CathCAD® THE SOFTWARE FOR DEVELOPING YOUR NEXT MICROCATHETER

CathCAD® is the software solution that allows the User to analyze and predict the mechanical characteristics of microcatheters. The Software is based (in part) on the engineering fundamentals summarized in the article, Design Considerations in Small-Diameter Medical Tubing, which was the January, 2001 Cover Story in Medical Device & amp; Diagnostic Industry (MDDI) magazine.

The computational algorithms are based on the following models and/or data sources:

- Mechanics of Materials
- Composite Laminate Theory
- The Tube Buckling (kink radius) computations are based on the model developed by Brazier
- Vendor material data sheets are used for loading material properties for standard materials used in medical catheter products.
- The software computational engine is NOT based on empirical or tabulated measurement data.

As of 2022 our customer base consists of over eighty medical device firms with over 300+ licensed users. Since the software inception over 185,000 computational CathCAD models have been completed by our licensed users.

The Software was mentioned in a peer reviewed journal publication: Computer Assisted Surgery is an open access journal that aims to improve patient care by publishing research which advances the use of computers during surgical treatment. The CathCAD® software was utilized by researchers in designing a sensorized guiding catheter Authors: Roberta



Piazza, Sara Condino, Aldo Alberti, Raffaella Nice

						<u>م الحجم الم الم</u>						
ML CathCAD® V2.1.	.2 FULL ML											
STATUS BAR											STIFFNES	S MODEL
WAITING: Plea	se enter the l	MultiLume	n Tubing Design								CIMAL	UPD
	CONFIGURATI	ON			PROJE	CT DESIGNS					ORIO	1
Number of Lay	yers	3	IDx (inches)	.0399	6	-	SA	VE				
Overall OD (in	nches)	0.05700	IDy (inches)	.0376	8							
	GURATION										DEFLECTIO	
Base ML	MultiLumen (Designer	MultiLumen Matl		lxx (in^4)	lyy (in^4)	Jzz (inʻ	14) Area (i	n^2)	ML OD (inches)	Equiv W	all (inch)
Layer 1: D	ouble D ML	•	PEBAX 7233 SA01	•	1.8155E-7	2.078E-7	3.8935	E-7 9.0686	E-4	0.05000	0.00502	0.00616
Secondary Co	onfiguration	Thickness (inches)	Layer Material		Braid Wire	Size		# of Wires		Pick Count	Wire Angle	Surface Area Cov
Layer 2: B	raid 💌	0.00200	PEBAX 7233 SA01	•	1 mil rd SS 3	304V ST	•	16 BW	•	80.0	58.53	0.179
Layer 3:	onBraid 💌	0.00150	PEBAX 7233 SA01	•								
MODEL OUTPU	л											MOUTE
Elxx (lbf-in**2	2)	0.04242	KR x-axis (inches)	0.1	98 / 0.269						0	WPUTE
Elyy (lbf-in**2	2)	0.04359	KR y-axis (inches)	0.1	58 / 0.263						1	
EA (lbf)		161.41	Tensile (lbf)		2.02 / 8.70			E	XPO	RT TO EXCEL	B	
GJzz (lbf-in**)	2)	0 07203	Torque (lbf-inch)	1	0.0505			2				

min Applied Force App	lied Mon	nent									
STATUS BAR						PROJECT DESIGN	vs		[and the second se	PPD
WAITING: Please er	ter the	Composite	ubing Design into th	e Software		RT100140-05 0.0	0320x0	.0398	•		an
DIMENSIONS						SEGMENT ASSIG	NMEN	T			
Tubing ID (inches) 0.032		Tubing OD (inches) 0.0398			1 2 3	5			•		
Number of Layers	Γ	1	Bend Radius (in	ches) 2.000						DEFIECTION	MODE
LAYER CONFIGURAT	IONS					Num of Num		Numer		VIII	NODE
Layer # Design		Thickness (inches)	Layer Material	Braid/Coll Wire Size		CW CC	CW	Ends	PPI/WPI	Angle	SAC
Layer 1: NonBra	id 💌	0.00150	Polyimide	-							
Layer 2: Braid	•	0.00140	Polyimide	[0.7x5 mil SS 304V ST	•	8 BW • 8 BW		1 Strd 💌	60	40.62	0.70
Laver 3	id 💌	0.00100	Polyimide	-							
rayer 5. [Nonbig											
MODEL OUTPUT											
MODEL OUTPUT EI (Ibf-inch**2)		0.10690	Ext Press (psi)	748						COMF	PUTE
MODEL OUTPUT EI (lbf-inch**2) EA (lbf)		0.10690	Ext Press (psi) Kink Radius (inch)	748 0.506 / 0.279						COMP	UTE
MODEL OUTPUT EI (lbf-inch**2) EA (lbf) GJ (lbf-inch**2)		0.10690 655.81 0.19730	Ext Press (psi) Kink Radius (inch) X_ID/Y_ID (inch)	748 0.506 / 0.279 0.0323 0.0317		FUSEDOWI	N	EXPORT	TO EXCEL	COMP PICK C MAR	OUNT





Software License includes three variants: CathCAD® Standard. CathCAD® Advanced, and MultiLumen CathCAD®

Roth Technologies

Address: 14111 Bluff Grove Dr, San Antonio, TX 78216 Phone: 210-380-9890 Email: sales@cathcad.com Website: www.cathcad.com

CathCAD® THE SOFTWARE FOR DEVELOPING YOUR NEXT MICROCATHETER

Independent comparison of the Software's outputs to actual device measured properties is typically within 25 percent for flexural, longitudinal, and torsional rigidities.This table summarizes a braiding comparison to

Design		Kink Radius		F	lexural Modulu	IS		Shear Modulus	lulus	
Braid Pattern	CathCAD (in)	Measured (in)	Percent Error (%)	CathCAD (ksi)	Measured (ksi)	Percent Error (%)	CathCAD (ksi)	Measured (ksi)	Percent Error (%)	
1u1o1		0.460	2%		44.71	3%		157.80	2%	
1u2o2	0.451	0.470	4%	46.05	46.61	1%	160.48	163.90	2%	
2u2o2		0.440	2%		46.36	2%		100.30	37%	

the Software for a 7Fr guide catheter.



The Software assumes "small deflections" and the results from elongation testing and/or three point bending of physical samples may be directly correlated to the Software outputs.

MODEL RUN ID	UNITS	RT 100147-01		
i0	inches	0.0320		
00	inches	0.0390		
TOTAL WALL	NA	3.9 mils		
	Layer 1	1.5 mils Polyimide		
COMPOSITE LAYERED DESIGN Layer 1 = Inside Layer BB = Breid Angle SBC = Sector State Concerns	Layer 2	Braid: 0.7x5 mil 55.304V ST, 8V/8W, 60 PPI, BA-40.6 DEG, SAC=70.9%, BM = Polyimide 1.0 mills Polyimide		
BM = Braid Matrix Material	Laver 4	RIA.	 2	
	Lavar 5	RUA.		
	Loverfi	11/4		
CathCAD(R) Outputs				
E OMPOSTE MODULUS OF ELASTICITY	PSI	1,490,961		
G COMPOSITE SHEAR MODULUS	PSI.	1,375,912		
B FLEXURAL RIGIDITY	bf-indh#2	0.10690		
EA LONGITUDINAL RIGIDITY	10F	605.81		
TORSIONAL RIGIDITY	bf-indh**2	0.19730		
KINKMATL FAILURE RADIUS	inches	0.506 / 0.279		
BEND RADIUS (X_DIM, Y_DIM) @ BEND RADIUS	inches inches	2.000 (0.0323/0.0317)		
TEN SHE STRENGTH		8 198 / 24 245		1
EST MATED YIELD TORQUE	Ibf-inch	0.19629		
INTERNAL PRESSURE	PSI	1.015/3.320		
EXTERNAL PRE SSURE	PS	748	 	
BUCKI BO FORCE @1 + 120 mmh	-	6.490	-	

The Software outputs are seamlessly exported to Microsoft Excel in a "ready to print" format

Y = MINOR AXES



The Pick Count Maco allows the User to look at the design property outputs as a function of a range of braid angles in graphical form



The Matrix Material Bend function allows the User to create a custom blend of two materials by volumetric percentages The Ovalization function allows the User to review the design's ovalized dimensions as a funtion of bend radius

X = MAJOR AXIS DIMENSION

PERCENTAGE DECREASE IN LUMEN SIZE

12 18

Catheter Bend Radius (mm)

WAITING: Select and view applicable graphs. Select EXPORT to Export to Excel. Select RETURN to EX

CathCAD® Lumen Ovalization EXPORT RETURN HELP

MAJOR DIAMETER DIMENSION

Catheter Bend Radius (mm

12 1.5.8 - 24

Cathieter Bend Radius (mm)

MINOR DIAMETER DIMENSION

STATUS BAR



The Fuse-down Designer allows the User to compute the expected dimensions of the design obtained during the lamination manufacturing process.

CathCAG	08 Deflect	on Model							-12
STATUS WAITIN	BAR IG: Pleas	e enter an up	dated applied	force (lbf) and/or Individual segmen	t lengths as	applicable			
Applied	Force (II	of) (p.or	893 Longitud	Inal Force that is applied to the comp	osite tube	т	otal Deflect	ion (inches)	0.069186
Seg #	Enable	ID (inches)	OD (inches)	Segment Design	Length (inches)	EA (Ibf)	Stiffness (Ibf/inch)	Deflection (inch)	Strain (inch/inch)
				0.75 mils PTFE Film Cast/ Braid: 1 mil rd SS 304V ST, 8W/8W, 80 PPI,		-			
1	1 🖻	0.03000 0.03710	8A=46.5 DEG, SAC=20.9%, BM = VESTAMID CARE ML21/ 0.8 mils VESTAMID CARE ML21	36.00	136.91	3.803	0.023474	0.00065	
				0.75 milis PTFE Film Cast/ Braid: 1 mil rd SS 304V ST, 8W/8W, 80 PPI,					
2	P	0.03000	0.03710	BA=46.5 DEG, SAC=20.9%, BM = PEBAX 7233 SA01/ 0.8 mils PEBAX 7233 SA01	3.00	55.63	18.544	0.004814	0.00160
				0.75 mils PTFE Film Cast/ Braid: 1 mil rd 55 304V ST, 8W/8W, 80 PPI,					
3	4	0.03000	0.03710	BA=46.5 DEG, SAC=20.9%, BM = PEBAX 6333 SA01/ 0.3 mils PEBAX 6333 SA01	3.00	34.02	11.341	0.007872	0.002624
				0.75 mils PTFE Film Cast/ Braid: 1 mil rd SS 304V ST, 8W/8W, 80 PPI,					
4	.F	0.03000	0.03710	BA=46.5 DEG, SAC=20.9%, BM = PEBAX 4033 SA01/ 0.8 mils PEBAX 4033 SA01	3.00	13.05	4.349	0.020526	0.006842
				0.75 mills PTFE Film Cast/ Braid: 1 mil rd SS 304V ST, 8W/8W, 80 PPI,					
5	12	0.03000	0.03710	BA=46.5 DEG, SAC=20.9%, BM = PEBAX 3533 SA01/ 0.8 mils PEBAX 3533 SA01	1.00	7.14	7.142	0.012500	0.012500

The Applied Force/Applied Torque modules allow the User to compute the expected strain or shear strain as a function of applied force or torque for a multisegmented design.

CathCAD® includes a comprehensive materials and braid wire database hosted on a MySQL server. The base materials library includes over sixty materials including Polyimide, PTFE, PFA, PEEK, FEP, ETFE, PeBax, Polyurethanes, Polyethylene (LDPE, MDPE, and HDPE), Grilamid, and Vestamid. The software will model Extrusion AND Film Cast materials as well as material combinations, that is, the software modelling capabilities are process independent.

CathCAD® is the SOFTWARE solution that allows the User to develop/define the construction parameters for the fabrication of composite tubing with the desired output mechanical properties.

- Construction parameters include materials and reinforcement wires (braid, coil, and/or reinforcement wires)
- Geometry includes ID, OD, and individual layer thicknesses
- Mechanical properties include flexural, axial/longitudinal, torsional rigidities and also include kink radius, tensile strength, and internal/external failure pressures.
- Supports the analysis of Single and Multilumen Designs
- The SOFTWARE includes a Fusedown Designer algorithm which may be used to precisely specify the design of the fuse down tube for braided composite tubing

Roth Technologies

Address: 14111 Bluff Grove Dr, San Antonio, TX 78216 Phone: 210-380-9890 Email: sales@cathcad.com Website: www.cathcad.com