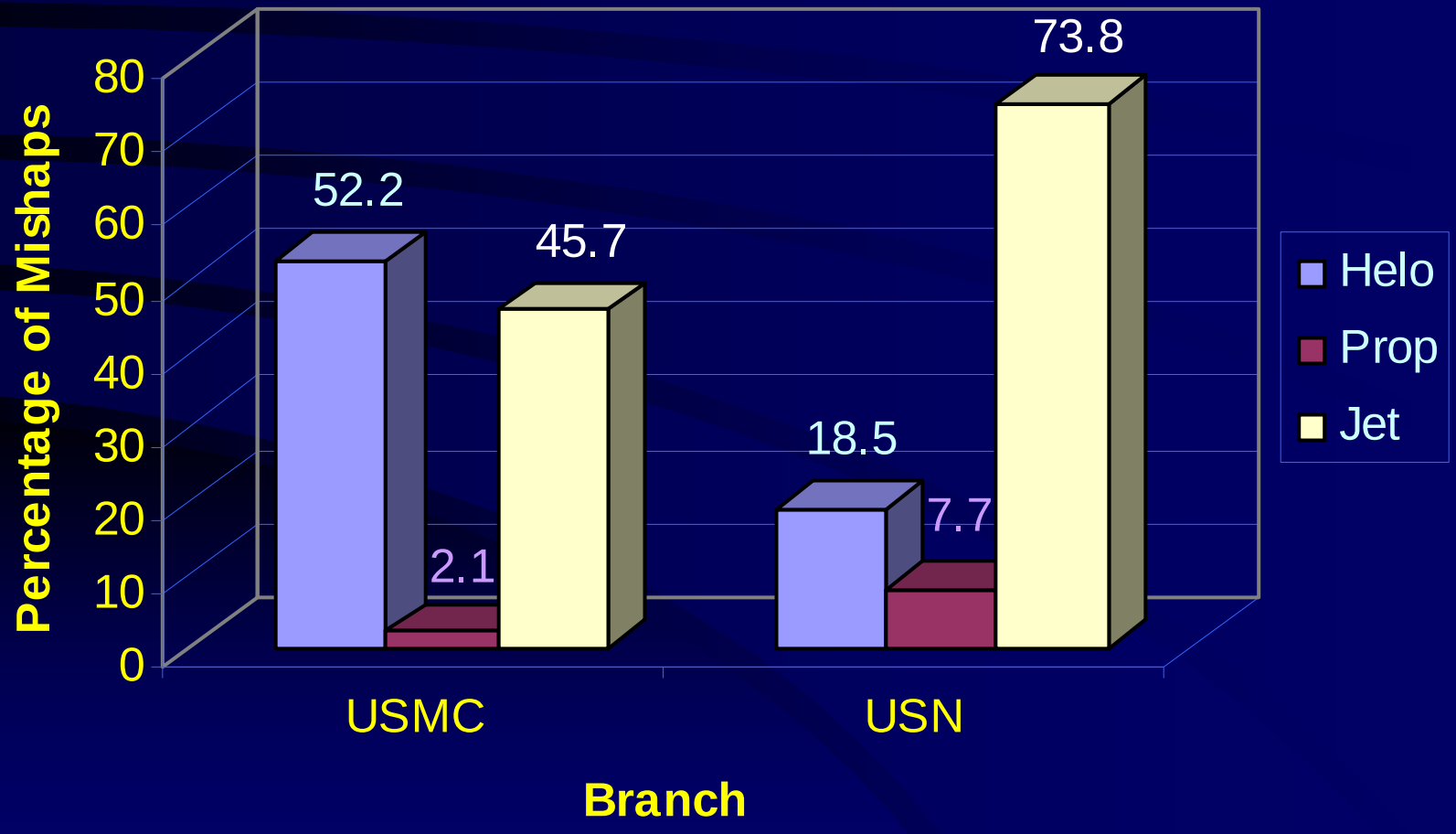
USN and USMC Mishaps: FY90 - FY98



Spatial Disorientation Mishaps: USN vs. USMC



SD mishaps in the Navy and Marine Corps: Type of aircraft



Overall Findings

Factor	SD	Non-SD
# mishaps	101	276
% Mishaps	26	70
Total Lives	172	168
Avg lives/Acc	1.70	0.61
Mean flight hours	1690.3	1494.9
Mean hours in type	686.1	611.2
NVG's in use	20	10

Conclusions

- Spatial disorientation plays a larger part in military aviation mishaps than previously indicated
- Mishaps due to spatial disorientation claim nearly three times more lives than non-SD mishaps
- Pilots-at-controls are often very experienced aviators
- The influence of Night Vision Devices appears to be under reported in aviation mishaps.
  - Further research into training methods and HUD symbology may be warranted

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